AN INVESTIGATION TO PREDICT ACADEMIC SUCCESS OF STUDENTS ENROLLED IN COLLEGE FRESHMAN MATHEMATICS COURSES BY EINSTELLUNG

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by

John William Daniels

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THESIS ABSTRACT

It was the purpose of this investigation (1) to predict the academic success of college students enrolled in freshman mathematics courses by Einstellung, and (2) to validate the Einstellung Test by use of the Iowa High School Content Examination, Section 2, Mathematics, for the purpose of finding an economical and easily administered test.

In this investigation three standardized tests, two Einstellung tests, and a questionnaire were given to sixty-five students who were enrolled in freshman mathematics courses at Appalachian State Teachers College. The three standardized tests were (1) Barrett-Ryan-Schrammel English Test, (2) Co-operative School and College Ability Test, and (3) The Iowa High School Content Examination, Section 2, Mathematics. The two Einstellung tests were (1) Arithmetic Process Test and (2) Water Jar Problem Test. The Einstellung tests were used to predict the academic success of students enrolled in freshman mathematics courses. All sixty-five students took the six tests during the summer sessions of 1958.

Correlations were made between the standardized tests and the Einstellung test in order to measure the predictive value of the Einstellung test. These correlations ranged from .036 on the Water Jar Problem Test to .63 on the Arithmetic Process Test. Further correlations were made between standardized tests and letter grades. These correlations ranged from .44 on the Barrett-Ryan-Schrammel English Test to .60 on Section 2 of the Iowa High School Content Examination Test. To predict success of college students enrolled in freshman mathematics courses, correlations were made between the Einstellung test and letter grades. These correlations were .11 on the Water Jar Problem Test and .61 on the Arithmetic Process Test.

In finding an economical and efficient predictor of success in mathematics, a series of multiple correlations were made. These correlations ranged from .61 to .69.

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To my beloved wife, I wish to express my deepest appreciation for her continued sacrifices, for her confidence, encouragement, and inspiration which have enabled me to undertake the study and pursue it to its completion.

J. W. D.

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CHAPTER I

THE PROBLEM AND DEFINITIONS OF TERMS USED

The testing movement had its beginning nearly a half century ago in the measurement of individual differences in the psychological laboratories of European universities.[1] Testing has passed out of the realm of the mysterious in which it was once placed by conservative educators, and has made a lasting contribution to education at all levels and is recognized in many schools as an integral and indispensable part of the educational process.[2] Viewed in long-time perspective, the greatest success has been in the development of scales, tests, and techniques to measure the mastery of specific habits and facts. Considerable success has come from the attempts to measure thinking, reasoning, and problem solving in the processes of arithmetic, algebra, geometry, and the sciences.[3]

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[1]Paul B. Jacobson and others, Duties of School Principals (New York: Prentice Hall, Inc., 1950), p. 575.

[2]Ibid., p. 576.

[3]Lawrence E. Cole and William F. Bruce, Educational Psychology (New York: Yonkers-on-Hudson, 1950), p. 632.

I. THE PROBLEM

Statement of the problem. Two related purposes provided the problem for investigation in this study. They were (1) to predict the academic success of college students enrolled in freshman mathematics courses by Einstellung and (2) to validate the Einstellung Test by use of the Iowa High School Content Examination, Section 2, Mathematics, for the purpose of finding an economical and easily administered test.

Importance of the study. It is reasonable to assume that the grouping of students according to mathematical ability has become an important factor in our educational policies. Many institutions have established elaborate testing programs through which they attempt to predict the ability of students in order to group them.

"Since a student's status in school is to an extent determined by testing, testing has an important and awesome role in the lives of many students."[4] In many instances, the process of testing requires many unhappy hours of anxiety and frustration for students, as well as, for the

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[4] A. S. Luchins, "On Recent Usage of the Einstellung-Effect As A Test of Rigidity," Journal of Consulting Psychology, XV (November, 1951), 89-94.

examiner who must score and administer the test. Every test which is used should be administered for a specific purpose which is clear to those administering and interpreting the test and to those taking it.[5]

In our modern times, the length and number of testing programs should be reduced to a minimum. The results of these tests should enable the instructor to obtain information concerning the students which is necessary to classify them according to mathematical ability.

II. DEFINITIONS OF TERMS USED

Set. A person is said to have a "set" toward a problem when, because of past experience, he is predisposed to a particular hypothesis or plan of action and steadfastly maintains this predisposition.[6]

Einstellung. Einstellung is the set which immediately predisposes an organism to one type of motor or conscious act.[7]

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[5]Merle M. Ohlsen, Guidance: An Introduction (New York: Harcourt, Brace and Company, 1955), p. 128.

[6]Abraham S. Luchins, "Mechanization in Problem Solving, The Effect of Einstellung," Psychological Monographs, LIV (No. 6, 1942), p. 3.

[7]Ibid., p. 3.

Arithmetic Process Test. The Arithmetic Process Test is a task involving culturally induced set.[8]

Water Jar Problem Test. The Water Jar Problem Test is a task involving an experimentally induced set.[9]

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[8]Gilbert Rugg Gredler, "Ethnocentrism In Adolescents. A Study of Certain Aspects of Cognitive and Affective Characteristics" (unpublished Doctoral dissertation, The University of Illinois, 1956), p. 43.

[9]Ibid., p. 40.

CHAPTER II

REVIEW OF THE LITERATURE

Little has been written in regard to the problem of testing by Einstellung.

Since Einstellung is concerned primarily with sets, the most valid research that the writer was able to locate on sets was done by Luchins.[1] Luchins gave his subjects a group of seven problems which required the subjects to find a stipulated volume of fluid by manipulating three containers. All seven problems were solved by the formula a - b - 2c. For example, if the subjects had a ten-quart measure full of liquid and two empty measures, one holding five quarts and the other two quarts, and were required to obtain exactly one quart, they would fill the five-quart measure once and the two-quart measure twice. This would leave one quart in the ten-quart measure. The formula was not known by the subjects.

