PORTIONS OF THE *DIFFERENTIAL APTITUDE TESTS* AS A TOOL TO PREDICT STUDENT SUCCESS IN TECHNICAL MECHANICAL DRAFTING AND DESIGN CURRICULUM

A Thesis

Presented to

the Faculty of the Department of

Industrial and Technical Education

East Carolina University

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts in Industrial and Technical Education

by

James Arlen Horton

May 1969

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ABSTRACT

James Arlen Horton. PORTIONS OF THE DIFFERENTIAL APTITUDE TESTS AS A TOOL TO PREDICT SUCCESS IN TECHNICAL MECHANICAL DRAFTING AND DESIGN CURRICULUM. (Under the direction of Thomas J. Haigwood, Jr.) Department of Industrial and Technical Education, May 1969.

The purpose of this study is to determine the possible utility of two aptitude tests, i.e. the *Space Relations Test* and the *Mechanical Reasoning Test*, of the *Differential Aptitude Tests*, as predictors of success in the Mechanical Drafting and Design Curriculum at Lenoir County Community College.

Problem. The problem is to obtain an instrument or score that permits rapidly obtaining information concerning a student's ability to perform successfully in the field of Mechanical Drafting and Design. There is a potential danger of a student enrolling in an "Open Door" institution to enter into a program in which the student's interest foreshadows the student's ability. Reliable predictive information is necessary to identify properly problem students so that guidance procedures can be initiated to aid the student in selecting a program more suited to his basic skills and abilities.

Procedure. In October 1967, two aptitude tests, i.e. the *Space Relations Test* and the *Mechanical Reasoning Test* were administered to twenty-six first and second year Technical Mechanical Drafting and Design students at Lenoir County Community College. Additional data consisted of selected elements from the students' high school transcript, college entrance test - the *School and College Ability Test*,

and selected academic performance elements from the college transcript. All data were assigned to three classes. Class I Predictor Variables were made up of three sets of variables which are the raw scores of the School and College Ability Test, the Space Relations Test, and the Mechanical Reasoning Test. Class II Performance Variables consisted of grade averages in six areas - overall college average, English, mathematics, science, drafting, and machine shop. Class III Predictor Variables contained a set of six variables - overall high school average, English, mathematics, science, drafting, and machine shop.

Criteria for success and failure were established with a successful student considered to have a college average greater than 77.8 or not less than 75.0 if remaining in school under probational status. The relative measure of success was considered the student's overall college academic average.

All sets of data within the three classes were compared to the overall college average using the Spearman Rank Order Method. The Median Test with a Chi square analysis was used to obtain significance of difference between student success and failure ratio on three sets of variables - the Space Relations Test, high school average, and high school drafting.

Conclusions. Analyses of data indicate the following:

1. That the Space Relations Test was superior to the School and College Ability Test and the Mechanical Reasoning Test in correlations with student's college performance.

2. That the overall high school average and the high school drafting average was superior to other Class III Variables in correlations with college performance.

3. That a tentative cutoff score on the Space Relations Test of forty raw score points be considered the minimum for probable success in Technical Mechanical Drafting and Design.

ACKNOWLEDGMENT

Grateful acknowledgment is given to the administrators of Lenoir County Community College for permission to use student data that provides the basis of this thesis.

Further acknowledgment is given to Dr. Haigwood, Chairman of the Department of Industrial and Technical Education, East Carolina University, for the supervision, counsel, and encouragement given to me during the course of this study.

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CHAPTER I

INTRODUCTION TO THE PROBLEM

Need for the Study. In an open door institution, a student enrolls in programs largely by his own choice. For the past several years, under the open door policy, student choice has been the major factor considered for individuals entering the Mechanical Drafting and Design Curriculum at Lenoir County Community College.

A potential danger exists that a student will be unsuccessful if he enters any program where the entrance criterion is primarily based on a student's own interest. It is particularly important in the field of drafting that a student have necessary basic skills and ability in addition to interest if he is to be successful.

The hazard inherent in program selection by a student's choice is being studied by the administration and guidance counselors at Lenoir County Community College. Counselors have screened high school transcripts, conducted individual and group counseling periods, and administered a battery of entrance tests in order to gain enough information about the individual student to adequately provide useful guidance to students concerned about program selection.

Guidance based on the analysis of the results of a battery of tests in English, mathematics, and The Cooperative School and College Ability Test, together with a review of the student's high school transcript, is the method that has been used at Lenoir County Community College for the past three years. Even with the present method, approximately one-half of the students enrolled in the Mechanical

Drafting and Design Curriculum do not complete their degree. With an increase in the number of student applications for admission to drafting and design, less time will be available to screen transcripts in detail, to study results of administered entrance tests, and to determine adequately the potential problem areas of the student early enough in the term to suggest a transfer into a subject area in which he is qualified and will probably succeed. The Drafting and Design Department and the guidance counselors need a more adequate guideline to better enable them to determine if a student has the ability to perform successfully in the drafting curriculum. This information should be available by the second or third class period so that it will be possible to recommend to a potentially unsuccessful candidate that he choose another curriculum more suited to his abilities. A longer period of time will not allow the student sufficient time to catch up with classes missed if he changes his curriculum.

Statement of the Problem. The primary purpose of this thesis is the determination of the possible utility of two aptitude tests, i.e. the Space Relations Test and the Mechanical Reasoning Test of the Differential Aptitude Tests, as predictors of student success in the Mechanical Drafting and Design Curriculum at Lenoir County Community College. Secondary objectives of this thesis are presented in Chapter III. These objectives deal with the comparisons of high school data available on students prior to their enrollment in the drafting program with data available from the battery of entrance tests given to students upon arrival at the college and prior to registration procedures.

Procedure for Solution. At the beginning of this study, it was assumed that unless a student could visualize positions and views of an object, he would possibly become frustrated in his attempt to draw and would probably be unsuccessful in the drafting curriculum. This assumption implied the need for an instrument that would measure an incoming student's ability to visualize space relations. A review of each test in the battery of tests given to arriving students revealed that none of the tests could be considered appropriate to determine if a student could mentally visualize space relations.

In the search for an appropriate instrument, literature concerning test type and composition was reviewed. The aptitude test was selected as the type of test to be used, as it is the test best suited for making predictions.[1] In this case, since the students were to be in the Mechanical Drafting and Design Curriculum, test composition should contain mechanical elements and space perception elements. No single test was found to include both mechanical and space perception elements, so two tests were obtained. One test measured mechanical aptitude while the other test measured space perception aptitude.

The problem, after test selection, proceeded through the following steps: (1) The test was given to drafting and design students; (2) Data were obtained from the high school transcript; (3) Data were obtained from the entrance battery; (4) Data were obtained on college

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[1]Dorothy Adkins Wood, Test Construction-Development and Interpretation of Achievement Tests (Columbus, Ohio: Charles E. Merril Books, Inc., 1961), p. 5.

performance; and (5) Comparisons were made between predictive data and performance data.

The above procedure and analysis of data are presented in greater detail in Chapters III and IV following a review of literature in Chapter II. Chapter V contains the summary and conclusions.

CHAPTER II

REVIEW OF LITERATURE

In the research for information relating to this thesis, no article or study was found that dealt exactly with this particular problem. There are many articles and studies that explore, experiment with, and study related aspects of problems of a similar nature in other fields in general education. Presented in this chapter are selected articles that closely parallel this study in the basic nature of the problem and in the general procedure for obtaining a solution to the problem. The first group of articles, summarized under Foundation Material, are those that contain information concerning the general area of this thesis. The second group of articles, summarized under Related Material, are types which contain information that guided the selection of variables used in this study. The last type of information is presented under the title of Differential Aptitude Tests and is included to give basic facts about the Differential Aptitude Tests used as measurement instruments in this problem.

Foundation Material. A study into relationships among mechanical drawing experiences showed certain academic factors and knowledge of drawing fundamentals that could be used as a basis for assigning students to accelerated sections of engineering drawing. This study was conducted by Clifton D. Lemons in 1965. The procedure he used was to administer a constructed drawing test to students at the beginning of engineering drawing and again after one semester of drawing experience. Other data used consisted of numbers of semesters of drawing, average mechanical drawing grade, mathematics aptitude or achievement tests scores, English aptitude or achievement scores and engineering drawing final grade. Data were analyzed using multiple regression procedures; single classification analysis of variance tests were made to determine differences in knowledge of drawing fundamentals with different levels of drawing experience; and a chi-square analysis was used to determine the areas in which students performed well. His conclusions are summarized in part as follows:[1]

1. Students with at least two semesters of high school drafting have sufficient knowledge to qualify for accelerated classes.

2. The drawing experience factor does not merit omission of fundamentals in advanced classes.

3. The most valid predictor of success in engineering drawing is the combination of mathematics aptitude test scores, average mechanical drawing grade, and the number of semesters of drafting experience.

4. The number of semesters of mechanical drawing is the best single criterion for selection for advanced instruction.

5. After one semester of engineering drawing, students with at least two semesters experience in drawing made significantly higher

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[1]Clifton D. Lemons. "An Investigation of Relationships between Mechanical Drawing Experience, Certain Measures of Academic Ability and Knowledge of Drawing Fundamentals to Determine Criteria for Assigning Students to Accelerated Sections of Engineering Drawing." (unpublished Doctoral dissertation, the Texas Agricultural and Mechanical University, College Station, 1965), Dissertation Abstracts, Volume 26, Part 6, June 1966, p. 6533.

tests scores and final grades than students without prior drawing experience.

6. Students with and without mechanical drawing experience did not make significantly different scores on aptitude and achievement tests.

Relationships between certain variables and academic achievement by drafting and design students were studied by Eugene F. Hilton in 1965.[2] His problem, procedure, and conclusions are summarized in the following paragraphs.

It was noted that many students in the drafting major were unsuccessful and the magnitude of these students approached fifty percent of the class. He decided to make a study that would obtain the most pertinent predictor variables for academic achievement and would identify individuals that would probably succeed. The population in the study came from thirteen campuses of the Pennsylvania State University and contained three hundred and ninety-six freshmen in drafting and design. To test the similarity of students at each campus, four campus categories were established. Tests indicated that no significant differences existed. Variables that were included as predictive were grouped into three classes: (1) Performance Variables - obtained from selected high school grades; (2) Aptitude Variables - obtained

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[2]Eugene F. Hilton. "The Relationship between Selected Variables and Academic Achievement in the Drafting and Design Technology Major at the Pennsylvania State University." (unpublished Doctoral dissertation, the Pennsylvania State University, University Park, 1965), Dissertation Abstracts, Volume 26, Part 6, June 1966, pp. 6445-6446.

from aptitude test scores; and (3) Occupational Variables - obtained from an occupational survey instrument.

