DOCUMENT RESUME

ED 043 507 24 SE 009 570

AUTHOR Lind, Donald J.
TITLE The Identification of Those College Students for which Programmed College Basic Algebra Is Most Effective, Final Report.
INSTITUTION Coffeyville Community Junior Coll., Kans.
SPONS AGENCY Office of Education (DHEW), Washington, D.C. Bureau of Research.
BUREAU NO BR-8-F-106
PUB DATE May 70
GRANT OEG-6-9-008106-0052(010)
NOTE 35p.

EDRS PRICE EDRS Price MF-$0.25 HC-$1.85
DESCRIPTORS Achievement, Algebra, *College Mathematics, Independent Study, Instruction, *Junior College Students, Mathematics, *Programed Instruction, *Research, *Student Ability

ABSTRACT

Reported are the results of an eighteen-month study of junior college students using programmed algebra materials. Of the 118 students tested at the beginning of the study, only 77 completed the course. When the students were divided into three subgroups based on either their entering mathematics ability or reading ability, the highest group performed significantly better (.01) than those in the lower groups. There was no significant difference between the lower groups. All students were most successful with problems involving manipulation of algebraic terms, but had difficulty with recall or with verbal problems. There was no significant difference between students' pre- and post-attitudes. The author concluded that a motivation factor might have influenced the research results. (RS)

FINAL REPORT
Project No. 8-F-106
Grant No. OEG-6-9-008106-0052 (010)

The Identification of Those College Students for which Programmed College Basic Algebra is most Effective

Donald J. Lind
Coffeyville Community Junior College
Coffeyville, Kansas 67337

May 1970

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
Bureau of Research

PA24
BR 8-F-106
SE

Final Report

Project No. 8-F-106
Grant No. OEG-6-9-008106-0052 (010)

The Identification of Those College Students for which Programmed College Basic Algebra is most Effective

Donald J. Lind

Coffeyville Community Junior College

Coffeyville, Kansas

May 1970

The research reported herein was performed pursuant to a grant with the Office of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
Bureau of Research

ACKNOWLEDGMENTS

The writer wishes to acknowledge his indebtedness to two particular individuals who have assisted in the development and analysis of this study.

Sincere appreciation goes to the writer's major project consultant, Dr. John T. Roscoe, Associate Professor of Education, Kansas State University, for his technical advice and assistance in the interpretation of the final results.

Special thanks are extended to Dr. Burrel H. Beck, Dean of Coffeyville Community Junior College, for his professional interest and advice in connection with this study.

CONTENTS

SUMMARY

In an attempt to identify those college students for whom programmed elementary algebra taught on an independent study basis was most effective, the following study was conducted. For a period of approximately eighteen months, all students enrolled in elementary algebra (D.S. Math 70) at Coffeyville Community Junior College were treated as an experimental group in an effort to seek answers to four basic questions. Analysis of variance was used to obtain answers to the first three questions.

The first question considered was the effect of the student's entering math ability on his successful completion of the course. When divided into three subgroups based on their initial math ability, it was found that those in the highest group performed significantly better than those in groups two and one at the .01 level of confidence. Group two did not, however, perform significantly better than group one.

The effect of a student's reading ability on his progress in this course comprised the second question. The data suggested that when the same students were divided into three groups based on their reading ability, that the highest group performed somewhat better than group one (.05 level of confidence). There was no significant difference between the achievement of group three as compared to group two.

The third question dealt with the nature of the problems with which the students were to cope. Definitions or recall type questions or problems were designated as alpha test items on the final examination. Manipulation of algebraic terms and expressions were classified as beta test items, and story problems were termed gamma items. The most significant finding regarding question three was that all students apparently were more successful with beta items than alpha or gamma test items. The students encountered about equal difficulty with the alpha and gamma items.

By means of an attitudinal scale and a t-test analysis, it was found that the comparison of pre- and post-attitudes of the students did not change significantly. The attitude of the students remained consistently favorable toward the course.

Multiple regression analysis was used in an attempt to develop a prediction equation which would provide a means of ascertaining, to some extent, what degree of success a given student might expect to achieve upon entering the course. Using all project students, this attempt failed to yield any useful information. When the same analysis was applied to course completors only, considerably better results were obtained. This suggested that there might be a motivation of tenacity factor that was not apparent in the data which was

collected. The possibility of such factors playing an important role in this project was further supported by the fact that only about one out of two, or 53 percent of those students starting the course, finished within the project duration.

It was suggested that a second study be made with two groups of students, both groups using programmed materials but only one group operating on an independent study system. The second group would meet as a class and be subject to the usual course structure.