The problems were solved at first by the process of approximation and correction. The first problem required more time, but the last problems were solved

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[1] Abraham S. Luchins, "Mechanization in Problem Solving, The Effect of Einstellung," Psychological Monographs, LIV (No. 6, 1942), 1-95.

directly which indicates learning. Then, five problems, similar in nature at first glance, were given the subjects. All of these were simpler and could be solved by formulas a - c or a + c. The set that the subjects had attained toward the problem from their success with the initial seven problems predisposed them to go through the longer a - b - 2c process. Moreover, they persisted in this even though it failed to provide a solution.

Luchins used the name "Einstellung" for this kind of set. Under the impact of an Einstellung, a person does not look at a problem on its own merits, but tries mechanically to employ a previously learned method. Luchins decided that the greater the success on practice set, the greater was the force of the Einstellung, that all age groups were affected, and that education, as measured by the number of years of schooling and intelligent quotient, had no significant effect in reducing the Einstellung.

There has been various studies written in regard to the problem of prediction of academic success in mathematics. One of the most valid studies done in the prediction of academic success was done by Taylor.[2] Taylor

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[2]S. H. Taylor, "Classifying College Students On the Basis of Their Grades In Mathematics," Mathematics Teacher, XXVII (February, 1934), 76-78.

undertook the study of classifying college students on the basis of their grades in mathematics. This study consisted of sixty-six sections of analytic geometry classes under fifty instructors over a period of four years. There were approximately sixteen hundred students who participated in this study. The sectioning of students were classified on three levels, high, middle, and low ability and based on the grades in college algebra and trigonometry. By use of the Iowa Test, Taylor found that students who had five hours of college mathematics shows twenty-five per cent increase in aptitude and thirty per cent increase in training over students entering college courses in mathematics. At the end of the first six weeks the classes were given tests to check on the sectioning. The coefficient of correlations of these tests varied between .69 ± .02 to .71 ± .02 during the four years of the experiment. It was found that students sectioned into the three ability groups had greater progress than students in the control sections. Instructors and students favored this type of classification.

Another study in the field of prediction was done by Dickers.[3] Dickers was interested in the relationship between the scores made by students on the Mathematics Section

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[3]M. R. Dickers, "Relationship Between Scores On Scholastic Aptitude Test and Marks In Mathematics," Journal Of Educational Psychology, XXIX (May, 1938), 363-73.

of the Scholastic Aptitude Test at the time of their entrance to the University and their later academic success, as judged by their marks, in specific courses in first year mathematics. Dickers used five one semester mathematics courses over a period of six years involving 4,423 cases. The results of this study showed that there was a higher correlation on the Mathematics Section than the Verbal Section of the Scholastic Aptitude Test in each of the five courses each year. These correlations exceeded 0.4 with only one exception. The relationship between the Verbal Section and the achievement in mathematics was low. The results obtained from the Mathematics Section showed sufficient promises for its continued use for guidance and teaching of students in mathematics.

An investigation to obtain numerical data for correlations with known facts of success in college was done by Schoepfle and Arnold.[4] This investigation consisted of two hundred and fifty-four students enrolled in remedial or regular freshman mathematics courses. One hundred and fourteen students had average high school marks of C or D. Seventy-one per cent of this number did

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[4]G. H. Schoepfle and D. L. Arnold, "Correlation of High School and College Grades," American Journal of Physics, XXVI (November, 1958), 537-39.

unsatisfactory work the first year in college. Thirteen per cent did acceptable college work and sixteen per cent did above college work. One-third of the group which made B in high school failed to do satisfactory work during their first year in college.

For success in college mathematics, Schoepfle and Arnold concluded that a student should be among the top forty percentile of the entering college freshman or among the top twenty-two percentile of his high school senior class.

CHAPTER III

PROCEDURE

The following procedure was used in order to predict the academic success of students enrolled in freshman mathematics courses.

Selection of Subjects. During the summer terms of 1958, the writer undertook the possibilities of studying sixty-five of the students enrolled at Appalachian State Teachers College in freshman mathematics classes. For securing data for this study, the writer used the six freshman mathematics classes that were being taught by four instructors at different periods of the day. The classes that were taught the first summer term were as follows: one course of basic mathematics at 11:30 A. M., one course of college algebra at 9:30 A. M., and one course of plane trigonometry at 8:30 A. M. Classes taught during the second summer term included two basic mathematics courses, one at 11:15 A. M. and the other at 12:15 P. M., while the college algebra course was taught at 10:00 A. M.

The sixty-five subjects used were college freshmen, sophomores, and juniors. Each of the subjects consented to participate in this study and no attempt was made to determine class memberships either before or after the course began. Each of the subjects was participating in a regular summer schedule of at least six quarter hours

of work.

Selection and Description of Standardized Test. In planning the procedure the writer selected the Barrett-Ryan-Schrammel English Test and the Co-operative School and College Ability Test. The writer selected these tests because they are given to all freshmen entering Appalachian State Teachers College. The Iowa High School Content Examination, Section 2, Mathematics, was given to all subjects.

I. BARRETT-RYAN-SCHRAMMEL ENGLISH TEST

The Barrett-Ryan-Schrammel English Test is designed to measure objectively proficiency of both student and classes in the essential mechanics of English. The areas included are fundamental to success in written expression and many are also related to effectiveness in oral expression. The test may be used for diagnostic and survey purposes, as well as for placement or grouping in high school and college classes. The test is entirely objective, consisting of one hundred and eighty items, and the working time required is sixty minutes.[1]

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[1]E. R. Barrett, T. M. Ryan, and H. E. Schrammel, Barrett-Ryan-Schrammel English Test Manual of Directions (New York: Yonkers-on-Hudson, 1954), p. a.