Each variable in each class was compared to the criterion of "First Term Grade Point Average." The first term grade point average was selected by Hilton as the criterion for academic achievement. Additionally, each variable in each of the three classes was correlated against the length of time that the student remained active in the curriculum. He used the length of time that each student remained in the curriculum as the "Termination Criterion."

Hilton's findings, based on data containing thirty-two different variables within the three classes of predictor variables, were (1) that a multiple correlation coefficient of R=0.6998 was achieved; (2) that twenty-seven of the thirty-two variables could be eliminated without an appreciable change in R; and (3) that the five variables giving the highest correlation to the criterion for academic achievement were two portions of the Pennsylvania State University Academic Aptitude Examination, i.e. arithmetic test - Part III, and algebra test - Part IV; the high school rank of the student; and two portions of the occupational survey instrument. When the criterion of termination was compared to the three classes of predictor variables, results were (1) that a multiple correlation coefficient of R=0.4830 was obtained; (2) that thirty of the thirty-two variables could be eliminated without appreciable change in R; and (3) that the two variables that were most predictive were a portion of the Pennsylvania State University Academic Aptitude Examination, i.e. algebra - Part III, and a mathematics test, algebra - Part I. He also computed regression equations for each of the two criteria academic achievement and termination.

Related Material. A study by Jerry R. B. Rigg compared the reading ability of college drafting students with the readability of drafting textbooks. A standard comparison formula was used to evaluate words used in each book. He concluded that material contained in textbooks varied from eighth grade reading level to sixteenth grade reading level. For more effective use by college drafting students, drafting textbooks should be written at a level of less than thirteenth grade level.[3] His study was cited to support, in part, the selection of the aptitude tests used to measure space relations abilities and mechanical reasoning abilities of drafting students. This study brings out the reading ability factor of students.

Robert E. Blum conducted a study supporting the need for testing for student placement in the college drafting courses. Conclusions of the study were based on a questionaire survey of 3,656 college drafting students. He concluded that more than fifty percent of the students entering college have at least one year of high school drawing, and that normally the more drafting experience in high school, the more skillful is the student in college drafting. He also concluded that students should be placed in accelerated programs in drafting if the

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[3]Jerry Roy B. Rigg. "Reading Abilities of College Drafting Students Compared with Readability of Drafting Textbooks and with Informational Achievement in Drafting." (unpublished Doctoral dissertation, the University of Missouri, Columbia, 1962), Dissertation Abstracts, Volume 23, Number 7, Part 3, January 1963, p. 2432.

student indicated drafting skill on a placement test and had high school drafting experience.[4]

A survey, conducted by Jimmy Hatley of thirty-two heads of college drafting departments, pointed out that in the opinions of the majority of these men, high school drafting was valuable to the college drafting student. In addition, the high school courses considered most valuable to college drafting students were machine drafting, geometry, general drafting, and descriptive geometry.[5]

Differential Aptitude Tests. The Differential Aptitude Tests, or portions of this test, was selected as the measuring instrument for comparisons made in the following chapters of this thesis. A short description of the Differential Aptitude Tests is presented in the following paragraphs.

The Differential Aptitude Tests is a published test that consists of a group of seven tests, which are listed below.[6]

PART	NAME	TIME
I	Abstract Reasoning	25 minutes
II	Clerical - Speed and Accuracy	6 minutes
III	Language Usage	35 minutes

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[4]Robert E. Blum, "The Need for Testing and Placement in College Drafting Courses," Industrial Arts and Vocational Education, Volume 55 (December, 1966), pp. 41-42.

[5]Jimmy Hatley, "The College Drafting Student-Helped or Hindered by High School Drawing?" Industrial Arts and Vocational Education, Volume 56 (February, 1967), pp. 41-42.

[6]George K. Bennett, Harold G. Seashore, and Alexander G. Wesman, Manual for the Differential Aptitude Tests (New York: The Psychological Corporation, 1959), p. 14.

PART	NAME		TIME
IV	Numerical Ability		30 minutes
V	Mechanical Reasoning		30 minutes
VI	Space Relations		30 minutes
VII	Verbal Reasoning		30 minutes
		TOTAL	186 minutes

It was designed by George K. Bennett, Harold G. Seashore, and Alexander G. Wesman and was published by The Psychological Corporation. The Differential Aptitude Tests, (DAT), was published in 1947. It was developed to provide a standardized procedure for measuring abilities of both sexes for the purposes of educational and vocational guidance. The educational test level is primarily for grades eight through twelve. However, the manual indicates that it is suitable for the educational and vocational counseling of young adults out of school. It is also useful for the selection of employment applications.[7]

A review by J. A. Keats, Reader in Psychology, University of Queensland, Brisbane, Queensland, Australia, mentioned that the Differential Aptitude Tests were validated by 50,000 cases in 195 schools from 41 states. One comment was that in some cases the test language was of old form.[8]

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[7] Ibid., p. 1.

[8] Krisen Buros (ed.), The Sixth Mental Measurements Yearbook (New Jersey: The Gryphon Press, 1965), p. 767.

Richard E. Schultz, Professor of Education and Director, Testing Service, Arizona State University, Tempe, Arizona, stated that the authors of the Differential Aptitude Tests had substantiated the test by adequate testing and had attempted to produce the best possible test.[9]

The test manual indicates that the space relations portion of the test is a combination of two previous approaches to measuring space perception ability. One method was to have the individual visualize a constructed object from a pattern while the other was to have the individual imagine an object as if it had been rotated. After the instructions just prior to taking the test, no word reading skill is required.

The Mechanical Reasoning Test consists of a picture presenting a mechanical situation with a simple worded question. This test is somewhat similar to Bennett's Mechanical Comprehension Test, which has a copyright date of 1941. Again, as in the Space Relations Test, little word reading ability is required.

The Space Perception and Mechanical Reasoning tests are of most interest because they are reported to measure qualities important to the mechanical draftsman. A draftsman drawing machine parts must be able to visualize size, shape, and position as well as to visualize various parts functioning separately or integrally.

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[9] Ibid.

CHAPTER III

PROCEDURE AND DATA COLLECTION

Problem. The problem is to determine the possible utility of two aptitude tests of the Differential Aptitude Tests, i.e. the Space Relations Test and the Mechanical Reasoning Test, as predictors of student success in the Mechanical Drafting and Design Curriculum at Lenoir County Community College.

Secondary objectives are to determine if other tests given to students prior to enrolling in the drafting curriculum are predictive of student success in the same degree as either of the two Differential Aptitude Tests and to determine if the course grades in selected high school subjects and the overall high school average are useful as predictors of student success.

The reasons behind the choice of the Space Relations Test and the Mechanical Reasoning Test were (1) it was readily available; (2) reviews of the tests indicate a high degree of reliability for the Differential Aptitude Tests as a whole and also for the two parts; (3) the test manual indicated that the tests would measure the desired factors; (4) a study of the tests themselves revealed that they were of the type where little reading was necessary; and (5) the Space Relations Test was a combination of two methods used for the measurement of space perception ability.

In October 1967, drafting students at both first year and second year levels were given the Space Relations Test and the Mechanical

Reasoning Test. All of the first year students had graduated from high school some few months earlier. The second year students had completed three quarters of the six quarter curriculum. The number of students tested in the first year and second year groups is nineteen and seven respectively. Both tests were administered and scored according to the method prescribed by the third edition of the Differential Aptitude Tests Manual.

Assumptions. The following assumptions are accepted as reasonable and true, though not proven, and the rejection of any of these assumptions would effect the interpretation of the data obtained for this study:

1. The ability to visualize space relations, or space perception ability, is a necessity for a student to be a successful draftsman.

2. The ability to visualize mechanical laws and machine members moving according to these laws, or mechanical reasoning, is a necessity for success in mechanical drafting.

3. The Space Relations Test of the Differential Aptitude Tests measures the ability to perceive space relations.

4. The Mechanical Reasoning Test of the Differential Aptitude Tests measures the ability to reason in the mechanical area.

5. A sample size of 14 to 26 students is sufficient to determine if the Space Relations Test and the Mechanical Reasoning Test do indicate student success or failure.

Variables That May Affect Data. No test can be conducted in an environment free of variables. The following variables must be considered in the interpretation of data:

1. A student that has drafting ability but for some reason, i.e. reading, emotional, or personal problem, does poorly in the tests

2. A student that does well on tests, is academically successful and performs successfully in drafting, and for no apparent reason drops out of school

3. The validity of each type of test to measure abilities that it is designed to measure

4. The student's socio-economic background and environmental effect on the tests scores

5. A student that is for some reason a good guesser or is an expert at taking tests and shows high scores but has little drafting ability

6. Student differences in ability as individuals or as a class - one class's score norm may be higher than another successful drafting class

7. Underachieving and overachieving students

8. Miscellaneous variables - variables of time, test sequence, room conditions, i.e. light, temperature, test proctor's instructions and presentation

9. Incomplete data on any student

Questions To Be Answered. The goals of this study in addition to the objectives and the basic problem as previously stated are listed in the form of questions below:

1. What factors or test scores indicate success in drafting as well as the Space Relations Test and the Mechanical Reasoning Test?

2. Would a combination of several factors including or excluding one or both the Space Relations Test or the Mechanical Reasoning Test be more indicative of success?

3. Is the Space Relations Test more indicative of success than the Mechanical Reasoning Test, or conversely?

4. Are high scores usually made on the Space Relations Test and Mechanical Reasoning Test by successful students?

5. Are low scores usually made on the Space Relations Test and the Mechanical Reasoning Test by unsuccessful students?

6. With data at hand, can there be assigned a tentative cutoff score or range of scores on each test, the Space Relations Test or the Mechanical Reasoning Test, above which success would be expected and below which students would probably be unsuccessful?

7. Does the norm for each class agree within reasonable closeness to norms quoted by publishers?

The questions listed above will be discussed further at the conclusion of Chapter V and will be answered on the basis of data presented in Chapter IV.

Method. Predictive variables used in this study are assigned to three classes. The first class, Class I Variables, is the array of scores made by students on aptitude tests given upon entering the Mechanical Drafting and Design Curriculum. Three sets of variables were selected in Class I, and these sets are the School and College Ability Test (SCAT), the Space Relations Test, and the Mechanical Reasoning Test.

Class II Variables are indicative of students' academic performance in the Mechanical Drafting and Design Curriculum at Lenoir County Community College. There are five selected subject area grade averages and the overall academic average in Class II. Sets of variables in Class II are English, mathematics, science, drafting, machine shop, and overall academic average.