Background for the Study

Educational research over the last two decades has revealed that the most effective programmed formats may be written in subject areas which are highly cognitive in their nature rather than those subjects where the learning process is deeply rooted in the affective or psychometer domain. Mathematics, a highly cognitive study, lends itself quite well to the programmed approach.

Shiflett (1) conducted an experimental investigation involving students enrolled in courses of trigonometry and intermediate algebra at Southwest Missouri State College, Springfield, Missouri. The TEMAC series of these courses were utilized in this study. Conventional classes of the same two subjects were administered to another group of students, and the performance of both groups were compared. This study had as its primary purpose the use of programmed materials for making up deficiencies in the student's mathematical background. This study revealed that the programmed course in algebra compared favorably to that program taught in a conventional manner. The programmed course in trigonometry indicated a slight difference in favor of the conventional teaching approach. Shiflett also commented that there were no significant expressions of disapproval on the part of the students relative to the programmed approach.

Eigen (2) studied the effects of using programmed texts in comparison to teaching machines. His study involved programmed mathematics on the high school level in which he measured achievement, transfer, attitude, and time to complete the course. Eigen's findings indicated that there was no reason to believe that teaching machines are superior to programmed texts in effectiveness.

Hillman (3) reported on the study conducted in an elementary school in Detroit, Michigan and also presented to a group of elementary school teachers attending an in-service mathematics course at the University of Michigan. His mode of study was that of comparing a students achievement in mathematics when required to make overt responses, in written form, to a math course which was programmed, as contrasted to a second group of students making non-overt responses by merely reading through a filled-in programmed text, and a third group which used a conventional text. Hillman's findings imply that the overt response does not influence learning achievement when using programmed materials and can even negatively influence achievement.

Yesselman (4) investigated the advantages and disadvantages of varying degrees of supervision while teaching programmed mathematics. Those students involved in this study were college-age students enrolled in programmed courses in intermediate algebra. His findings indicated that varying the amount of supervision does not significantly affect learning from a program; however, a greater number of students dropped out of the totally non-structured group as compared to those groups which did have structuring in various degrees.

A second major concept was incorporated within the confines of this study, the use of independent study with programmed materials. As B. Lamar Johnson (5) points out, there has been much talk among college administrators and faculty concerning independent study and its importance, but little is apparently being done systematically to develop programs which embody this type of study.

Several advantages of independent study with programmed materials are noted by Inlow (6), namely:

1. In a typical classroom situation, teachers tend to teach towards the middle group, boring the brighter student and losing the slower learner. Under proper conditions, the use of programmed materials enables each student to progress at his own rate.

2. Working individually, a student is less likely to invoke ridicule from his peer group and to experience less open disapproval by the instructor as might be the case in a conventional classroom situation.

3. Programmed study tends to keep all students, at the same time, active in the learning process.

This study was undertaken as a result of the recognition of the merits of programmed instruction in mathematics in conjugation with independent study. At the time this project was initiated it was apparent that some college students seemed to respond more positively to programmed instruction than others. This report represents the attempt, on the part of the investigator, to identify certain traits or characteristics common to those students whose performance indicated an ability to successfully cope with, and learn by, programmed basic algebra using an independent instructional system.

The four major questions which were studied are as follows:

1. Given a population of students divided into three sub-groups based on their entering math ability, which group will show the greatest increase of mathematics comprehension?

2. How does a student with a reading and/or vocabulary deficiency respond to a mathematics course taught with programmed materials?

3. What types of mathematical questions and problems are most effectively conveyed in a programmed manner?

4. What is the attitude of the students, participating in this study, toward this type of instruction?

The students involved in this study included both full-time and part-time students enrolled at Coffeyville Community Junior College in the course D.S. (Directed Study) Math 70. The study ran from September, 1968 to February, 1970. Although the total number of students who took the course was two hundred and fifty-eight, only one hundred and eighteen students were classified as major project students due to the lack of a full set of data on many students and the fact that some are still in the process of completing the course.

It was hoped that this study would supply sufficient data to make certain predictions, with reasonable accuracy, as to the probability of a student's success in this course prior to his enrollment. In the final analysis the results were found to be somewhat more implicit than had been anticipated and therefore proved to be of little value for use in individualized predictions.

METHODS

The students of Coffeyville Community Junior College are required to take a battery of placement tests upon enrollment. Three of these tests were of particular significance: the mathematics placement exam (7), the test for reading comprehension (8), and the I.Q. exam (9).

Those students making a score which falls within a predetermined range on the Lankton First-Year Algebra test are recommended to enroll in D.S. (Directed Study) Math 70. This recommendation also involves a study of the student's high school mathematics background and in most instances, a personal interview with the individual.