II. CO-OPERATIVE SCHOOL AND COLLEGE ABILITY TEST

The Co-operative School and College Ability Test contains four subtests. Two are a measure of developed ability in skills that are closely related to student success in the verbal kinds of school learning. The other tests are measures of ability in certain quantitative skills of number manipulation and problem solving. The component parts of the tests are sentence completion task, numerical computation task, vocabulary task, and numerical problem solving task. The test can be used to estimate the general level of students and instruction. The test also can be used roughly to group students according to their quantitative ability.[2]

III. IOWA HIGH SCHOOL CONTENT EXAMINATION, SECTION 2, MATHEMATICS

The Iowa High School Content Examination is designed to provide a quick and accurate appraisal of high school juniors', seniors', and college students' knowledge in each of the four basic areas. These four areas are: (1) English

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[2] Cooperative School and College Ability Test Examination Test Examiner's Manual (Princeton: Educational Testing Service, 1955), p. 3.

and Literature, (2) Mathematics, (3) Science, and (4) History and the Social Studies. The total score furnishes an over all evaluation of the student's general mastery of the subject matter content of these fields. Examination of the four subjects scores reveals the extent to which the student is strong or weak. In Section 2, Mathematics, are problems of skills which a student might be expected to acquire in typical courses in Plane Geometry and High School Algebra.[3]

Selection and Description of Other Tests. The writer selected the Arithmetic Process Test and Water Jar Problem Test for the reason that the first involves a culturally induced set and the second involves an experimentally induced set.

I. ARITHMETIC PROCESS TEST

The Arithmetic Process Test consists of a number of easy mathematical problems involving addition, subtraction, multiplication, and division. These problems are worked in the conventional manner except for the following changes: (1) The plus sign means subtract, (2) the minus sign means add, (3) the multiplication sign means divide, and (4) the

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[3]D. B. Stuit, H. A. Greene, and G. M. Ruch, The Iowa High School Content Examination Examiner's Manual (Iowa City: Bureau of Educational Research and Service Extension Division, 1943), p. 8.

division sign means mutiply. A high score indicates a lack of set while a low score indicates the presence of set. The test contains sixty problems with a working time of ten minutes.[4] (See Appendix for test copy.)

II. WATER JAR PROBLEM TEST

The Water Jar Problem Test is composed of eight problems involving three water jar containers of different capacities. These water jars must be manipulated in order to obtain a required amount of water. The first five problems can only be solved by the set or indirect method. The next two problems can be solved by either the set or direct method. The last problem can be worked by the direct method only. Einstellung is measured in problem six or seven by whether or not the direct or indirect method was used. Working time of the test is twenty minutes.[5] (See Appendix for test copy.)

Description of the Questionnaire. The questionnaire consists of two parts. The first part is a list of

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[4]Gilbert Rugg Gredler, "Ethnocentrism In Adolescents. A Study of Certain Aspects of Cognitive and Affective Characteristics" (unpublished Doctoral dissertation, The University of Illinois, 1956), pp. 43-44.

[5]Ibid., pp. 40-41.

thirty-seven statements that are answered by use of agree, strongly disagree, or undecided. The thirty-seven statements are intended to help discover what the subjects think of mathematics.[6] The second part is for the purpose of gaining information concerning past experiences in mathematics and the letter grade of what the subjects expect to receive in the mathematics course in which they are enrolled. (See Appendix for questionnaire copy.)

Description of Letter Grade. The academic standing of a subject in any course at Appalachian State Teachers College is indicated by letters as follows: A excellent, B good, C average, D passing, and F failure.

METHOD OF PROCEDURE

The Iowa High School Content Examination, Section 2, Mathematics, Water Jar Problem Test, Arithmetic Process Test, and the questionnaire were distributed to three instructors. These tests were administered during the first class period of each summer session. The following directions for the tests were given to the instructors.

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[6]The National Council of Teachers of Mathematics, Twenty Second Yearbook: Emerging Practice In Mathematics Education (Washington, D. C., 1954), pp. 408-09.

I. IOWA HIGH SCHOOL CONTENT EXAMINATION, SECTION 2, MATHEMATICS

The subjects were instructed to read the cover page of the test for the basic directions. Other directions were given from the manual by the instructors. The instructors gave the signal to begin and after the twenty-minute time period the tests were collected promptly and returned to the writer.

II. WATER JAR PROBLEM TEST

The subjects were instructed to read the cover page of the test which contained basic directions. Prior to the test other directions given to the instructors by the writer were as follows:

1. Have each person to fill in the blanks at the top of the test.
2. Be sure each person reads all directions.
3. Give only twenty minutes for the test. If anyone finishes before the twenty minutes time period, take up his test.
4. Be sure that no one returns to test problems previously attempted.
5. No talking during the test.

The signal to begin the test was given by the instructors and after the twenty minute time period all tests were collected and returned to the writer.

III. ARITHMETIC PROCESS TEST

All subjects were instructed to read the cover page of the test which contained basic directions. Directions given to the instructors by the writer were as follows:

1. Have all subjects fill in blanks at the top of the test.
2. Be sure each subject reads the basic directions.
3. Give only ten minutes for the test. If any subject completes the test before the ten minute time period, take up his test.
4. Be sure that no one returns to previous test problems attempted.
5. No talking during the test.

The signal to begin the test was given by the instructors. After the ten-minute time period all tests were collected and returned to the writer.

IV. QUESTIONNAIRE

Each instructor read the basic directions to the subjects. The instructor then notified the subjects that there was no time limit set on answering the questionnaire. All subjects were asked to answer the questionnaire as honestly as possible. When the subjects had finished their questionnaires, they were collected and returned to the writer.

In gathering test score data the writer found that the transfer students had not taken the Barrett-Ryan-

Schrammel English Test and the Co-operative School and College Ability Test. They were requested to take these tests. They took the tests which were given by the Director of Counseling Service at Appalachian State Teachers College. The test scores of the Barrett-Ryan-Schrammel English Test and the Co-operative School and College Ability Test of all participating subjects were obtained from the Personnel Office at Appalachian State Teachers College.