Class III Variables indicate the student's high school performance. As in Class II, there are six variables - English, mathematics, science, drafting, machine shop, and overall high school average. High schools varied in their curriculums and consequently courses in each of the six fields were grouped together. To cite some examples, Industrial Arts machine shop was grouped with Vocational Agriculture machine shop, and Business Mathematics was grouped with General Mathematics. Similar groupings were made for English, science, and drafting. If the courses were similar, they were placed in the related group. If the courses were doubtful as to their content, they were omitted from any group and placed with ungrouped courses and considered in the computation of the overall high school average.

Student raw test scores make up the three sets of data within Class I Variables. In organizing the data for Class II and Class III, it was noted that no uniform grading system was found between the various high schools and Lenoir County Community College. Some schools required sixteen credits to graduate while others required eighteen. Grading was in the single integer, i.e. one, two, three, and four, in some cases, while other cases, grading was in letters. Usually four levels of grades were found even though numerical increments varied. It was necessary to establish a system so that Class II and Class III variables could be compiled in a uniform manner. The system employed in this study was to reduce letter and single integer grades to the basis of one hundred points as the maximum score possible on a course. In all cases, a numerical code was entered on the transcript for this conversion. All courses were assumed to be of equal weight. For example, to arrive at a student's composite score for English, the grades received for each English course attempted were totaled. This total was then divided by the number of English courses attempted to yield a composite score for English. Similarly, the total academic average was computed by adding the values achieved on all courses and dividing this total by the total number of courses attempted. Forms were devised to aid in arriving at values for each element in each set of data in both Class II and Class III variables. Examples of these forms are included in Appendix C, page 54. Included in Appendix A, page 46 are all tabulated raw data presented by class.

The criterion for success for a student in the Mechanical Drafting and Design Curriculum was considered to be an overall academic average above 77.8 or with an overall academic average not less than 75.0 and remaining at Lenoir County Community College on probation. The criterion for failure was defined as any student that at any time withdrew from the curriculum with an academic average equal to or less than 77.8. In addition, for a student with an average above 77.8, failure was considered if the student had one or more grades below 70.0 in any set of Class II Variables. The score of 77.8 was observed to be that score above which 15 out of 19 - 79 percent - of the students succeeded and 6 out of 7 - 86 percent - of the students failed. Four students were probational and one student withdrew passing. A graph indicating this is included in Appendix A, page 49.

Class II data, compiled on the group consisting of seven students, is based on the students' completion of six quarters of the curriculum, while Class II data on the group of nineteen students is based on the completion of three quarters of the curriculum. During the time the group of nineteen students were completing the three quarters of work, nine students entering the curriculum with the group of nineteen students withdrew. The withdrawal ratio is approximately fifty percent of the class. Of the nine students withdrawing, complete data are available only on eight of these students. All data are not available on each student for various reasons. Therefore, each table will show the number of students on which each comparison was made.

Comparison of the results of each group of students separately and as a total group on the _Space Relations Test_ and the _Mechanical Reasoning Test_ was made to the published norms for each test. Also, each of the three classes of data was compared to the student's overall academic average by means of the Spearman Rank Order Method.[1] Means of successful students and unsuccessful students were compared by application of the Median Test. Chi-square was computed for student means.[2] Sample calculations are included in Appendix B, page 50. Also included are formulas for each statistic used and a definition of each statistical variable used. Figures and tables showing the relationships between various data are given in Chapter IV. Multiple correlation procedures were not used because of the large variation between variables within sets and because of the small size of the group studied.

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[1]Janet T. Spence, _et. al_., _Elementary Statistics_ (New York: Appleton-Century-Crofts, Inc., 1968), pp. 129-132.

[2]_Ibid_., pp. 200-203.

CHAPTER IV

ANALYSIS OF DATA

Validation of the Tests. To determine the relationship between the tests given and the results obtained by the test authors, the scores made by students were tabulated and the mean, mode, standard deviation, and variance were computed using accepted statistical methods. Actual formulas used in computations are cited in Appendix B, page 50. The published norm used as a comparison is that obtained at the twelfth grade level for boys. The author's norm was based on a sample size on $N = 2,100$.[1] Table I shows a consolidation of these comparisons. This table indicates that the raw score mean on both the Space Relations Test and the Mechanical Reasoning Test are higher by approximately five points for the second year drafting group than for the author's norm for twelfth grade boys. It should be noted that the second year group was one year past high school and a higher mean would be reasonable. The combined mean raw score for both groups was higher than the norm by approximately one point. For the first year group, a mean on both tests was below the norm by one point and less than one point respectively. The results in Table I are such that it is reasonable to believe that the tests scores are valid and do compare favorably with standardized norms.

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[1]George K. Bennett, Harold G. Seashore, and Alexander G. Wesman, *Manual for the Differential Aptitude Tests* (New York: The Psychological Corporation, 1959), p. 29.

TABLE I

TESTS RESULTS COMPARED TO AUTHOR'S NORM

Test	Student Level	Number Tested	Mean (raw score)	Mode (raw score)	Standard Deviation	Variance
MECHANICAL REASONING	Year 2	7	50.6	47	12.9	8.5
	Year 1	19	44.9	42	12.9	8.4
	Years 1 and 2	26	46.4	42	12.9	8.6
NORM	Grade 12	2,100	45.9	--	11.2	--
SPACE RELATIONS	Year 2	7	62.6	87	23.2	24.2
	Year 1	19	53.8	51	23.2	18.0
	Years 1 and 2	26	56.2	51	23.2	19.7
NORM	Grade 12	2,100	54.6	--	23.6	--

Compilation of Data. After the tests were administered and graded, information was taken from the college records pertaining to the students in groups one and two. These data are consolidated by class in Appendix A, page 50. Under each of the three classes, each variable set is grouped with the related extracted student data.

To aid in visualizing the relationship between sets of variables within each class, a graph of each class of data is given in the following group of three figures. Figure 1 contains data assigned to Class I. Figures 2 and 3 likewise graphically present data assigned to Class II and III, respectively.