D.S. Math 70 is a course in introductory algebra presented in a programmed format (10), and taught, for the duration of this study, in an independent study mode. Except for minor variations in class organization, all four semesters included in this study were identical in that the same programmed materials were used and each student's progress was on an individual basis.

In as much as it was not the intent of this study to compare the relative merits of programmed instruction and conventional techniques, a control group as such was not used. All students were treated in an experimental mode with various comparisons and analyses being made statistically.

Each student enrolled in D.S. Math 70 was assigned a personal file in which was kept data pertaining to conferences, records of testing, and attitudinal scale forms. All students were encouraged to progress as rapidly as possible and to avail themselves of the tutorial help made available by the project director and the student project assistant.

A course syllabus written in behavioral terms was distributed which indicated that each student was to be tested upon the completion of each of the seven required units. A midterm exam was administered after unit four and a comprehensive final examination was given upon the completion of the course. All tests except those for unit one, two, and the midterm were of a multiple choice type. The individuals involved in this study were allowed to take one retest on those unit exams for which a score below sixty percent was made. The higher of the two scores was used in averaging the student's course grade. All unit exams as well as the midterm were counted as one test, whereas, the final exam counted as two test scores. Letter grades were assigned on the basis of the following percentage scale:

90--100 "A"
80--89 "B"
70--79 "C"
60--69 "D"
59 and below--Failing

The final exam consisted of seventy test items especially selected and/or composed by the project director so that there would be approximately equal numbers (22 or 24) of three different types of questions or problems. The first type of test item was called an Alpha item and consisted of questions or problems which could be correctly answered by simple recall or recognition such as definitions, symbols, etc.

The second type of test question or problem was referred to as Beta items. These items required the ability to manipulate simple algebraic terms. Such items involved algebraic addition, multiplication, factoring, etc.

The last type of test item considered was the Gamma item. These were problems or questions which required the student's ability to apply and manipulate algebraic terms and expressions in order to arrive at a specific conclusion or answer. The Gamma items could best be described as "story-problems."

Those students for which all data was available were designated as project students and included in this study. Through the effort of the Guidance department, many students had taken the project pretest which was the form E of the Lankton algebra test. Upon completion of the course, students were given an equivalent form F of the same exam. All Lankton scores used in this report are standard rather than raw scores.

In an attempt to ascertain the student's response to this type of course the Remmer Attitude Scale (11) was administered as a pre and post device. The students were assured that this written account of their attitude would in no way affect their grades. The Remmer scale has a value of six as its neutral point, values above six suggest favorable attitudes, and those below six suggest a negative attitude.

With the intention of studying the results of students with varying entering math abilities as well as those with differing reading comprehension scores and their ability to cope with a course of this nature, all project students were divided into math and reading sub-groups. Three sub-groups based upon entering Lankton algebra scores were made. Based upon entering percentile scores, the Coop reading test was also used to compose three sub-groups of students. In both

instances, the number of students in each group was determined by placing the lowest scoring students in group one, the next lowest, in group two, etc. Tables 1 and 2 indicate the exact nature of the composition of these various sub-groups.

Table 1 - Initial Lankton Score Data for the Grouping of all Project Students, N = 118

	N	Mean	Standard Deviation
Group 1	43	133.930	7.275
Group 2	42	148.143	2.683
Group 3	33	161.455	7.040

Table 2 - Initial Coop Score Data for the Grouping of all Project Students, N = 118

	N	Mean	Standard Deviation
Group 1	41	7.341	3.998
Group 2	39	23.410	6.095
Group 3	38	54.737	14.185

A total of nineteen variables were recorded and used for all project students, where appropriate. Table 3 provides a list of these variables and explanations where needed.

Table 3 - Project Variables

	Variable	Description
1.	Student I.D.	Assigned identification number
2.	Completion Code	1=project students finishing course 0=project students, noncompletors
3.	Age	Stated in years
4.	Sex	1=male, 2=female
5.	Class	1=freshman, 2=sophomore
6.	Initial Lankton Score	
7.	Discrete Lankton Score	Lankton sub-group 1, 2, or 3
8.	Initial Coop Score	Reading score in percentiles
9.	Discrete Coop Score	Coop sub-group 1, 2, or 3
10.	Mathematics background	0=no algebra, 1=algebra I, 2=algebra II, 3= advanced math
11.	Initial Remmer	
12.	I.Q.	
13.	Course grade	Percentage grade over exams
14.	Alpha Score	Number of correct alpha items on final exam
15.	Beta Score	Number of correct beta items on final exam
16.	Gamma Score	Number of correct gamma items on final exam
17.	Final Lankton	Score on Lankton form F
18.	Final Remmer	
19.	Number of units completed	

An attempt was made to ascertain the effect of a student's entering math ability on his success in the course as well as various types of questions and problems with which he would come in contact. This initial compentency as well as the initial reading scores was tested against the above mentioned criteria by means of analysis of variance.