Four consultants were selected to act as judges for the purpose of tabulating and reviewing the thirty-seven statements from the questionnaire. Each of the thirty-seven statements was placed on a coded index card and mixed to make a random selection. The cards were then presented to each judge separately to be placed in different categories as determined by similarity of content.

The following directions accompanied the thirty-seven statements:

Please follow the steps. Do not mark on the cards.

1. Read the following cards.
2. Place the cards that refer to similar ideas into groups.
3. Label each group as to a similar idea expressed.
4. Arrange the groups according to their importance.

Upon completion of their evaluation, the judges returned their findings to the writer. The results of the findings are as follows:

Judge A

1. Importance of Mathematics, easy if you like it and work at it.
2. Mathematics is hard.
3. Mathematics is not important.
4. Compelled to take it.

Judge B

1. Reasons for liking Mathematics.
2. Suggestions for improving teaching and learning in Mathematics.
3. Student's viewpoint, classroom work.
4. Reasons for disliking Mathematics.

Judge C

1. Success and, or failure with Mathematics.
2. Procedural (Class organization, teaching, method, time, etc.)
3. Personal satisfaction aspects of Mathematics.
4. The value of Mathematics.
5. The practical use of Mathematics.
6. Miscellaneous.

Judge D

1. Reasons for liking Mathematics.
2. General attitudes about Mathematics.
3. Reasons for not liking Mathematics.
4. Teaching procedures in Mathematics.
5. Time required for Mathematics.

After tabulating the decisions of the judges, the writer selected three categories which appeared most frequently in the decisions of the judges. Using the same index cards, the writer returned the thirty-seven state-

ments to the judges with the following letter:

PLEASE FOLLOW DIRECTIONS

The following categories were selected by you. Segregate the cards into one of the following categories and under each heading below record the code number of the card that you segregated.

I. Positive attitudes toward Mathematics.
II. Procedure for teaching and learning Mathematics.
III. Negative attitudes toward Mathematics.

The results of the findings of the judges are shown in Table I. The four judges placed nineteen statements in the category named positive attitudes toward mathematics, and twelve statements in the category named negative attitudes toward mathematics. If two or more judges agreed on an item, it was considered in that particular category. The writer tabulated and then assigned a numerical value to the thirty-seven statements in order to equate them. These values were: For positive attitudes toward mathematics (1) a plus two for agree, (2) a zero for undecided, and (3) a minus two for strongly disagree. For negative attitudes toward mathematics (1) a minus three for agree, (2) a zero for undecided, and (3) a plus three for strongly disagree.

TABLE I

THE PLACEMENT OF THE THIRTY-SEVEN STATEMENTS OF THE QUESTIONNAIRE BY FOUR JUDGES

Statement	Judges				Group Placement
	A	B	C	D	
1	3	1	3	3	3
2	1	1	1	1	1
3	1	1	1	1	1
4	3	3	3	3	3
5	2	2	2	2	2
6	2	2	2	2	2
7	3	3	3	3	3
8	1	1	1	1	1
9	2	2	2	2	2
10	3	1	2	2	2
11	3	3	3	2	3
12	3	2	1	3	3
13	1	1	1	1	1
14	1	1	1	1	1
15	3	3	3	3	3
16	1	1	1	1	1
17	2	2	1	1	1
18	3	3	2	2	3
19	1	1	1	1	1
20	1	1	1	1	1
21	1	1	1	1	1
22	1	1	1	1	1
23	1	1	3	3	3
24	1	1	1	1	1
25	1	1	1	1	1
26	1	1	1	1	1
27	1	1	1	1	1
28	1	1	1	1	1
29	3	3	3	3	3
30	2	3	2	2	2
31	1	1	1	1	1
32	1	1	1	1	1
33	3	3	3	3	3
34	3	3	3	3	3
35	2	2	2	2	2
36	3	3	3	3	3
37	1	1	1	1	1

V. GRADES

Letter grades were secured which the instructors gave the subjects at the end of the summer sessions. These grades were used in Pearson product-moment coefficient of correlation, chi-square, and the biseral correlation and used as criteria for success in mathematics.

CHAPTER IV

ANALYSIS OF DATA

To obtain the predictive success of college students enrolled in freshman mathematics courses, sixty-five subjects were given a series of standardized tests, two Einstellung tests, and a questionnaire, the results of which were compared to the letter grade given by the instructor.

Correlations were made between the standardized tests and the Einstellung tests in order to measure the predictive value of the Einstellung tests. These correlations ranged from .036 on the Water Jar Problem Test to .63 on the Arithmetic Process Test. Further results of these correlations can be found in Table II and Table III.

Further correlations were made between the letter grades given to the subjects by the instructors and the standardized tests. These correlations ranged from .44 on the Barrett-Ryan-Schrammel English Test to .60 on Section 2 of the Iowa High School Content Examination Test. Further results of these correlations can be found in Table IV.

To predict success of college students enrolled in freshman mathematics courses, correlations were made

TABLE II

PEARSON PRODUCT-MOMENT COEFFICIENT OF CORRELATION, RANGE, MEAN, STANDARD DEVIATION, AND STANDARD ERROR OF CORRELATION DATA WITH ARITHMETIC PROCESS TEST

Test	Range	Mean	Standard Deviation	Correlation	Standard Error of Correlation
Iowa High School Content Examination, Section 2, Mathematics	44	51.58	9.04	.63	.099
Co-operative School and College Ability Test	79	288.26	15.82	.39	.105

TABLE III

BISERAL CORRELATION, RANGE, MEAN OF GROUP I, MEAN OF GROUP II, STANDARD DEVIATION, AND ERROR OF CORRELATION DATA OF WATER JAR PROBLEM TEST