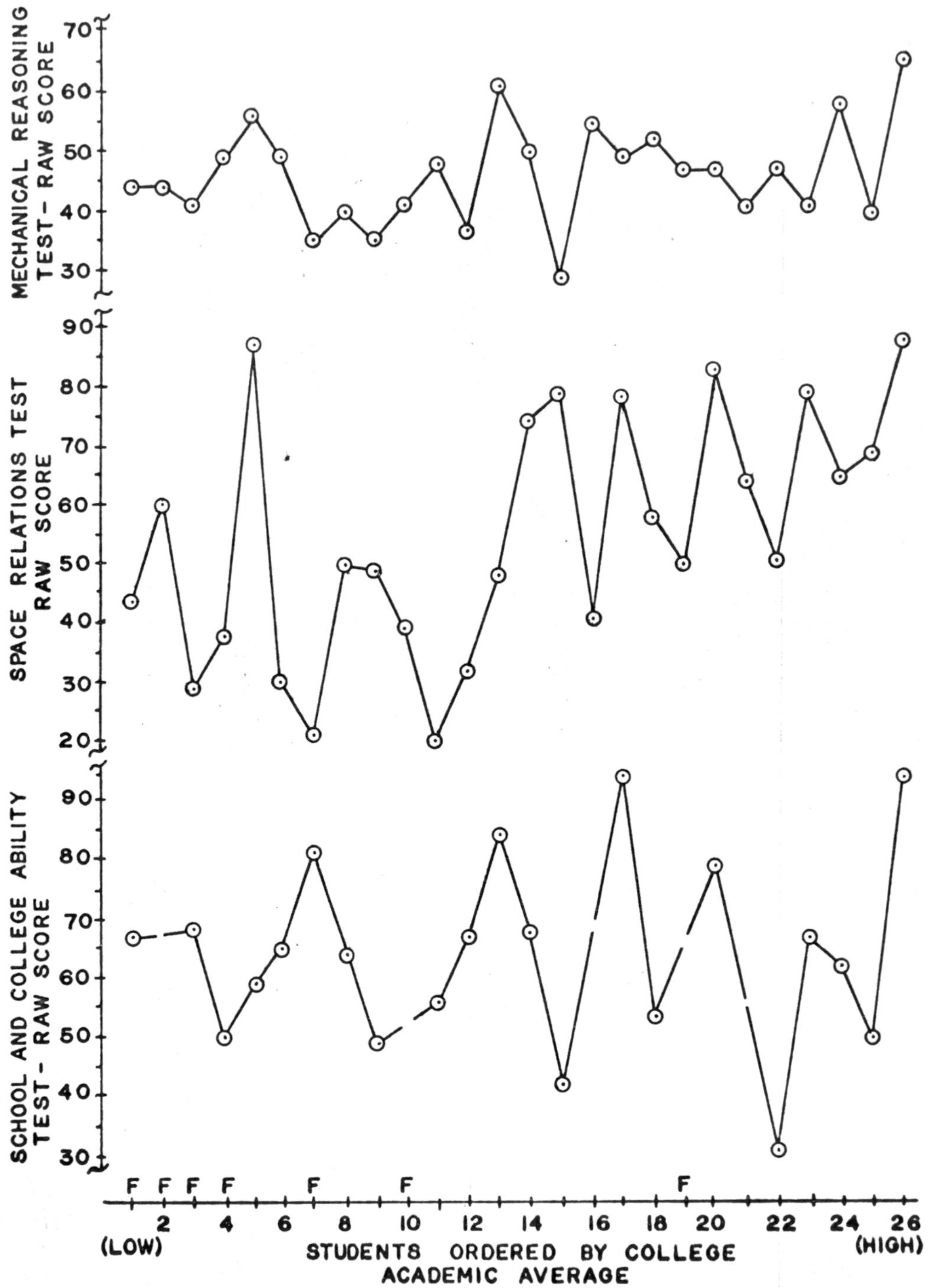

FIGURE I

CLASS I PREDICTOR VARIABLES
APTITUDE TESTS DATA

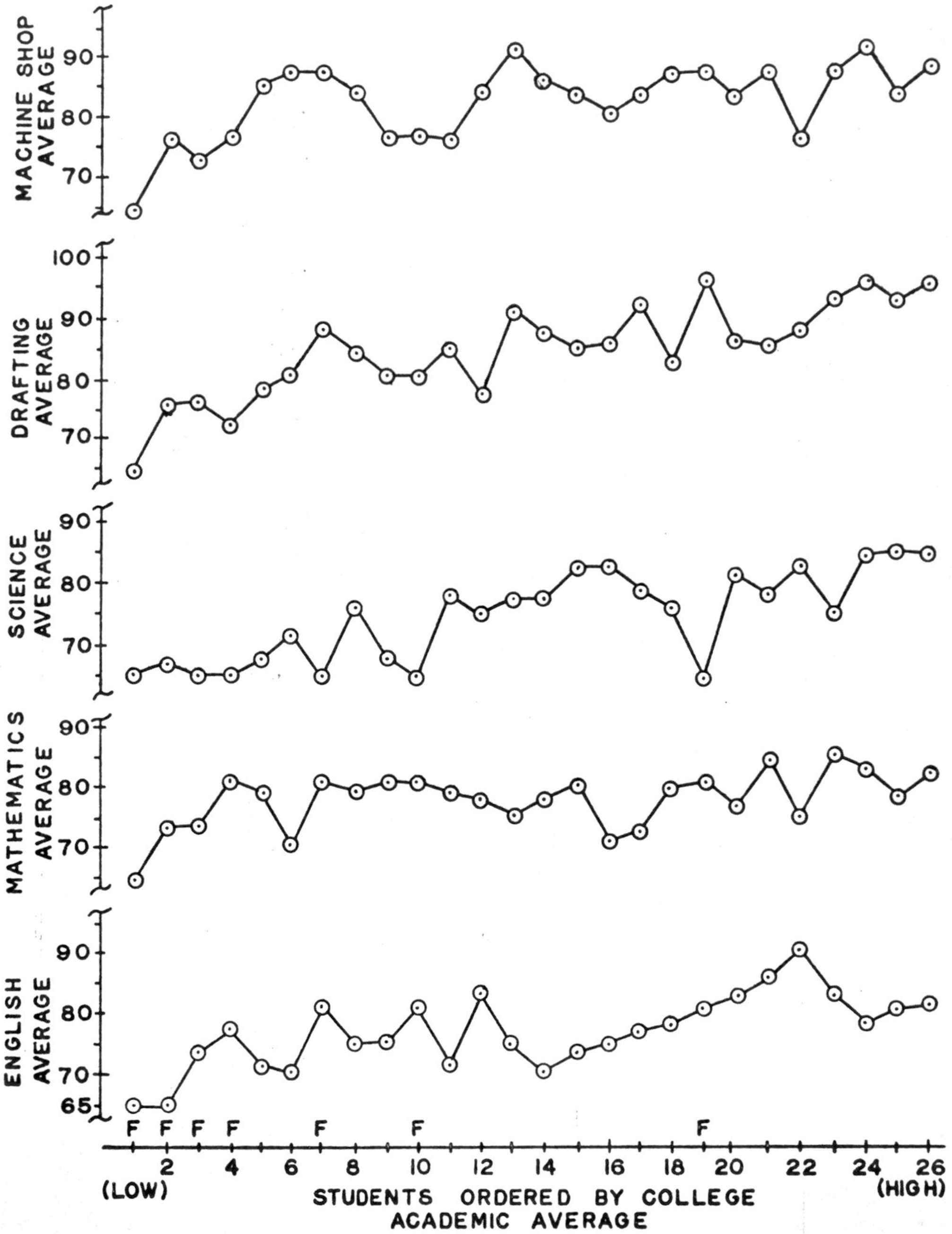

FIGURE 2

CLASS II PERFORMANCE VARIABLES
COLLEGE DATA

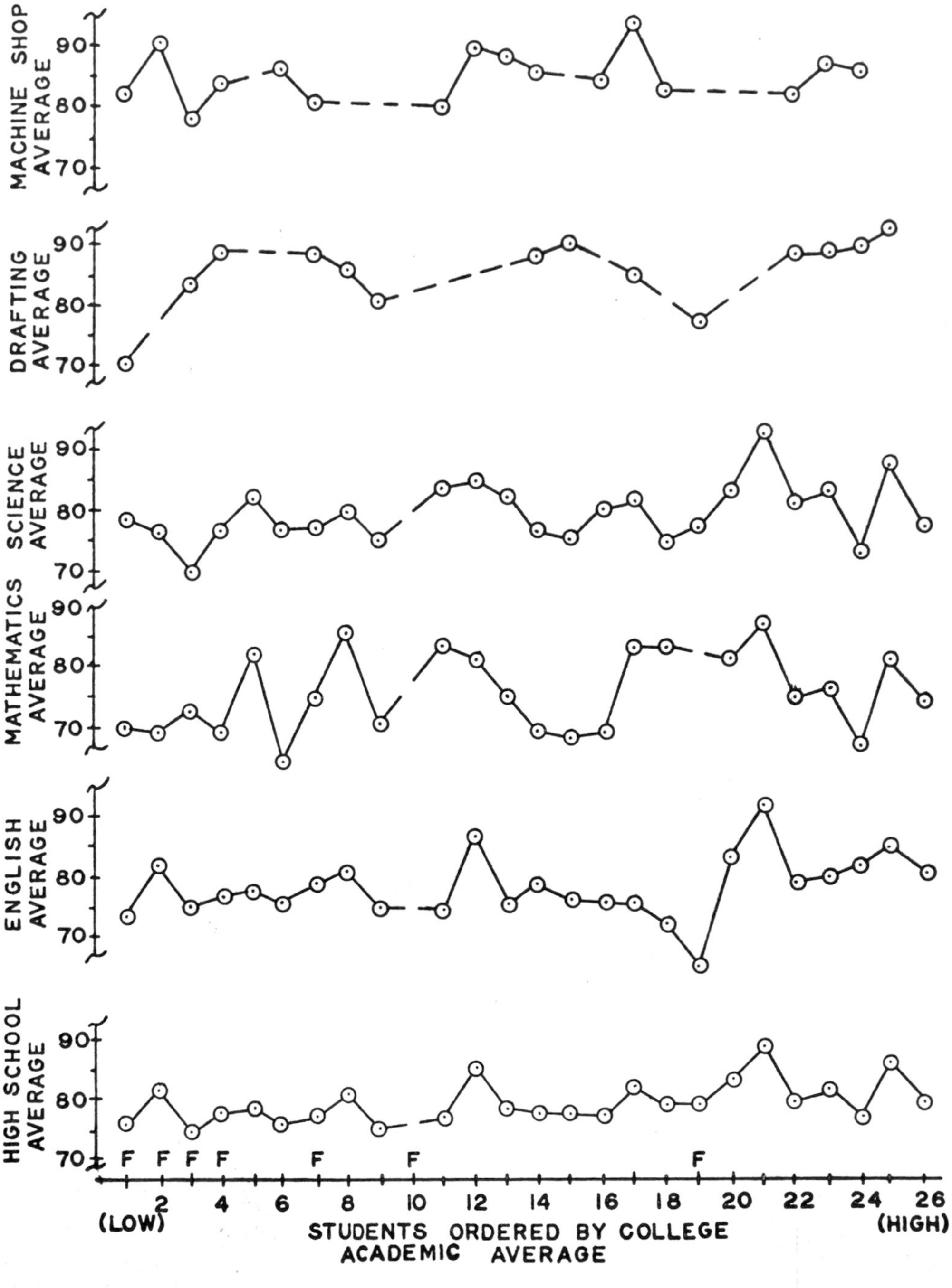

FIGURE 3

CLASS III PREDICTOR VARIABLES
HIGH SCHOOL DATA

In each of the figures, the range of raw score values obtained by the group of students is placed on the ordinate axis. On the abscissa, students are assigned positions based on their relative standing on their community college overall academic average. The student with the lowest average occupies the extreme left position on the abscissa while the student with the highest academic average occupies the extreme right position.

Observations that can be made from the graphic presentation of data are: (1) that for each class of data there is considerable variation between individuals' scores within each set of data; (2) that generally there is a tendency for students with a high academic average to have higher set scores and students with lower academic averages to have lower set scores; and (3) that the magnitude of the gradual upward slope observed for each set of data varies between sets.

Statistical Analysis of Data. The Spearman Rank Order method of correlation was applied in comparing each set of data within each of the three classes of variables to the students' college academic average.[2] The students' college academic average was taken as the measure of the criterion of success. The results of these correlation computations are presented in the following three tables. Table II contains the results of comparing Class I Predictive Variables to students' overall college academic average. Table III contains the

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[2]John W. Best, Research in Education (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1959), pp. 234-235.

TABLE II

COEFFICIENTS OBTAINED BETWEEN CRITERION OF SUCCESS AND CLASS I PREDICTOR VARIABLES

	School and College Ability Test	Space Relations Test	Mechanical Reasoning Test
Overall College Average	ρ=0.017 N=21 *NS p=0.01	ρ=0.564 N=26 **S p=0.01	ρ=0.208 N=26 NS p=0.01

*not significant
**significant

TABLE III

COEFFICIENTS OBTAINED BETWEEN CRITERION OF SUCCESS AND CLASS II PERFORMANCE VARIABLES

	English Average	Mathematics Average	Science Average	Drafting Average	Machine Shop Average
Overall College Average	ρ=0.711 N= 26 S p=0.01	ρ=0.412 N=26 S p=0.05	ρ=0.764 N=26 S p=0.01	ρ=0.846 N=26 S p=0.01	ρ=0.571 N=26 S p=0.01

TABLE IV

COEFFICIENTS OBTAINED BETWEEN CRITERION OF SUCCESS AND CLASS III PREDICTOR VARIABLES

	High School Average	English Average	Mathematics Average	Science Average	Drafting Average	Machine Shop Average
Overall College Average	ρ=0.490 N=25 S p=.05	ρ=0.338 N=25 NS p=.05	ρ=0.209 N=24 NS p=.05	ρ=0.309 N=25 NS p=.05	ρ=0.552 N=14 S p=.05	ρ=0.226 N=16 NS p=.05

results of comparisons between students' college average and students' performance while Table IV presents comparisons between high school variables and students' college average.

Summarizing the results presented in Tables II, III, and IV, correlation coefficients between the overall students' college average and each set of variables in all three classes of variables were all positive and varied in magnitude from ρ=0.017 to ρ=0.846. Sets of predictive variables that agreed most closely with the students' overall college average were the Space Relations Test (Class I, ρ=0.564, N=26, Significant p=0.01)[3] and two sets of variables in Class III. Class III Variables that significantly correlated with the students' overall college average were the high school overall average (ρ=0.490, N=25, Significant p=0.05) and the high school drafting average (ρ=0.552, N=14, Significant p=0.05). In Class II Performance Variables, all of the five sets of variables yielded correlation coefficients that were significant at the one percent level except the students' mathematics average and that was significant at the five percent level. Since the five sets of variables in Class II compose the overall community college average to which they were compared, the coefficients could be considered as verifying an obvious fact. However, when the view is taken of what relative degree of correlation each set of variables in Class II bears to the other, then additional observations

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[3]Janet T. Spence, et. al., Elementary Statistics (New York: Appleton-Century-Crofts, Inc., 1968), p. 237.

are meaningful. For Class II Variables, the five variables are listed as follows, beginning with the set that has the highest significant coefficient of correlation: the drafting average, the science average, the English average, the machine shop average, and the mathematics average. Students with the highest academic average made the highest grades primarily in the first four sets and the students with lowest grades made lowest in the first four sets of variables. In the fifth set, the mathematics average, this relationship did not exist to the degree as in the first four sets.