The pre and post attitude scales administered to the students were graded and the results were subjected to a t-test for meaningful interpretation. Although the four basic questions which are to be answered as listed in the section of the report referred to as the background for the study are covered by the statistical analysis as mentioned above, it was deemed desirable that the project variables be subjected to a series of multiple regression analyses using several different variables as criteria and others as predictors.

RESULTS

Upon the completion of the proposed study, some eighty students were initially classified as course completors. These students were then listed in one of three groups based on their entering mathematics (Lankton) ability. The same population of students were also divided into three groups based on their entering reading ability (Coop).

This method of cross-grouping resulted in some students being in the highest math group and the lowest reading group, etc. Tables 4 and 5 indicate the nature of these groups. An interesting fact brought out in the zero order correlation among all variables is that the correlation between initial Lankton scores and reading scores for all students is quite low, $r = 0.14$.

Table 4 - Initial Lankton Score Data for Discrete Lankton Groups of Course Completors

	N	Mean	Standard Deviation
Group 1	28	134.000	7.041
Group 2	27	148.111	2.767
Group 3	25	162.600	7.473

Table 5 - Initial Coop Score Data for Discrete Coop Groups of Course Completors

	N	Mean	Standard Deviation
Group 1	27	7.4074	4.2359
Group 2	27	23.0000	6.8275
Group 3	26	55.1923	14.5052

Using analysis of variance as a test between the groups and Scheffe's test for multiple comparisons, the following results for the proposed questions were obtained.

Those students in Lankton group three, highest entering math ability, scored significantly higher than did those in groups one and two on the final Lankton exam. Group two did not score significantly higher than did group one. The significance of these results are based on a .01 level of confidence.

In reference to the second proposed question, the data suggests that those students completing the course with the highest final Lankton scores were those who had the highest initial Coop reading scores. The number three Coop group, those with the best reading scores, did significantly better than the number one Coop group, the significance being at the .05 level of confidence. There was no significant difference between group three and group two.

In the final course examination as compiled by the project director, seventy test items were used. These items consisted of twenty-four alpha, twenty-four beta, and twenty-two gamma type questions of problems. Group three of both the math and Coop groupings missed fewer alpha items than group two or one. The same was found to be true of the beta and gamma items also.

For all three groups of both the math and Coop groupings, item analysis of the final examination revealed that all students were most successful with beta type items and experienced about equal amounts of difficulty with the alpha and gamma items.

Question four in the proposed study sought an answer which would reveal the student's attitude toward algebra taught in this manner. Using a t-test, it was found that there was no significant difference in the change of attitude of the students during the course of their study. The pre and post attitude scores were, however, consistently favorable. With 6.0 as a neutral score, the results of the t-test are listed in Table 6.

Variables for all project students and those course completors for whom all data was available were analyzed and means and standard deviation were computed. The results of this analysis are listed in Table 7. The means were rounded to the nearest tenth, the standard deviations to the nearest hundredth.

Table 6 - Comparison of Pre-test and Post-test Attitudinal Scores for Those who completed the Course, N=77

Pre-test	Post-test
Mean = 8.043	Mean = 7.888

df = 76

t = -1.250 (non-sig.)

As a part of the math placement program at Coffeyville Community Junior College, a student must attain a raw score of at least 28 on the Lankton First-Year Algebra Test, form E. The mean of variable seventeen in Table 7 indicates that for those project students finishing the course the final Lankton average was sufficiently high as to permit them to enter college algebra on this test score basis. The mean referred to on the final Lankton was 161.5 which, when converted to a raw score, was equivalent to 28.

An attempt was made by using multiple regression and the variables previously mentioned, to determine whether or not a student will complete the course. Using variable 17 as the criterion and variables three through twelve as predictors, as listed in Table 7, only 4.3% of the variables could be accounted for. Using variable seventeen as the criterion and variables three through twelve as predictors, a variation of only 8.6 percent was obtained.

When a multiple regression was run using the same variables but for course completors only, a higher percent of variation was obtained. Using variable seventeen, the final Lankton score, as the criterion, and variable three through twelve as the predictors, the test could account for nearly 49 percent of the variance with variable ten, mathematics background, heavily weighted.