Test	Range	Mean of Group I	Mean of Group II	Standard Deviation	Correlation	Standard Error of Correlation
Arithmetic Process Test	60	50.84	53.68	10.60	.173	.077
Iowa High School Content Examination, Section 2, Mathematics	44	50.77	50.82	9.04	.036	.064
Co-operative School and College Ability Test	79	288.63	286.73	15.82	.078	.079

TABLE IV

PEARSON PRODUCT-MOMENT COEFFICIENT OF CORRELATION,
RANGE, MEAN, STANDARD DEVIATION,
STANDARD ERROR OF CORRELATION
DATA WITH LETTER GRADES

Test	Range	Mean	Standard Deviation	Correlation	Standard Error of Correlation
Arithmetic Process Test	60	51.80	10.60	.61	.078
Barrett-Ryan-Schrammel English Test	120	93.46	30.30	.44	.133
Co-operative School and College Ability Test	79	288.26	15.82	.53	.118
Iowa High School Content Examination, Section 2, Mathematics	44	51.58	9.04	.60	.079
Questionnaire	98	22.48	23.59	.39	.105

between the Einstellung tests and the letter grades given by the instructors. These correlations were .11 on the Water Jar Problem Test and .61 on the Arithmetic Process Test. Other results of these correlations can be found in Table IV and Table V.

In obtaining a relationship of individual attitudes and predictive success, a correlation was made between the questionnaire, Part I and the letter grades. This correlation was .39. Further results of this correlation can be found in Table IV. Question one of Part II of the questionnaire was misleading; therefore, no results could be obtained. Question two, Part II, indicated that 67 per cent of the subjects expected higher letter grades than earned and 19 per cent of the subjects expected a lower letter grade than earned.

To find an economical and efficient predictor of success in mathematics a series of multiple correlations were made. The correlation of letter grades compared to the Iowa High School Content Examination, Section 2, Mathematics, and the Arithmetic Process Test was found to be .67. The correlation of letter grades compared to the Co-operative School and College Ability Test and the Arithmetic Process Test was found to be .69. The correlation of letter grades

TABLE V

A CHI-SQUARE TEST OF THE DISTRIBUTIONS OF LETTER GRADES AND WATER JAR PROBLEM TEST

Grades	Group I		Group II		Group I	Group II
	Fo	Fe	Fo	Fe	$\frac{(Fo-Fe)^2}{Fe}$	$\frac{(Fo-Fe)^2}{Fe}$
A	5	5.95	4	3.05	.152	.296
B	6	5.95	3	3.05	.001	.001
C	14	13.89	7	7.11	.001	.002
D	7	7.28	4	3.72	.011	.021
F	11	9.92	4	5.08	.117	.230
Σ	43	42.99	22	22.01	$X^2 = .832$	

Phi Correlation Coefficient = .11

compared to the Water Jar Problem Test and the Arithmetic Process Test was found to be .61.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

SUMMARY

During the past half century testing has become an important tool. From measuring intelligence quotients to the most specialized fields progress has been acquired through testing. For the students and instructors a more adaptable type of testing is the predictive test. Predictive tests should be used to prescribe success for students in courses in which they could be successful. Frequently instructors of mathematics have students who do not belong in a particular course because the level of that course does not correspond to their abilities. By giving predictive tests, students could be placed in academic levels in which they could succeed. These levels would then give the instructor an opportunity to challenge or motivate the class as a whole without having the problem of the extreme upper and lower ability students. The ability to perform with an academic level comparable to other students would give some students motivation that is not acquired when they are misplaced.

One of the major purposes of this investigation was to predict the academic success of college students enrolled in freshman mathematics courses by Einstellung and secondly, to validate the Einstellung test by use of Section 2, Iowa High School Content Examination for the purpose of finding an economical and easily administered test. The writer recognizes the following limitations of this study: only sixty-five cases were used and such factors as age, sex, intelligence, prior experience, environment, desire, courage and resourcefullness could not be controlled. The writer further realized that more than one testing should be made and that one instructor should be used in order to substantiate all results.

In this study three standardized tests, two Einstellung tests, and a questionnaire were administered to sixty-five subjects enrolled in freshman mathematics classes at Appalachian State Teachers College. The tests consisted of: (1) Iowa High School Content Examination, Section 2, Mathematics; (2) Barrett-Ryan-Schrammel English Test; (3) Co-operative School and College Ability Test; (4) Water Jar Problem Test; (5) Arithmetic Process Test; (6) questionnaire. All sixty-five subjects took these tests at the beginning of the summer sessions and each test was recorded

in raw scores. The standardized tests were used to validate letter grades given by the instructors. The correlations between the letter grades and the standardized tests ranged from .44 on the Barrett-Ryan-Schrammel English Test to .60 on Section 2, Iowa High School Content Examination. To validate the Einstellung test correlations were made between the Einstellung test and the standardized test. These correlations ranged from .036 on the Water Jar Problem Test to .63 on the Arithmetic Process Test. To obtain predictive success correlations were made between letter grades and the Einstellung tests. These correlations were .11 on the Water Jar Problem Test and .61 on the Arithmetic Process Test. The questionnaire was used to determine those attitudes that subjects had toward mathematics. The correlation between the letter grades and the questionnaire was .39.

Three multiple correlations were made to devise an economical and easily administered test. These correlations ranged from .61 to .69.

The most important factor of a testing program is the use of the results obtained from the test. The results from this study can be used in the following ways: (1) classification of academic success of the students enrolled in freshman mathematics courses, (2) determining students who need counseling in attitudes toward mathematics,

(3) motivation, and (4) evaluating student and teacher performance.

CONCLUSIONS

As a result of the survey of literature available and the analysis of data obtained, it may be concluded that: (1) no significant results could be obtained because of the use of four different instructors; (2) the Water Jar Problem Test showed very little significance in predicting academic success; (3) the Arithmetic Process Test indicated some relationship in the prediction of academic success; (4) the questionnaire showed very little significance in attitudes toward mathematics; and (5) letter grades compared to Einstellung test with standardized test show some relationship as an easy predictor of academic success.