Tables V, VI, and VII show the comparison between the averages made by successful students, the averages made by unsuccessful students, and the mean average on the combined group and each variable class. For each of the three classes of variables, only in Class I did unsuccessful students achieve a higher average than that achieved by successful students. Normally, one would expect that unsuccessful students would achieve lower scores than those achieved by successful students. The observation that unsuccessful students in drafting scored higher on the average than the successful students for the School and College Ability Test would indicate that the students who were unsuccessful in drafting withdrew for reasons other than academic aptitude. The students were classed either successful or unsuccessful based on the criterion for success and failure as stated in Chapter III, page 18.

Median Test Comparisons and Chi square were computed to determine the significance of difference between the number of students succeeding and failing. This comparison was performed only on selected sets of variables in all classes. The sets of variables chosen for this analysis were selected because they most highly correlated to the students' overall college academic average. In these tests the criteria for success and failure were used to determine the number of students that fell in each category. A sample calculation illustrating the median test is included in Appendix B, page 51.

Table VII below shows the results of this test. There was significant difference between the Space Relations Test ($x^2 = 3.9$, $df = 1, p = 0.05$) and three sets of variables in Class II. In Class III Variables, the high school overall average and the high school drafting average were very low in significance of difference between students that succeeded in college drafting and those that failed.

In the Median Test[4] the following procedure was used: (1) the group mean score on each set of variables was computed; (2) the students were identified as either a success or failure; (3) the number of successful students above and below the group mean were placed in a two by two table, and similarly the number of unsuccessful students above and below the group mean were placed in the table; (4) chi-square was computed to determine if the number of students in each category differed significantly from the expected success to failure ratio of a randomly selected group; and (5) values of chi-square[5] were compared with the appropriate table listing significant values of chi-square.

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[4]Ibid., pp. 200-203.

[5]Ibid., p. 240.

TABLE V

STUDENT AVERAGES ON SETS OF CLASS I PREDICTOR VARIABLES COMPARED FOR SUCCESS AND FAILURE

	School and College Ability Test	Space Relations Test	Mechanical Reasoning Test
Success	63.8 N=17	60.3 N=19	47.3 N=19
MEAN	64.3 N=21	54.8 N=26	46.2 N=26
Failure	66.5 N= 4	40.0 N= 7	43.0 N= 7

TABLE VI

STUDENT AVERAGES ON SETS OF CLASS II PERFORMANCE VARIABLES COMPARED FOR SUCCESS AND FAILURE

	College Average	English Average	Mathematics Average	Science Average	Drafting Average	Machine Shop Average
Success	81.6 N=19	78.1 N=19	78.7 N=19	78.4 N=19	87.4 N=19	85.5 N=19
MEAN	79.6 N=26	77.2 N=26	78.1 N=26	74.9 N=26	85.3 N=26	83.5 N=26
Failure	74.3 N= 7	74.8 N= 7	76.5 N= 7	65.3 N= 7	79.4 N= 7	78.1 N= 7

TABLE VII

STUDENT AVERAGES ON SETS OF CLASS III PREDICTOR VARIABLES COMPARED FOR SUCCESS AND FAILURE

	High School Average	English Average	Mathematics Average	Science Average	Drafting Average	Machine Shop Average
Success	79.9 N=19	79.0 N=19	76.2 N=19	80.2 N=19	87.5 N=19	85.8 N=11
MEAN	79.3 N=25	78.0 N=25	75.1 N=24	79.2 N=25	85.4 N=14	84.9 N=16
Failure	77.3 N= 6	75.0 N= 6	70.8 N= 5	75.9 N= 6	81.5 N= 5	82.8 N= 5

TABLE VIII

CHI SQUARE COMPUTED FOR SELECTED SETS OF EACH CLASS OF VARIABLES

	Class I	Class II			Class III	
	Space Relations Test	Science Average College	Drafting Average College	Machine Shop Average	High School Average	High School Drafting Average
N	26	26	26	26	25	14
X^2	3.9	15.3	3.3	5.7	1.3	2.0
Significant	YES	YES	YES	YES	YES	YES
Level	p=.05	p=.01	p=.10	p=.05	p=.30	p=.20

Comparison of Success to Tests Results. Figure 4 is a graph on which is plotted the Space Relations Test score made by twenty-six Mechanical Drafting and Design students. The raw point score is given on the ordinate axis, while plotted on the abscissa is the relative position of each student in the group. The number assigned to each student that failed is marked with the letter F. Also added is the students' academic average, shown as a dashed line. Horizontal lines are given to aid in commenting about the failure ratio below a given score. Below and including the A level, 60 raw score, there are sixteen students. Of the sixteen students, seven students failed or a 44 percent failure ratio. Below the B level, there are thirteen students. Of these students, six failed, yielding a 46 percent failure ratio. Below the C and D level, the failure rate is 55 percent and 57 percent respectively. Above a raw score of 60 there is 100 percent success ratio.