There were some 258 students who had enrolled in this course during the duration of the project, and of these, 137 or 53% completed the course. Of the 258 students who were enrolled in this course, sufficient data was available to qualify 118 as project students. Table 25, in the appendix, indicates the zero-order correlation between the pertinent variables collected for these 118 students. The analysis of variance and multiple regression data may also be found in the appendix.

Table 7 - Means and Standard Deviations of Variables

Variables	All Students N = 118		Course Completors N = 77	
	Mean	Std. Dev.	Mean	Std. Dev.
3. Age	18.4	2.05	18.5	2.22
4. Sex	1.3	0.46	1.3	0.47
5. Class	1.1	0.31	1.1	0.32
6. Initial Lankton Score	146.7	12.48	147.3	13.17
7. Discrete Lankton Score	1.9	0.80	1.9	0.81
8. Initial Coop Score	27.9	21.58	28.6	22.07
9. Discrete Coop Score	2.0	0.82	2.0	0.81
10. Mathematics Background	1.2	0.45	1.2	0.48
11. Initial Remmer	8.0	0.67	8.0	0.73
12. I.Q.	100.3	8.80	100.7	9.09
13. Course Grade	50.6	38.25	77.6	12.20
14. Alpha Score	9.6	7.47	14.6	3.5
15. Beta Score	10.3	8.42	15.8	4.81
16. Gamma Score	8.8	6.92	13.2	3.63
17. Final Lankton	106.5	77.02	161.5	12.90
18. Final Remmer	5.3	3.76	7.9	0.82
19. Number of Units Completed	6.2	1.59	7.0	0.87

CONCLUSIONS AND RECOMMENDATIONS

The results of this investigation demonstrated that under the conditions set forth by the project study no outstanding unexpected results were obtained. The study did, in fact, confirm what might be considered preconceived notions pertaining to those characteristics of students who would be successful in this type of study.

Although it was not stipulated as a proposed question, the investigator had hoped to come forth with a prediction equation by a multiple regression analysis which would enable one to determine, in advance, the probability of success for a given student in this course. This was tried and found to be totally ineffective as is evident by inspection of Tables 16 and 17 in the appendix. A series of multiple regression analyses using course completors was, however, capable of accounting for rather large percentages of variance for a number of criteria.

The single most significant factor which became apparent as a result of this study was the large number of students who started their course of study but did not complete it. As was mentioned in the preceeding section of this report, approximately one out of two, or 53 percent of the students finished this course of elementary algebra. The fact that the series of multiple regression analyses failed to provide meaningful interpretations for all students but proved to be considerably more revealing for course completors only, tends to be a significant finding in itself. It is the firm conviction of this investigator that there was a motivation or tenacity factor not apparent in the data collected. As might have been expected, some of the more capable students rejected this course of study while others less capable persisted in their efforts until completion of the course.

It is the conclusion of the investigator that the lack of more explicit findings may have resulted from the incorporation of essentially two experimental treatments simultaneously. The use of programmed materials in conjunction with a system of independent study may very well have produced a "double-gate" effect. Some students who may have been quite responsive to a programmed format could have encountered difficulty in coping with the self discipline required of independent study, while for others the converse may have been the case. If this "double-gate" effect did, in fact exist, it could very possibly have been the factor which made it impossible to predict in advance the approximate degree of success for a given student. As it resulted,

those variables which carried heavier weights in the predictor equations for course completors were, in a sense, retrospective.

The findings collected in this study leads the investigator to suggest that a second study may be of considerable significance in identifying which variables are capable of functioning more explicitly as predictors for this mode of learning. A recommended format for such a study might include two groups of students both using programmed materials but one group meeting as a class and the other on an independent study basis. As to the motivation or tenacity factor, the investigator is presently at a loss to suggest a means by which such factors could effectively be measured. It is felt, however, that a study as recommended may go far in shedding light on what would be involved in isolating these factors and possibly even measuring them.

REFERENCES

1. Shiflett, Thomas L. "A Comparative Study of Programmed and Conventional Instruction in Mathematics at the College Level", (unpublished doctor's dissertation, George Peabody College for Teachers, 1963). As reported in Dissertation Abstracts, Volume XXIV, p. 5441.

2. Eigen, David L. "An Investigation of some Variables Affecting the Use of Programmed Instruction in Mathematics Education", (unpublished doctor's dissertation, Columbia University, 1964). As reported in Dissertation Abstracts, Volume XXV, p. 289.

3. Hillman, Peter T. "A Study of Three Response Modes Using Two Programmed Mathematics Textbooks", (unpublished doctor's dissertation, University of Illinois, 1964). As reported in Dissertation Abstracts, Volume XXV, p. 1045.

