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The value of the Read general science test and of the Cooperative algebra test for predicting success in high school physics

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THE VALUE OF THE READ GENERAL SCIENCE TEST AND OF THE COOPERATIVE ALGEBRA TEST FOR PREDICTING SUCCESS IN HIGH SCHOOL PHYSICS

Submitted by

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

NATURE AND SCOPE OF THE PROBLEM

Statement of the Problem.-- This study is an attempt to determine statistically the value of the Read General Science Test[1/] and the Cooperative Algebra Test[2/] in predicting success in the study of Physics in Brookline High School.

Scope of the Study.-- This study was done with 104 Junior and Senior pupils enrolled in the physics course at Brookline High School during the school year 1956-1957. Only ten girls were in the group of 104 to whom three tests were administered. The Read General Science Test and the Cooperative Algebra Test were administered in September of 1956. The Cooperative Physics Test[3/] was administered in May of 1957, toward the end of the physics course. Correlations were run between the raw scores of the Read General Science Test and the raw scores of the Cooperative Physics Test; between the raw scores of the Cooperative Algebra Test and the raw scores of the Cooperative Physics Test; and between the physics

1/John G. Read, Read General Science Test, World Book Company, New York, 1951.

2/Educational Testing Service, Cooperative Test Division, Cooperative Algebra Test, Princeton, New Jersey, 1950.

3/Educational Testing Service, Cooperative Test Division, Cooperative Physics Test, Princeton, New Jersey, 1950.

items of the Read General Science Test and the Cooperative Physics Test. These correlation coefficients will determine statistically the value of the Read General Science Test and the Cooperative Algebra Test in predicting success in the study of physics at Brookline High School.

Justification of the Study.-- During the last several years writers have been noting a decrease in the enrollment of pupils in physics. This factor, with the increased demand for scientists and technicians, has caused alarm among our leaders. Teachers want and need the results of marks and tests to properly advise the pupils who are entrusted to their guidance. The more a teacher has in this regard, the more successful the teacher becomes. The importance of this guidance has been expressed by Bingham: "Misdirection of effort is costly. Loss is incurred by society as well as by the individual himself when ambitions are ill-advised."[1/] From these words of Bingham, if a student is qualified for a subject he should be guided toward that subject and, naturally, if he isnot qualified for a subject, he should be guided away from that subject. This study may help the teacher to better guide his pupils.

Secondly, Brookline High School has recently added a course in advanced physics. The problem of picking from many

1/Walter Van Dyke Bingham, Aptitude and Aptitude Testing, Harper & Brothers, New York, London, 1942, p. vii.

applicants the few pupils who will take this "college course" in high school now faces the science department. Possibly this study will show a pattern of the abilities of the more able students. This pattern if present could be used to pick the pupils for these advanced courses.

Definition of Terms.-- The Read General Science Test and the Cooperative Algebra Test are explained by their names. The Read General Science Test may be used to evaluate individual achievement, to help in individual guidance, and to evaluate group achievement.1/ The Cooperative Algebra Test is designed to evaluate understanding of relationships and processes through the ability to apply information and skills to problems.2/

Success in physics will be determined by the raw score obtained on the Cooperative Physics Test. Test scores are used in this study because, as Angell3/ has pointed out, teachers' grades tend to be subjective, while test scores provide a more objective criterion.

Procedure.-- The general procedure will be to administer the Read General Science Test and the Cooperative Algebra Test at the beginning of the physics course. Toward the end

1/John G. Read, "Manual of Directions", Read General Science Test, World Book Company, New York, 1951, p. 6.

2/Educational Testing Service, Catalog of Cooperative Tests, 20 Nassau St., Princeton, New Jersey, 1954, p. 45.

3/George Angell, Jr., The Value of the Differential Aptitude Tests for Predicting Success in Ninth Grade General Science, Unpublished Master's Thesis, Boston University, 1952, p. 29.

of the school year, the Cooperative Physics Test will be administered to determine success in physics. Correlations between the Cooperative Algebra Test and the Cooperative Physics Test, between the Read General Science Test and the Cooperative Physics Test, between the physics items of the Read General Science Test and the Cooperative Physics Test will be run. The correlations will be evaluated and conclusions will be drawn.

Re-Statement of the Problem.-- This study is an attempt to determine statistically the value of the Read General Science Test and the Cooperative Algebra Test in predicting success in the study of physics at Brookline High School.