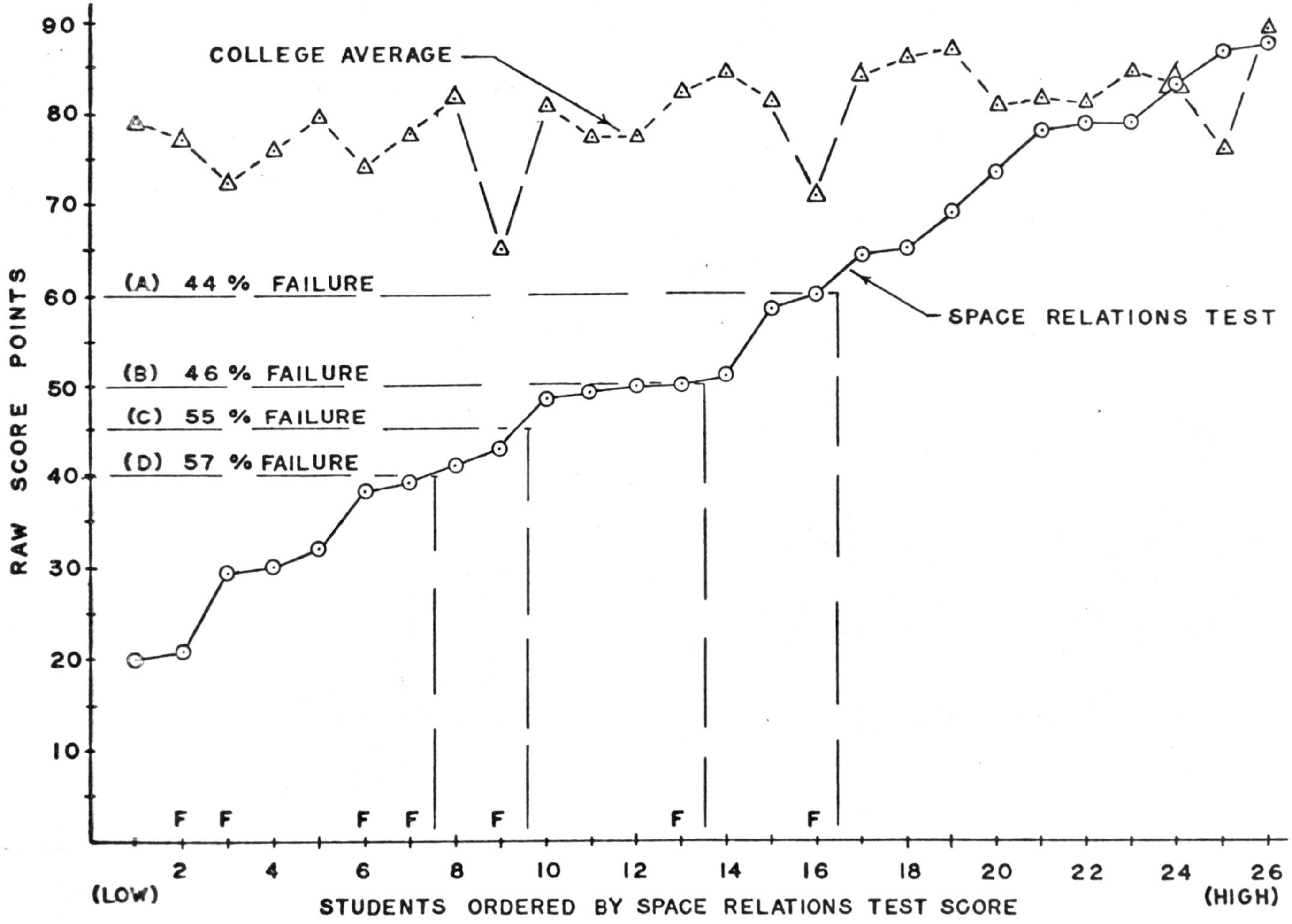

FIGURE 4

RELATIONSHIP BETWEEN SPACE RELATIONS TEST
AND STUDENT SUCCESS

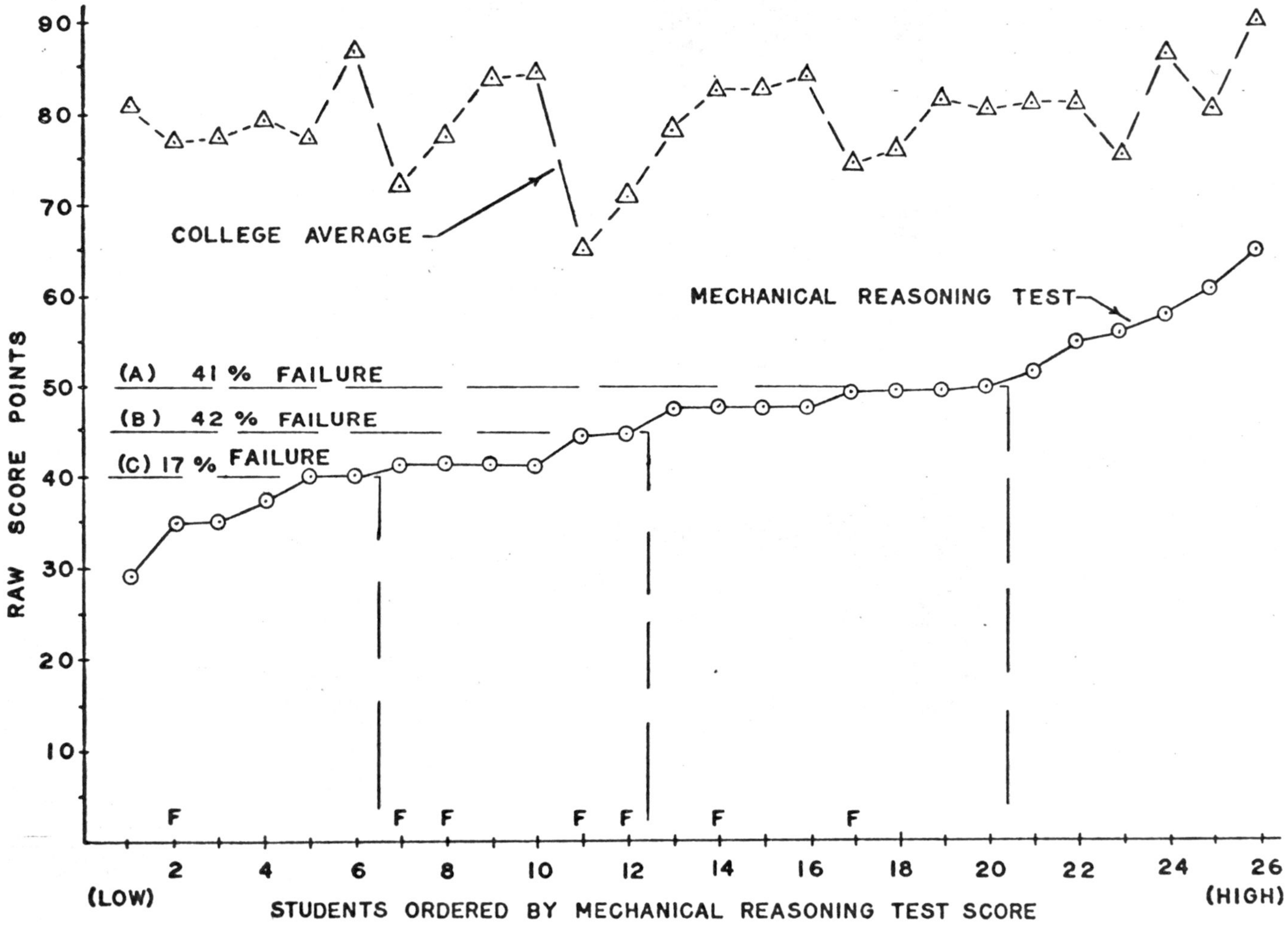

FIGURE 5

RELATIONSHIP BETWEEN MECHANICAL REASONING
TEST AND STUDENT SUCCESS

A similar graph, Figure 5, was constructed for the results of the _Mechanical Reasoning Test_. As in Figure 4, similar increments were established and the failure ratio is entered on the respective level.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary. The purpose of this thesis was to determine the possible utility of two aptitude tests of the *Differential Aptitude Tests*, the *Space Relations Test* and the *Mechanical Reasoning Test*, as predictors of student success in the Mechanical Drafting and Design Curriculum at Lenoir County Community College.

These two tests were administered to the first and second year Drafting and Design students in October 1967. Of the twenty-seven students enrolled, only twenty-six students received both tests and consequently the population studied consisted of these twenty-six individuals. Since complete data were not available in all categories of data and obtaining these data was not possible for several reasons, each table indicating a result bears the sample size.

The basic approach to solving the problem was first to test the students and then to compare the students' scores with their following academic achievement. Additionally, certain sets of high school data were obtained. This information was compared to the students' college performance in order to determine what of several selected areas most closely correlated with student success.

Information available to the counselors, advisors, and instructors on students initially enrolling in the Drafting and Design Curriculum would consist of only that information obtained from a student's high school transcript, personal interview, or entrance test. The question that arises is what information, readily available, indicates how a student would probably perform in the drafting curriculum. Without information of this type, a student could enroll in the program without certain drafting ability, struggle through one or more quarters of drafting, lose interest because of poor results, and consequently face the several costly alternatives open to him.

Observations. Based on the information presented in Chapter IV, the following observations are noted:

1. Two items of information that correlate significantly with academic performance in Mechanical Drafting and Design are the overall high school average and the drafting average. This information can be readily obtained from a student's high school transcript.

2. The aptitude test that correlates significantly with students' academic performance in Mechanical Drafting and Design is the Space Relations Test of the Differential Aptitude Tests.

3. The Mechanical Reasoning portion of the Differential Aptitude Tests did not significantly correlate with academic performance in Mechanical Drafting and Design.

4. Other sets of data in Class I and Class II Predictor Variables did not significantly correlate with academic performance.

5. The set of Class II Performance Variables in which 100 percent of the student failures occurred was in science.

Conclusions. It is concluded that the Space Relations Test of the Differential Aptitude Tests can be an effective tool in predicting student success in Mechanical Drafting and Design. Also, it is concluded that the Mechanical Reasoning portion of the Differential Aptitude Tests is not as useful for prediction as is the case with the Space Relations Test.

It is further concluded that the questions submitted for consideration in Chapter III have been answered. To summarize these questions and answer them, the following comments are made: (1) the factors and test scores that indicate success are the Space Relations Test, the overall high school average, and the high school drafting average; (2) a combination of all three of these informational sources would be more substantial in predictive value than any one; and (3) a tentative cutoff score of 40 raw score points is suggested for students entering the Mechanical Drafting and Design Program, with the caution that other data, to include a personal interview with the student, be taken into consideration prior to barring a student from the program. Other questions not answered in this paragraph have been adequately discussed in this paper.

Related Comments. Human nature is in some cases predictable and in other cases it is not. A larger survey in the area of this thesis would add much to this very limited study. It may be that other standardized tests may perform more successfully than the one studied here.

It is believed that the Space Relations Test will be a useful tool in the areas of counseling and identification of students that require more personal instruction or programmed instruction to improve their skill level so that success in drafting would be probable. Also, the use of this tool, if properly used, can be beneficial in upgrading existing drafting programs, or if improperly used, can deny students a chance to obtain a marketable drafting skill.

Recommendations for Further Study. There are three basic avenues or approaches that are recommended that would supply important information concerning the identification and subsequent counseling of potentially unsuccessful drafting candidates. The first approach would be to conduct a larger study similar to the one presented in this thesis. This study would verify or deny the present conclusions more significantly. Other technical institutes and community colleges offering courses in drafting could be selected to participate in such a study. Participation by several institutions would increase the size of the population to be studied as well as incorporate individuals from different cross-sections of the population. Problems such as expense, time, and analysis must be overcome if such a study would be successfully completed.

The second avenue that is worthy of further study is the possibility that other test instruments may be available that will perform equally or more satisfactorily as predictive and guidance tools. Either standard tests or tests of original design could be studied to verify their usefulness.

A third approach, possibly the most important to future drafting students, would be to conduct a study that would indicate the fields that could be recommended as those that probably could be successfully pursued by unsuccessful drafting students. Based on selected variables from the student's high school transcript and entrance tests, would adequate and reliable information be available to suggest a more suitable field of endeavor for the potentially unsuccessful drafting student, or must other psychological tests and guidance methods be used for this purpose?

BIBLIOGRAPHY

BIBLIOGRAPHICAL ENTRIES

A. BOOKS

Arkin, Herbert, and Raymond R. Colton. Tables for Statisticians. New York: Barnes and Noble, Inc., 1963.

Berdie, Ralph F., Wilbut L. Layton, Edward O. Swanson, and Theda Hegenah. Testing in Guidance and Counseling. New York: McGraw-Hill Book Company, Inc., 1963.

Batten, James William. Research as a Tool for Understanding. Dubuque, Iowa: William C. Brown Book Company, Inc., 1965.

Best, John W. Research in Education. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1959.

Bryant, Edward C. Statistical Analysis. New York: McGraw-Hill Book Company, Inc., 1960.

Burow, Oscar Krisen (ed.). Test in Print: A Comprehensive Bibliography of Tests for Use in Education, Psychology, and Industry. Highland Park, New Jersey: The Gryphon Press, 1961.

______. The Third Mental Measurements Yearbook. Reprinted 1960. Highland Park, New Jersey: The Gryphon Press, 1949.

______. The Fourth Mental Measurements Yearbook. Highland Park, New Jersey: The Gryphon Press, 1953.

______. The Fifth Mental Measurements Yearbook. Highland Park, New Jersey: The Gryphon Press, 1965.

Chauncey, Henry, and John E. Dobbin. Testing: Its Place in Education Today. New York: Harper and Row, Publishers, 1963.

Dixon, Wilfrid J., and Frank J. Massey, Jr. Introduction to Statistical Analysis. New York: McGraw-Hill Book Company, Inc., 1957.

Fisher, Ronald A. Statistical Methods for Research Workers. New York: Hafner Publishing Company, Inc., 1958.

Kurtz, Thomas E. Basic Statistics. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1963.

Mills, Frederick C. Statistical Methods. Third edition. New York: Holt, Rinehart and Wilson, Inc., 1955.

Nunnally, Jum D., Jr. Tests and Measurements: Assessment and Prediction. New York: McGraw-Hill Book Company, Inc., 1959.

Seibel, Dean W. Published Standardized Tests: An Annoted List for Junior Colleges. Princeton, New Jersey: Educational Testing Service, 1967.

Spence, Janet T., Benton J. Underwood, Carl P. Duncan, and John W. Cotton. Elementary Statistics. Second edition. New York: Appleton-Century-Crofts, Inc., 1968.

Vernon, Philip E. The Measurement of Abilities. New York: Philosophical Library, 1961.

Whitney, Frederick L. The Elements of Research. Third edition. New York: Prentice-Hall, Inc., 1950.

Wood, Dorothy A. Test Construction: Development and Interpretation of Achievement Tests. Third printing. Columbus, Ohio: Charles E. Merril Books, Inc., 1961.

B. TEST MANUALS

Bennett, George K., Harold G. Seashore, and Alexander G. Wesman. Manual for the Differential Aptitude Tests. Third edition. New York: The Psychological Corporation, 1959.

______. Manual for the Differential Aptitude Tests. Fourth edition. New York: The Psychological Corporation, 1966.

Likert, Rensis, and William H. Quasha. Revised Minnesota Paper Form Board Test. New York: The Psychological Corporation, 1948.