4. Yesselman, Charlotte B. "Programmed Instruction in College Mathematics", (unpublished doctor's dissertation, University of New Mexico, 1966). As reported in Dissertation Abstracts, Volume 27, p. 1568-A.

5. Johnson, B. Lamar, New Directions for Instruction In The Junior College, Junior College Leadership Program, 1965.

6. Inlow, Gail, The Emergent in Curriculum, John Wiley and Sons, Inc. New York, 1966. p. 173-176.

7. Lankton First-Year Algebra Test, Robert S. Lankton, Harcourt, Brace and World, Inc. New York, 1965.

8. Cooperative English Test, Cooperative Test Division. Educational Testing Service, Princeton, N. J. - Los Angeles, California, 1960.

9. Otis-Lennon, Advanced Level Form J, Arthur S. Otis and Roger T. Lennon, Harcourt, Brace, and World, Inc. New York, 1967.

10. Drooyan, Irving and Wooton, William. Programmed Beginning Algebra. John Wiley and Sons, New York, 1963.

11. A Scale to Measure Attitude Toward Any School Subject, Edited by H. H. Remmers, Purdue Research Foundation, 1960.

APPENDIX

Table 8 - Analysis of Variance Using Discrete Lankton Groups as Predictors and Number of Correct Alpha Test Items as Criterion.

Sources of Variation	DF	Sum of Squares	Mean Squares	F-Ratio	
Between Groups	2	173.5039	86.7520	8.7520	P<.01
Within Groups	77	763.2461	9.9123		
Total	79	936.7500			

***

	N	Mean	Standard Deviation
Group 1	28	13.04	3.10
Group 2	27	14.41	3.00
Group 3	25	16.64	3.35

Table 9 - Analysis of Variance Using Discrete Lankton Groups as Predictors and Number of Correct Beta Test Items as Criterion.

Sources of Variation	DF	Sum of Squares	Mean Squares	F-Ratio	
Between Groups	2	532.6953	266.3477	16.3768	P<.01
Within Groups	77	1252.3040	16.2637		
Total	79	1785.0000			

***

	N	Mean	Standard Deviation
Group 1	28	12.96	4.02
Group 2	27	15.37	4.63
Group 3	25	19.28	3.27

Table 10 - Analysis of Variance Using Discrete Lankton Groups as Predictors and Number of Correct Gamma Test Items as Criterion.

Sources of Variation	DF	Sum of Squares	Mean Squares	F-Ratio	
Between Groups	2	200.4141	100.2070	9.2347	P<.01
Within Groups	77	835.5391	10.8512		
Total	79	1035.9530			

***

	N	Mean	Standard Deviation
Group 1	28	11.68	3.36
Group 2	27	12.74	3.45
Group 3	25	15.48	3.04

Table 11 - Analysis of Variance Using Discrete Lankton Groups as Predictors and Final Lankton Score as Criterion.

Sources of Variation	DF	Sum of Squares	Mean Squares	F-Ratio	
Between Groups	2	4521.0000	2260.5000	20.5016	P<.01
Within Groups	77	8490.0000	110.2597		
Total	79	13011.0000			

***

	N	Mean	Standard Deviation
Group 1	28	154.07	9.87
Group 2	27	159.63	12.48
Group 3	25	172.24	8.67

Table 12 - Analysis of Variance Using Discrete Coop Groups as Predictors and Number of Correct Alpha Test Items as Criterion.

Sources of Variation	DF	Sum of Squares	Mean Squares	F-Ratio
Between Groups	2	108.1172	54.0586	5.0233 P<.01
Within Groups	77	828.6328	10.7615	
Total	79	936.7500		

***

	N	Mean	Standard Deviation
Group 1	27	13.37	3.27
Group 2	27	14.37	3.31
Group 3	26	16.19	3.26

Table 13 - Analysis of Variance Using Discrete Coop Groups as Predictors and Number of Correct Beta Test Items as Criterion.

Sources of Variation	DF	Sum of Squares	Mean Squares	F-Ratio
Between Groups	2	103.4180	51.7090	2.3678 Non-Sig.
Within Groups	77	1681.5820	21.8387	
Total	79	1785.0000		

***

	N	Mean	Standard Deviation
Group 1	27	14.44	5.16
Group 2	27	15.63	4.63
Group 3	26	17.23	4.16

Table 14 - Analysis of Variance Using Discrete Coop Groups as Predictors and Number of Correct Gamma Test items as Criterion.