RECOMMENDATIONS

In the light of the findings of this study, it is recommended: (1) that the placement of students according to academic success should be of prime importance; (2) that all students who show the Einstellung effect be counseled in the logic of mathematics; and (3) further study should be made to determine an effective method to remove negative set.

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APPENDIX

TABLE VI

FREQUENCY DISTRIBUTION DATA
OF BARRETT-RYAN-SCHRAMMEL ENGLISH TEST

Raw Score	Frequency
34- 43	1
44- 53	4
54- 63	4
64- 73	7
74- 83	10
84- 93	9
94-103	5
104-113	4
114-123	10
124-133	4
134-143	3
144-153	1
154-163	3

TABLE VII

FREQUENCY DISTRIBUTION DATA
CO-OPERATIVE SCHOOL AND COLLEGE ABILITY TEST

Raw Score	Frequency
255-261	2
262-268	6
269-275	1
276-282	14
283-289	18
290-296	7
297-303	6
304-310	5
311-317	3
318-324	1
325-331	1
332-338	1

TABLE VIII

FREQUENCY DISTRIBUTION DATA
OF LETTER GRADES

Grade	Frequency
A	9
B	9
C	21
D	11
F	15

TABLE IX

FREQUENCY DISTRIBUTION DATA
OF ARITHMETIC PROCESS TEST

Raw Score	Frequency
0- 3	2
4- 7	0
8-11	0
12-15	0
16-19	0
20-23	0
24-27	0
28-31	0
32-35	1
36-39	0
40-43	4
44-47	2
48-51	14
52-55	14
56-59	22
60-63	6

TABLE X

FREQUENCY DISTRIBUTION DATA
OF QUESTIONNAIRE

Raw Score	Frequency
-34- -28	3
-27- -21	1
-20- -14	0
-13- - 7	2
- 6- 0	5
1- 7	6
8- 14	9
15- 21	3
22- 28	5
29- 35	13
36- 42	4
43- 49	4
50- 56	5
57- 63	4
64- 70	1

TABLE XI

FREQUENCY DISTRIBUTION DATA
OF IOWA HIGH SCHOOL CONTENT EXAMINATION,
SECTION 2, MATHEMATICS

Raw Score	Frequency
38-41	9
42-45	13
46-49	10
50-53	11
54-57	10
58-61	5
62-65	4
66-69	0
70-73	1
74-77	1
78-81	0
82-85	1

TABLE XII

TABULATION OF RAW SCORES

KEY

Test 1 - Barrett-Ryan-Schrammel English Test
Test 2 - Iowa High School Content Examination, Section 2, Mathematics
Test 3 - Co-operative School and College Ability Test
Test 4 - Arithmetic Process Test
Test 5 - Water Jar Problem Test
Test 6 - Questionnaire
Test 7 - Letter Grade
Test 8 - Anticipated Grade

Case	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Test 8
1	57	64	313	58	I	38	C	C
2	117	50	300	57	I	30	B	C
4	74	42	262	43	I	-12	F	C
5	75	42	281	52	II	1	B	B
8	80	49	257	32	I	11	F	C
9	117	49	292	56	I	10	C	B
10	160	61	325	59	II	6	A	B
11	128	48	280	54	I	1	F	C
12	85	47	285	51	II	-31	D	C
13	87	44	288	60	I	27	D	C
14	74	50	277	52	II	30	B	A
15	89	47	289	52	I	1	F	B
16	69	40	281	51	I	37	F	D
17	95	39	313	58	I	- 1	D	B
18	124	53	278	59	I	38	A	B
19	108	42	298	60	I	62	C	A
20	101	59	304	55	I	32	C	D
21	46	49	272	55	II	11	F	A
22	66	45	266	41	I	30	C	C
24	114	49	288	59	II	1	D	C
25	73	57	293	49	I	1	A	C
26	108	50	279	59	II	- 5	F	F
27	112	55	286	54	I	- 4	B	C
28	50	43	280	46	I	11	D	A
30	135	56	286	53	II	- 7	C	B

TABLE XII (continued)

Case	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Test 8
31	89	44	288	60	I	-34	F	D
32	89	47	283	50	II	53	C	C
33	99	62	298	60	I	53	B	A
35	63	40	280	45	II	61	C	B
36	97	45	305	49	I	22	F	C
37	81	53	263	57	I	56	B	A
38	144	54	292	59	I	21	B	C
39	121	53	286	56	I	35	C	A
40	114	55	295	56	I	-24	D	C
41	82	61	288	55	II	45	C	A
42	83	43	281	57	II	31	C	B
43	75	38	283	0	I	24	D	B
44	156	82	336	59	I	54	A	B
45	137	49	296	58	II	11	A	B
46	75	45	276	49	II	62	B	B
47	72	40	286	50	I	30	F	B
48	157	56	313	60	I	47	C	B
49	120	63	320	57	II	44	A	B
50	70	44	279	40	I	48	C	C
51	60	50	283	49	I	-29	F	C
52	129	54	281	54	I	13	C	B
53	45	45	289	51	II	- 4	F	D
54	120	57	281	54	I	23	C	A
55	51	53	286	48	I	51	F	C
57	85	49	297	59	II	26	C	A
58	82	39	257	51	II	35	F	B
59	89	51	282	59	I	34	C	B
60	37	39	268	41	I	11	D	B
61	93	58	295	53	I	30	C	A
62	130	54	310	58	I	17	A	B
63	121	54	290	60	I	61	B	B
64	72	43	284	55	I	40	C	C
65	106	62	297	57	II	30	C	C
66	118	71	306	51	II	64	A	B
67	58	39	266	1	I	- 1	D	C
68	135	77	308	59	I	30	A	B
69	119	61	300	52	II	34	B	B
71	67	39	263	49	II	12	D	C
72	91	50	284	48	I	17	F	B
73	99	52	289	56	I	10	C	B

Name _____ Reg. No. _____

STUDENT INVENTORY OF MATHEMATICS

This check list is intended to help us discover what you think about mathematics. Mark each statement truthfully and thoughtfully so that the best kind of course can be planned for you and for those who follow you.