Moore, Bruce V., C. J. Lapp, and Charles H. Griffin. Manual Engineering and Physical Science Aptitude Tests. Revised 1951. New York: The Psychological Corporation, 1951.

C. UNPUBLISHED MATERIALS

Hilton, Eugene F. "The Relationship between Selected Variables and Academic Achievement in the Drafting and Design Technology Major at the Pennsylvania State University." Unpublished Doctoral dissertation, The Pennsylvania State University, University Park, 1965. Dissertation Abstracts, Volume 26, Part 6, June 1966, pp. 6445-6446.

Lemons, Clifton D. "An Investigation of Relationships between Mechanical Drawing Experience, Certain Measures of Academic Ability and Knowledge of Drawing Fundamentals to Determine Criteria for Assigning Students to Accelerated Sections of Engineering Drawing." Unpublished Doctoral dissertation, The Texas Agricultural and Mechanical University, College Station, 1965. Dissertation Abstracts, Volume 26, Part 6, June 1966, p. 6533.

Rigg, Jerry Roy B. "Reading Abilities of College Drafting Students Compared with Readability of Drafting Textbooks and with Informational Achievement in Drafting." Unpublished Doctoral dissertation, University of Missouri, Columbia, 1962. Dissertation Abstracts, Volume 23, Number 7, Part 3, January 1963, p. 2432.

D. PERIODICAL ARTICLES

Blum, Robert E. "The Need for Testing and Placement in College Drafting Courses." Industrial Arts and Vocational Education, Volume 55, Number 10, (December, 1966), p. 27.

Hatley, Jimmy. "The College Drafting Student - Helped or Hindered by High School Drawing?" Industrial Arts and Vocational Education, Volume 56, Number 2, (February, 1967), pp. 41-42.

Suess, Alan R., and Herbert Dutt. "Drafting Tests that Evaluate." Industrial Arts and Vocational Education, Volume 55, Number 1, (January, 1966), pp. 31-33.

Wright, Lawrence S. "What About a Standardized Test in Drafting?" Industrial Arts and Vocational Education, Volume 55, Number 2, (February, 1966), p. 28.

APPENDIXES

APPENDIX A

CLASS 1 PREDICTOR VARIABLES

Line Number	Overall Community College Average	School and College Ability Test	Space Relations	Mechanical Reasoning
1	89.0	94	88	65
2	86.9	50	69	40
3	86.7	62	65	58
4	84.6	67	79	41
5	84.4	31	51	47
6	84.2	None	64	41
7	83.2	79	83	47
8-F*	82.4	None	50	47
9	81.8	53	58	52
10	81.7	94	78	49
11	81.5	None	41	55
12	81.3	42	79	29
13	80.4	68	74	50
14	80.1	84	48	61
15	79.5	67	32	37
16	78.5	56	20	47
17-F	77.8	None	39	41
18	77.5	49	49	35
19	77.4	64	50	40
20-F	77.3	81	21	35
21	76.2	65	30	49
22	75.2	59	87	56
23-F	74.5	50	38	49
24-F	72.4	68	29	41
25-F	70.9	None	60	44
26-F	65.0	67	43	44

*Failure.

CLASS II PERFORMANCE VARIABLES

Line Number	Overall Community College Average	English Average	Mathematics Average	Science Average	Drafting Average	Machine Shop Average
1	89.0	81.8	82.8	85.0	96.5	89.2
2	86.9	81.1	78.9	85.8	93.8	84.8
3	86.7	78.5	83.5	84.9	96.5	92.5
4	84.6	83.5	86.0	75.4	93.8	88.8
5	84.4	90.4	76.0	82.9	88.7	77.3
6	84.2	86.0	84.8	78.5	86.2	88.5
7	83.2	83.0	77.0	81.9	87.1	84.8
8-F	82.4	81.0	81.0	65.0	96.5	88.5
9	81.8	78.5	80.1	76.3	83.5	88.8
10	81.7	77.3	73.1	79.2	92.2	84.8
11	81.5	75.4	71.4	82.9	86.9	81.0
12	81.3	73.5	80.1	82.9	86.0	84.8
13	80.4	70.7	78.5	78.9	88.5	88.5
14	80.1	75.1	76.0	77.8	91.2	92.5
15	79.5	83.5	78.5	75.4	78.5	84.8
16	78.5	72.0	79.4	78.2	85.3	77.3
17-F	77.8	81.0	81.0	65.0	81.0	77.8
18	77.5	75.7	81.0	67.8	81.0	77.5
19	77.4	74.8	79.1	76.3	84.8	84.8
20-F	77.3	81.0	81.0	65.0	88.5	88.5
21	76.2	70.7	70.7	71.4	81.0	88.7
22	75.2	71.6	79.1	67.8	78.9	84.8
23-F	74.5	77.3	81.0	65.0	72.8	77.3
24-F	72.4	73.5	73.5	65.0	76.8	73.0
25-F	70.9	65.0	73.2	67.1	75.5	76.8
26-F	65.0	65.0	65.0	65.0	65.0	65.0

CLASS III PERFORMANCE VARIABLES
HIGH SCHOOL

Line Number	Overall College Average	Overall High School Average	English Average	Mathematics Average	Science Average	Drafting Average	Machine Shop Average
1	89.0	79.2	80.0	73.8	77.6	None	None
2	86.9	85.8	84.8	80.3	87.7	92.0	None
3	86.7	76.7	81.3	66.8	73.0	89.5	86.0
4	84.6	81.2	79.5	76.0	82.5	88.7	87.0
5	84.4	79.5	79.8	74.2	80.8	88.3	82.0
6	84.2	89.2	91.5	86.5	92.0	None	None
7	83.2	82.9	82.8	80.7	82.5	None	None
8-F	82.4	78.8	65.0	None	77.0	77.0	None
9	81.8	78.5	72.1	83.0	74.5	None	82.5
10	81.7	81.7	75.3	83.1	81.3	84.3	93.0
11	81.5	77.6	75.5	68.7	80.0	None	84.3
12	81.3	77.7	76.0	68.0	75.0	90.0	None
13	80.4	77.3	78.8	69.0	76.0	88.0	85.5
14	80.1	78.1	75.3	74.5	82.0	None	88.0
15	79.5	85.4	86.1	80.7	84.7	None	89.5
16	78.5	77.8	74.0	82.5	83.0	None	80.0
17-F	77.8	None	None	None	None	None	None
18	77.5	75.0	74.5	70.2	74.4	80.5	None
19	77.4	80.4	80.5	85.0	79.7	86.0	None
20-F	77.3	76.9	78.9	74.2	76.8	88.5	80.7
21	76.2	76.2	75.6	64.0	76.5	None	86.3
22	75.2	78.6	77.4	81.1	81.3	None	None
23-F	74.5	77.5	76.3	69.0	76.8	88.6	83.3
24-F	72.4	74.0	74.6	72.0	69.7	83.5	78.0
25-F	70.9	81.2	81.9	69.0	76.5	None	90.9
26-F	65.0	75.4	73.3	69.8	78.3	70.0	82.0

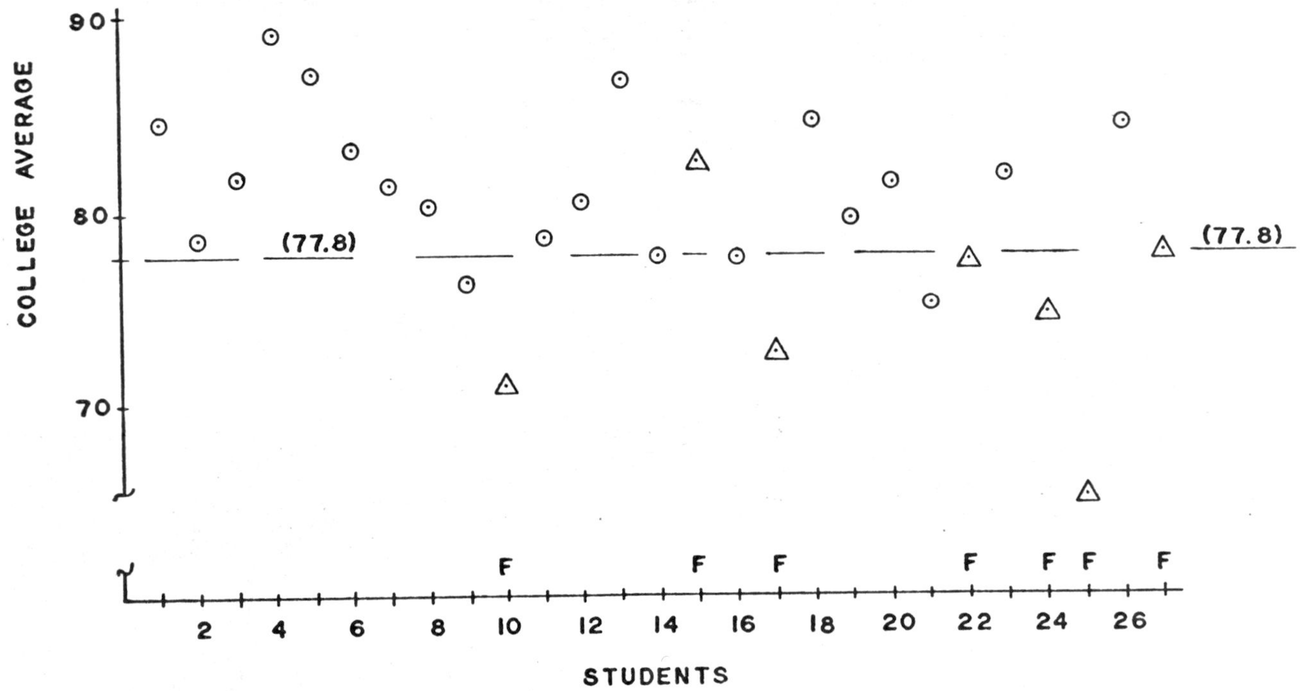

TABLE IX

DATA USED TO ESTABLISH
CRITERION OF SUCCESS

APPENDIX B

STATISTICS FORMULAS USED IN COMPUTATIONS AND SAMPLE CALCULATIONS

I. ARITHMETIC MEAN.[1]

$$\bar{Y} = \frac{\Sigma Y}{N}$$

$\bar{Y}$ - Arithmetic Mean
Σ - Sum or Total
Y - Midpoint in Interval
N - Number of Intervals

II. MEAN.[2] (The means quoted in TABLE I, page 22 were computed after tabulation of each score. An example showing this array is given below following presentation of formulas and definitions of variables. This table presents students' scores on the Space Relations Test and the Mechanical Reasoning Test.)

$$M = \frac{\Sigma fY}{n}$$

M - Mean
Σ - Sum or Total
f - Frequency of Scores
Y - Midpoint in Interval
n - Number of Students

III. MODE. The midpoint score within the interval into which most students' test scores fall. For example, if four students' scores were 46, 46, 47, and 48, and the interval range was 45-49 with a midpoint score of 47, the Mode then would be 47.