Sources of Variation	DF	Sum of Squares	Mean Squares	F-Ratio	
Between Groups	2	115.5938	57.7969	4.8355	P<.05
Within Groups	77	920.3594	11.9527		
Total	79	1035.9530			

***

	N	Mean	Standard Deviation
Group 1	27	11.74	3.82
Group 2	27	13.30	3.17
Group 3	26	14.69	3.34

Table 15 - Analysis of Variance Using Discrete Coop Groups as Predictors and Final Lankton Score as Criterion

Sources of Variation	DF	Sum of Squares	Mean Squares	F-Ratio	
Between Groups	2	1224.0000	612.0000	3.9980	P<.05
Within Groups	77	11787.0000	153.0779		
Total	79	13011.0000			

***

	N	Mean	Standard Deviation
Group 1	27	156.96	13.76
Group 2	27	161.52	12.95
Group 3	26	166.58	10.01

Summary of Raw Weights from Multiple Regressions for All Students

Variables Considered:

1. Student I.D.
2. Student did or did not complete course
3. Age
4. Sex
5. Class
6. Initial Lankton Score
7. Discrete Lankton Score
8. Initial Coop Score
9. Discrete Coop Score
10. Mathematics Background
11. Initial Remmer
12. I.Q.
13. Course Grade
14. Alpha Score
15. Beta Score
16. Gamma Score
17. Final Lankton
18. Final Remmer
19. Number of Units Completed

Table 16 - Criterion 2-Predictors 3-12

Variable	Raw Weight	R^2 = 0.043
3	0.008540	
4	0.083586	
5	0.037248	
6	0.006409	
7	-0.099623	
8	-0.002274	
9	0.064425	
10	0.102883	
11	0.080488	
12	0.002628	
Constant	-1.493454	

Table 17 - Criterion 19-Predictors 3-12

Variable	Raw Weight	R^2 = 0.086
3	0.131920	
4	0.504249	
5	0.024844	
6	0.011876	
7	0.158782	
8	-0.016913	
9	0.455190	
10	0.086742	
11	0.196687	
12	-0.006501	
Constant	-0.450397	

Summary of Raw Weights from Multiple Regressions for Course Completors Only

Variables Considered:

1. Student I.D.
2. Student did or did not complete course
3. Age
4. Sex
5. Class
6. Initial Lankton Score
7. Discrete Lankton Score
8. Initial Coop Score
9. Discrete Coop Score
10. Mathematics Background
11. Initial Remmer
12. I.Q.
13. Course Grade
14. Alpha Score
15. Beta Score
16. Gamma Score
17. Final Lankton
18. Final Remmer
19. Number of Units Completed

Table 18 - Criterion 13-Predictors 3-12

Variable No.	Raw Weight	R^2 = 0.376
3	1.221892	
4	4.089374	
5	3.149947	
6	0.245321	
7	3.056935	
8	-0.007697	
9	3.673870	
10	1.456143	
11	-0.469276	
12	-0.060417	
Constant	4.945160	

Table 19 - Criterion 14-Predictors 3-12

Variable No.	Raw Weight	R^2 = 0.302
3	0.275817	
4	0.829378	
5	0.208498	
6	0.002263	
7	1.710196	
8	-0.004624	
9	1.315773	
10	0.609390	
11	-0.032668	
12	-0.047770	
Constant	6.395962	

Table 20 - Criterion 15-Predictors 3-12

Variable	Raw Weight	R^2 = 0.487
3	0.330771	
4	2.776672	
5	-1.169763	
6	0.159974	
7	0.990564	
8	0.042679	
9	-0.421171	
10	1.357553	
11	0.420158	
12	-0.042733	
Constant	-19.266006	

Table 21 - Criterion 16-Predictors 3-12

Variable	Raw Weight	R^2 = 0.365
3	0.137407	
4	0.279602	
5	0.108432	
6	0.042808	
7	0.224085	
8	0.005361	
9	-0.246122	
10	0.586983	
11	0.0	
12	0.186514	
Constant	-15.655955	

Table 22 - Criterion 17-Predictors 3-12

Variable	Raw Weight	R^2 = 0.488
3	0.154443	
4	1.806545	
5	-2.295625	
6	0.350858	
7	0.196207	
8	0.101782	
9	-2.440171	
10	6.006502	
11	1.424317	
12	0.474159	
Constant	42.372116	

Table 23 - Criterion 18-Predictors 3-12

Variable	Raw Weight	R^2 = 0.170
3	0.033214	
4	-0.012015	
5	0.121614	
6	0.024065	
7	-0.167072	
8	0.022530	
9	-0.477272	
10	-0.290671	
11	-0.037682	
12	0.002646	
Constant	4.632487	

Table 24 - Criterion 19-Predictors 3-12

Variable	Raw Weight	R^2 = 0.721
3	-0.039182	
4	0.046881	
5	0.072986	
6	0.005088	
7	0.0	
8	0.002519	
9	-0.116238	
10	0.176216	
11	1.009053	
12	-0.004232	
Constant	-0.805024	

Table 25 - Zero Order Correlations* Between Variables 3-19 for All Students, N = 118.