PART ONE

Use the following code in describing your thinking with respect to the item:

Agree A Undecided U Strongly disagree D

Example: (A) a. Number work is interesting.

( ) 1. Mathematics is my most difficult course.
( ) 2. Mathematics is my easiest course.
( ) 3. I am taking this course because I like mathematics.
( ) 4. The only reason I am taking this course is that it is required for college work.
( ) 5. I learn mathematics best by working things out for myself.
( ) 6. I'd rather have my teacher make specific assignments than to plan my own work.
( ) 7. Most projects in mathematics are of little value.
( ) 8. Mathematics is as important a part of our culture as music or art.
( ) 9. I get more out of solving stated problems than out of practice exercises.
( ) 10. I don't have enough time to do my best in mathematics.
( ) 11. I think students are foolish to spend a lot of time doing neat work.
( ) 12. I think it is more important to do a lot of things than to do a few things well.
( ) 13. It is easy to get a good grade in mathematics.
( ) 14. This course is the most valuable course I am taking this year.
( ) 15. This course is the least valuable course I am taking this year.
( ) 16. One of the things I like best about mathematics is its logic and precision.
( ) 17. I get a lot of satisfaction out of doing my work in an orderly, neat way.

( ) 18. There is too much homework in mathematics.
( ) 19. Mathematics gives me a chance to do lots of independent projects.
( ) 20. This course will help me to become the kind of person I want to be.
( ) 21. Mathematics will be valuable all my life.
( ) 22. Mathematics teaches me how to discover facts.
( ) 23. I would like to have time to do still more work in the course.
( ) 24. I have advised my friends to take mathematics.
( ) 25. Mathematics is about problems that interest me.
( ) 26. One of the things I like about mathematics is that it is challenging.
( ) 27. I think mathematical training is necessary for most vocations.
( ) 28. Mathematics courses gives me a chance to do creative, original work.
( ) 29. I would like school better if I didn't take mathematics.
( ) 30. I need more help with arithmetic than with the mathematics in this course.
( ) 31. Mathematics has made me curious about many new ideas.
( ) 32. Mathematics has shown me how to buy things wisely.
( ) 33. Most of my work in this class will be done to get a good grade rather than to learn something worthwhile.
( ) 34. I have lost interest in mathematics because I am not successful.
( ) 35. I need help outside of class in order to keep up with my friends.
( ) 36. Mathematics doesn't help me learn how to study.
( ) 37. I would like to have more courses in mathematics.

PART TWO

Mathematics courses completed in high school and college:

_____ Grade ____ _____ Grade ____

_____ Grade ____ _____ Grade ____

_____ Grade ____ _____ Grade ____

What grade do you anticipate in this course? _____

FIRST LETTER TO JUDGES

Dear Sir:

Please follow the steps. Do not mark on the cards.

1. Read over the following cards.
2. Place the cards that refer to similar ideas into groups as you see them.
3. Label each group as to the central idea expressed.
4. Arrange the groups according to their importance.

Thank you,

John W. Daniels

SECOND LETTER TO JUDGES

Dear Sir:

PLEASE FOLLOW DIRECTIONS

The following categories were some selected by you.

1. Segregate the cards into one of the following categories.
2. Under each heading listed below record the code number of the card that you have segregated.

I. Positive attitudes toward mathematics.

II. Procedure for teaching and learning mathematics.

III. Negative attitudes toward mathematics.

Thank you,

John W. Daniels

DIRECTIONS GIVEN TO INSTRUCTORS FOR WATER JAR PROBLEM TEST AND THE ARITHMETIC PROCESS TEST

DIRECTIONS FOR THE WATER JAR PROBLEM TEST

1. Have each person fill in the blanks at the top of the test.
2. Be sure each person reads the directions.
3. Give only twenty minutes for this test. If anyone finishes before twenty minutes take up the test.
4. Be sure that no one returns to previous problems.
5. No talking during the test.

DIRECTIONS FOR THE ARITHMETIC PROCESS TEST

1. Have everyone fill in blanks at the top of the test.
2. Be sure each person reads the directions.
3. Give only ten minutes for the test. If anyone finishes before ten minutes take up the test.
4. Be sure that no one returns to previous problems.
5. Make sure that there is no talking while the test is going on.

ARITHMETIC TEST

NAME _____ Date _____

School _____ Class _____

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

INSTRUCTIONS

1. This test consists of a number of easy mathematical problems involving addition, subtraction, multiplication, and division . BUT the signs have been changed in the following way:

   \+ means subtract

   \- means add

   × means divide

   ÷ means multiply

2. Here is an example:

   8 ÷ 4 = 32 because we read the division sign as a multiplication sign so it is 8 multiplied by 4 = 32.

3. Try these:

   6 × 3 ÷ 2 =
   5 ÷ 2 + 1 =

   The answers to the above problems are 4 and 9 respectively.

4. When the signal is given (not yet) turn to the next page and do as many problems as you can. Work as quickly and as accurately as you can.