IV. STANDARD DEVIATION.[3]

$$SD = \left[\frac{\Sigma(Y - \bar{Y})^2}{N}\right]^{\frac{1}{2}}$$

SD - Standard Deviation
Σ - Sum or Total
Y - Midpoint Score
$\bar{Y}$ - Arithmetic Mean
N - Number of Intervals

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[1] Dorothy Adkins Wood, Test Construction - Development and Interpretation of Achievement Tests (Columbus, Ohio: Charles E. Merril Books, Inc., 1961), p. 66.

[2] Edward C. Bryant, Statistical Analysis (New York: McGraw-Hill Book Company, Inc., 1960), p. 55.

[3] Ibid., p. 46.

V. VARIANCE.[4]

$$s = \left[\frac{n\Sigma fY^2 - (\Sigma fy)^2}{n(n - 1)}\right]^{\frac{1}{2}}$$

s - Variance
Σ - Sum or Total
n - Number of Students
f - Frequency of Scores
Y - Midpoint Score

VI. COEFFICIENT OF CORRELATION.[5] (The Spearman Rank Order Method was used to compare criterion of success with each set of data within each of the three variable classes. An example of this method is given below.)

$$\rho = 1 - \frac{6\Sigma(U_i - V_i)}{N(N^2 - 1)}$$

ρ - (Rho) Coefficient of Correlation
Σ - Sum or Total
U_i - Rank Order of Variable One
V_i - Rank Order of Variable Two
N - Number of Ranks

VII. MEDIAN TEST.[6] (Test of Significance of Difference by Chi Square.)

	Success	Failure	
Number Above Mean	A	B	A+B
Number Below Mean	C	D	C+D
TOTAL	A+C	B+D	N

X^2 - Chi Square
A-D - Number of Individuals in each Class
N - Total Number of Individuals in Test

$$X^2 = \frac{N(AD-BC)^2}{(A+B)(C+D)(A+C)(B+D)}$$

[4] Ibid., p. 51.

[5] John W. Best, Research in Education (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1959), pp. 234.

[6] Janet T. Spence, et. al., Elementary Statistics (New York: Appleton-Century-Crofts, Inc., 1968), pp. 200-203.

VIII. SPACE RELATIONS TEST SCORES - Second Year Students.

Interval	Range	f	Y	fY	$(Y)^2$	$f(Y)^2$	$(Y-\overline{Y})$	$(Y-\overline{Y})^2$
1	92 - 100		96		7,569		36	1,296
2	83 - 91	2	87	174	7,569	15,138	27	729
3	74 - 82	1	78	78	6,084	6,084	18	324
4	65 - 73	1	69	69	4,761	4,761	9	81
5	56 - 64		60				0	0
6	47 - 55	1	51	51	2,601	2,601	9	81
7	38 - 46	1	42	42	1,764	1,764	18	324
8	29 - 37		33				27	729
9	20 - 28	1	24	24	576	576	36	1,296
N=9	TOTAL	f=7	540	438		30,924		4,860

Mode = 87

Mean = $\frac{438}{7} = 62.57$

Arithmetic Mean $\overline{Y} = \frac{540}{9} = 60$

Standard Deviation $SD = \sqrt{\frac{4,860}{9}} = 23.24$

Variance $s = \left[\frac{7(30,924) - (438)^2}{7(7-1)}\right]^{\frac{1}{2}} = 24.21$

IX. CORRELATION BETWEEN OVERALL COLLEGE AVERAGE AND HIGH SCHOOL DRAFTING.

Line Number	Overall College Average	High School Drafting Average	U_i	V_i	$(U_i - V_i)$	$(U_i - V_i)^2$
1	86.9	92.0	1	1.0	0.0	0.00
2	86.7	89.5	2	3.0	-1.0	1.00
3	84.6	88.7	3	4.0	-1.0	1.00
4	84.4	88.3	4	7.0	-3.0	9.00
5	82.4	77.0	5	13.0	-8.0	64.00
6	81.7	84.3	6	10.0	-4.0	16.00
7	81.3	90.0	7	2.0	5.0	25.00
8	80.4	88.0	8	8.0	0.0	0.00
9	77.5	80.5	9	12.0	-3.0	9.00
10	77.4	86.0	10	9.0	1.0	1.00
11	77.3	88.5	11	6.0	5.0	25.00
12	74.5	88.6	12	5.0	7.0	49.00
13	72.4	83.5	13	11.0	2.0	4.00
14	65.0	70.0	14	14.0	0.0	0.00
					0.0	204.00

N = 14

$$\rho = 1 - \frac{6(204.00)}{14\left[(14)^2 - 1\right]}$$

$$\rho = 0.552$$

APPENDIX C

MISCELLANEOUS MATERIAL

LENOIR COUNTY COMMUNITY COLLEGE
P.O. BOX 188, KINSTON, N.C. 28501

NAME ______________________ DATE TESTS GIVEN ________, 19__

COLLEGE ENTRANCE TESTS BATTERY DATA

TEST	RAW SCORE	MAXIMUM POSSIBLE SCORE	REMARKS (Date if other than above.)
A-SCAT (TOTAL)	______	______	______________
Verbal	______	______	______________
Quantitative	______	______	______________
B-PRE-MATHE-MATICS	______	______	______________
C-PRE-ENGLISH	______	______	______________
Vocabulary	______	______	______________
Level of Compre-hension	______	______	______________
Speed of Compre-hension	______	______	______________
Total Reading	______	______	______________
TOTAL ENGLISH	______	______	______________
D-DAT	______	______	______________
Space Relations	______	______	______________
Mechanical Reasoning	______	______	______________
E-OTHER	______	______	______________
	______	______	______________
	______	______	______________
	______	______	______________
	______	______	______________
	______	______	______________

LENOIR COUNTY COMMUNITY COLLEGE
P.O. BOX 188, KINSTON, N.C. 28501

HIGH SCHOOL TRANSCRIPT DATA

NAME ______________________ AGE ____ OVERALL HIGH SCHOOL AVERAGE ______
SCHOOL ______________________
ADDRESS OF SCHOOL ______________________ Total Credit Hours ______
(Unit) ______
____
____

DATE GRADUATED __________, 19___

EXTRACTED DATA

SUBJECTS	COURSE TITLE	GRADE	TIME	REMARKS
A-Drafting	______	______	______	______
	______	______	______	______
	______	______	______	______
	______	______	______	______
B-Math	______	______	______	______
(Algebra	______	______	______	______
Geometry,	______	______	______	______
etc.)	______	______	______	______
C-Science				
(Biology,	______	______	______	______
General,	______	______	______	______
Physics, etc.	______	______	______	______
	______	______	______	______
D-English	______	______	______	______
	______	______	______	______
	______	______	______	______
	______	______	______	______
E-Machine Shop	______	______	______	______
Industrial	______	______	______	______
Arts, Voc.	______	______	______	______
Agri., etc.	______	______	______	______
F-Misc.	______	______	______	______
	______	______	______	______
	______	______	______	______
	______	______	______	______

LENOIR COUNTY COMMUNITY COLLEGE
P.O. BOX 188, KINSTON, N.C. 28501

COMPUTATION SHEET

HIGH SCHOOL

____
STUDENT'S NAME

(A) SUBJECT	ENGLISH		MATHEMATICS		SCIENCE		DRAFTING		MACHINE SHOP		OTHER	
NUMBER OF COURSES	COURSE GRADE	MAX. GRADE	COURSE GRADE	MAX. GRADE	COURSE GRADE	MAX. GRADE	COURSE GRADE	MAX. GRADE	COURSE GRADE	MAX. GRADE	COURSE GRADE	MAX. GRADE
1	____	____	____	____	____	____	____	____	____	____	____	____
2	____	____	____	____	____	____	____	____	____	____	____	____
3	____	____	____	____	____	____	____	____	____	____	____	____
4	____	____	____	____	____	____	____	____	____	____	____	____
5	____	____	____	____	____	____	____	____	____	____	____	____
6	____	____	____	____	____	____	____	____	____	____	____	____
(B) — TOTAL	____	____	____	____	____	____	____	____	____	____	____	____
(C) — AVERAGE =	____		____		____		____		____		____	

$$\text{AVERAGE} = \frac{\text{TOTAL COURSE GRADES}}{\text{TOTAL MAX. GRADES}}$$

(D) — TOTAL LINE (B) TOTAL COURSE GRADE ______ TOTAL MAX. GRADE ______

(E) — OVERALL ACADEMIC AVERAGE ______

(F) — REMARKS ______________________________

LENOIR COUNTY COMMUNITY COLLEGE
P.O. BOX 188, KINSTON, N.C. 28501

COMPUTATION SHEET

COLLEGE

____
STUDENT'S NAME

(A) SUBJECT NUMBER OF COURSES	ENGLISH COURSE GRADE	MAX. GRADE	MATHEMATICS COURSE GRADE	MAX. GRADE	SCIENCE COURSE GRADE	MAX. GRADE	DRAFTING COURSE GRADE	MAX. GRADE	MACHINE SHOP COURSE GRADE	MAX. GRADE	OTHER COURSE GRADE	MAX. GRADE
1	____	____	____	____	____	____	____	____	____	____	____	____
2	____	____	____	____	____	____	____	____	____	____	____	____
3	____	____	____	____	____	____	____	____	____	____	____	____
4	____	____	____	____	____	____	____	____	____	____	____	____
5	____	____	____	____	____	____	____	____	____	____	____	____
6	____	____	____	____	____	____	____	____	____	____	____	____
7	____	____	____	____	____	____	____	____	____	____	____	____
8	____	____	____	____	____	____	____	____	____	____	____	____
9	____	____	____	____	____	____	____	____	____	____	____	____
10	____	____	____	____	____	____	____	____	____	____	____	____
(B) — TOTAL	____	____	____	____	____	____	____	____	____	____	____	____
(C) — AVERAGE = TOTAL COURSE GRADES / TOTAL MAX. GRADES	____		____		____		____		____		____	

(D) — TOTAL LINE (B) TOTAL COURSE GRADE ________ TOTAL MAX. GRADE ________

(E) — OVERALL ACADEMIC AVERAGE ________

(F) — REMARKS ________________________________