	3	4	5	6	7	8
3	1.0000	-0.0203	0.0226	-0.0948	-0.0982	-0.2416
4	-0.0203	1.0000	0.0085	-0.1085	-0.0473	0.2492
5	0.0226	0.0085	1.0000	-0.0042	0.0034	0.0403
6	-0.0948	-0.1085	-0.0042	1.0000	0.8812	0.2251
7	-0.0982	-0.0473	0.0034	0.8812	1.0000	0.2721
8	0.0896	0.2492	0.0403	0.2251	0.2721	1.0000
9	0.0062	0.2471	0.0109	0.3055	0.3343	0.8942
10	0.2782	-0.0674	0.0545	0.2562	0.2737	-0.9448
11	0.1554	0.0922	-0.0153	-0.9196	0.0209	0.0397
12	0.0461	0.1929	0.0937	0.4949	0.5040	0.6972
13	0.1146	0.1128	0.0585	0.1642	0.1353	0.1067
14	0.1265	0.1353	0.0458	0.1734	0.1528	0.1336
15	0.1321	0.1700	0.0180	0.2748	0.2376	0.1353
16	0.1117	0.1276	0.0516	0.2067	0.1650	0.1609
17	0.0900	0.1154	0.0284	0.1261	0.0809	0.0847
18	0.0907	0.0958	0.0246	0.0902	0.0355	0.0645
19	0.1478	0.1246	0.0003	0.1406	0.1440	0.0513

* r must have a value of at least 0.232 for significance at the .05 level of confidence.

Table 25 - (Continued)

	9	10	11	12	13	14
3	0.0062	0.2782	0.1554	0.0461	0.1146	0.1265
4	0.2471	0.2782	0.0922	0.1929	0.1128	0.1353
5	0.0109	0.0545	-0.0153	0.0937	0.0585	0.0458
6	0.3055	0.2562	-0.0196	0.4949	0.1642	0.1734
7	0.3343	0.2737	0.0209	0.5040	0.1353	0.1528
8	0.8942	-0.0448	0.0397	0.6972	0.1067	0.1336
9	1.0000	0.0111	-0.0498	0.7039	0.1341	0.1609
10	0.0111	1.0000	-0.0118	-0.0345	0.1607	0.1833
11	-0.0498	-0.0118	1.0000	0.0007	0.1175	0.1232
12	0.7039	-0.0345	0.0007	1.0000	0.1437	0.1467
13	0.1341	0.1607	0.1175	0.1437	1.0000	0.9551
14	0.1609	0.1833	0.1232	0.1467	0.9551	1.0000
15	0.1477	0.2292	0.1631	0.1848	0.9494	0.9238
16	0.1725	0.1459	0.1192	0.2528	0.9344	0.9316
17	0.0991	0.1360	0.1219	0.1211	0.9713	0.9478
18	0.0634	0.0751	0.1110	0.0751	0.9334	0.9207
19	0.0944	0.1197	0.1015	0.0893	0.8233	0.7905

Table 25 - (Continued)

	15	16	17	18	19
3	0.1321	0.1117	0.0900	0.0907	0.1478
4	0.1700	0.1276	0.1154	0.0958	0.1246
5	0.0180	0.0516	0.0284	0.0246	0.0003
6	0.2748	0.2067	0.1261	0.0902	0.1406
7	0.2376	0.1650	0.0809	0.0355	0.1440
8	0.1353	0.1609	0.0847	0.0645	0.0513
9	0.1477	0.1725	0.0991	0.0634	0.0944
10	0.2292	0.1459	0.1360	0.0751	0.1197
11	0.1631	0.1192	0.1219	0.1110	0.1015
12	0.1848	0.2528	0.1211	0.0751	0.1893
13	0.9494	0.9344	0.9713	0.9334	0.8233
14	0.9238	0.9316	0.9478	0.9207	0.7905
15	1.0000	0.9283	0.9223	0.8721	0.7730
16	0.9283	1.0000	0.1383	0.9070	0.7779
17	0.9223	0.9383	1.0000	0.9696	0.8461
18	0.8721	0.9070	0.9696	1.0000	0.8299
19	0.7730	0.7779	0.8461	0.8299	1.0000