5. Work each problem by starting with the first number and performing each mathematical operation in turn.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

ARITHMETIC TEST

$6 - 8 \times 7 \div 4 =$

$5 + 3 =$

$4 \times 2 =$

$9 \div 3 =$

$8 - 4 =$

$3 \times 3 =$

$5 + 5 =$

$6 \times 3 =$

$6 - 5 =$

$4 \div 2 =$

$7 + 3 =$

$6 + 3 - 2 =$

$5 + 4 - 7 =$

$3 - 9 + 6 =$

$8 \times 2 - 1 =$

$6 \div 3 \times 9 =$

$4 - 2 \times 2 =$

$9 + 6 - 4 =$

$8 \times 2 - 3 =$

$1 - 7 \times 4 =$

$5 \div 3 - 2 =$

$9 \times 3 + 2 =$

$5 + 3 - 2 =$

$6 \div 4 - 4 \times 7 =$

$4 \times 2 - 3 + 1 =$

$5 \times 5 - 4 \div 5 =$

$8 + 4 - 1 \div 3 =$

$9 + 2 + 3 - 1 =$

$3 \div 9 - 4 + 7 =$

$5 \div 4 - 5 + 6 =$

$7 + 1 \times 2 \times 3 =$

$8 \div 2 - 4 - 5 =$

$8 - 3 + 5 \times 3 =$

$3 + 2 \div 9 - 7 =$

$5 \div 5 - 2 + 8 =$

$4 \times 2 - 2 \div 4 =$

$3 \div 3 - 1 + 2 =$

$8 + 4 \div 4 - 1 =$

$7 + 1 \div 3 \times 2 =$

$5 - 3 \times 4 + 1 =$

$9 \times 3 + 2 \div 9 =$

$6 \div 3 - 2 \times 2 =$

$8 \times 2 \div 5 - 4 =$

$3 \times 3 - 5 \div 2 =$

$4 \div 2 + 1 - 5 =$

$7 + 3 - 5 \times 3 =$

$3 \times 3 + 1 =$

$6 \div 2 + 3 =$

$8 \times 2 + 1 =$

$4 - 4 \div 8 =$

$7 \div 9 + 3 \times 2 =$

$3 + 1 - 5 \div 4 =$

$2 \div 6 \times 4 - 7 =$

$5 \times 5 - 8 \div 4 =$

$2 - 2 \div 4 \times 8 =$

$6 + 2 \times 2 \div 9 =$

$8 \div 3 - 1 \times 5 =$

$3 + 1 - 4 \div 7 =$

$6 \times 3 + 1 \div 8 =$

$6 - 4 \div 2 + 5 =$

NAME _____ DATE _____

SCHOOL _____ CLASS _____

Water Jar Problems

In the following problems three water-jar containers of different capacity are available (Column X). You are to obtain the amount of water that is asked for in Column Y. Your solution to the problem should be stated in Column Z. The water supply is unlimited. You may use any or all of the jars given in Column X. Thus:

Examples:

	Column X (Jars Available)	Column Y (Obtain)	Column Z (Solution)
1.	4 quart, 10 quart, 3 quart	Measure out exactly 7 quarts	1. Fill the 10 qt. jar; Pour from this jar into the 3 qt. jar. You now have 7 qts. left in the large container - the amount asked for. This procedure can be shown thus: 10 - 3 = 7. Or you can fill the 4 qt. jar and the 3 qt. jar. Result - you have 7 qts. This can also be shown thus: 4 + 3 = 7.
2.	42 quart, 71 quart, 5 quart	19 quarts	2. Fill up the 71 qt. jar. Pour the water from this jar into the 42 qt. jar.

You now have 29 qts. left in the large container. Now pour 5 more qts. into the 5 qt. jar. Empty this jar and pour 5 more qts. into it. You now have 19 qts. left in the large container - the amount asked for. This procedure can also be shown thus: 71 - 42 - 5 - 5 = 19.

On the next page are eight problems involving water jars. You may write out your solution (see above examples), or you may show your solution by using numbers as above (i.e., 10 - 3 = 7; 4 + 3 = 7; 71 - 42 - 5 - 5 = 19.

Start with problem 1 and do each problem in the order presented. Do not return to any previous problem.

Water Jar Problems

	Column X (Jars)	Column Y (Obtain)	Column Z (Solution)
1.	21, 127, 3	100	
2.	14, 163, 25	99	
3.	18, 43, 10	5	
4.	11, 44, 8	17	
5.	20, 59, 4	31	
6.	23, 49, 3	20	
7.	15, 39, 3	18	
8.	28, 76, 3	25	

Use this space for figuring if necessary.

DIRECTIONS FOR GIVING
IOWA HIGH SCHOOL CONTENT EXAMINATION
SECTION 2, MATHEMATICS

The specific steps in the administration of the tests should be as follows:

1. When the students are seated in the classroom, count and check the number in each row. It is better if the students are not crowded more than is necessary.
2. Pass out the test booklets with the answer sheets inserted, placing one copy face up on the desk or arm of the chair.
3. Instruct the students to fill in the blanks on the answer sheet. Call attention especially to the fact that the number and form (L or M) of the test booklet must be entered in the blanks at the top of the answer sheet.
4. Then say, "The general directions for the test are given on the front page. Read these directions silently, while I read them aloud." Read the directions with emphasis on especially important points. Go through the samples carefully.

When using the machine-scored answer sheets, say: "The general directions for the test are given on the front page. Read these directions silently while I read them aloud." Read as follows: "This is a test of your knowledge of the field of Mathematics. Now look at the sample exercise just below where you wrote your name. The type of exercise and the method of recording responses are indicated on the answer sheet. In the sample, the answer is Washington, so the answer space under 4, corresponding to the fourth choice, is filled in. The answer spaces for the exercises in the test booklet are on the separate answer sheet. Make no marks on the test booklet. All answers must be placed on the answer sheet rather than on the test booklet."

5. Then say, "I should like to caution you about several things in taking the test. First, fold the pages back as you proceed through the book. (Demonstrate) Second, place the separate answer sheet under the test booklet with only the numbered answer spaced for the page showing along side of the numbers of the exercises.

The numbers of the answer spaces match the numbered items on the page. Be very careful to record your responses in the proper spaces on the answer sheet. Third, do all of your figuring on the scratch paper."

6. Then say, "Are there any questions? Remember, no questions will be answered after the examination has started."
7. Then say,"Turn the page and fold it back. Section 2, Mathematics, begins on page 6, continues through page 7, and to the bottom of page 8. There are 60 items in this section. you will have 20 minutes for this section of the test. Ready, Go!" Record the starting time.
8. After 20 minutes say, "Stop!"