CHAPTER II

REVIEW OF RELATED RESEARCH

Winegardner's Work.-- An exhaustive study of the research material has revealed several studies related to the subject of this paper. Winegardner 1/ developed a careful study of the relationship between secondary mathematics and physics and chemistry. He used the records of a single high school, and computed correlations between final grades.

The several conclusions drawn were that geometry grades seem to be the best predictor for the special abilities needed for physics and chemistry, whereas intelligence quotients and algebra grades seem to select more general abilities.

The following correlations were obtained between geometry and physics, between algebra and physics, and between intelligence quotients and physics:

Geometry-Physics	0.6879
Algebra-Physics	0.4878
I. Q.-Physics	0.4471

Albert Thorndike's Study.-- Albert Thorndike 2/ at Milton

1/J.H. Winegardner, "The Relationship between Secondary Math-Mathematics and Physics and Chemistry", Mathematics Teacher, May 1939, 32:220-222.

2/Albert Thorndike, "Correlation between Physics and Mathematics Grades", School Science and Mathematics, October, 1946, 46:650-653.

Academy ran a correlation between mathematics grades and physics grades. The total mathematics record was considered as one unit, and compared to the final physics grade. The correlation coefficient between these two factors was 0.77.

Hurd's Work.-- Hurd[1/] feels that a preliminary test covering identical subject is the best single criterion of final achievement. Working from Columbia University, he sent materials to various secondary schools in the area around New York City. The schools participating in his study gave a pre-test of the course to be given, presented the subject material, and then gave the final test. The results were returned to Hurd at Columbia.

The correlation between pre-test and final test for all schools was 0.54. However, Hurd felt that the directions for his study had not been followed by one school, for the correlations were very low. When the results from this school were removed from the total results, the correlation was 0.63. Hurd suggests several reasons for the low correlations from that one school.

The result according to Hurd shows that retesting produces a higher predictive value than intelligence quotient and achievement rating. Hurd goes on to say, "...in general, the preliminary test covering identical subject material is

1/A. W. Hurd, "Preliminary Test as Prognosis of Final Achievement in Physics", School Science and Mathematics, (June, 1931), 31:745-748.

the best single criterion of final achievement."[1]

The Work of Adams and Garrett.-- Adams and Garrett[2] made a study of the scholastic background of a pupil as related to success in college physics. The authors used the records of 877 students. The factors considered were first year college mathematics, high school physics, rank in high school, Algebra II, high school mathematics average, high school chemistry, mathematics entrance test, high school senior English, high school English average, composite rank on entrance tests, high school science average, chemistry entrance test, English entrance test, psychological test (total), psychological test (quantitative), and a reading test. Table I shows the correlations of the scholastic elements with success in college physics.

1/A.W. Hurd, Op. Cit., p. 748.

2/Sam Adams and H.L. Garrett, "Scholastic Background Related to Success in College Physics", Journal of Educational Research, (March, 1954), 47:545-549.

Table 1. Correlation between Success in Physics and Items from the Scholastic Background of 877 cases

Items	r
(1)	(2)
First year college mathematics......	0.435
High school physics.................	0.324
Rank in high school.................	0.306
Algebra II..........................	0.290
High School mathematics average.....	0.279
High school chemistry...............	0.263
Mathematics entrance test...........	0.258
High school senior English..........	0.247
High school English average.........	0.241
Composite rank on entrance tests....	0.214
High school science average.........	0.204
Chemistry entrance test.............	0.187
English entrance test...............	0.154
Psychological test (total)..........	0.130
Psychological test (quantitative)...	0.121
Reading test........................	0.077

The conclusions drawn from this study were:

"1. Articulation between college physics and various types of high school work are relatively poor.

"2. High school records appeared to tell more about probable success in college physics than did entrance test marks.

"3. A relatively high relationship appeared to exist between achievement in college physics and achievement in first year college mathematics."1/

Foster's Study.-- C. A. Foster's study 2/ indicated that influence of high school physics on success in college physics seems high, that influence of native intelligence seems to be higher than high s chool physics, and influence of high school mathematics seems negligible.

Implication of Review of Research.-- The review of research related to this study indicates that a positive correlation between success in mathematics and success in physics does exist. The relationship varies with the individual study, however. Most of the studies cited use final grades as the criterion of success rather than standardized tests.

No mention in any research can be found of the relationship between general science test scores and physics test

1/Sam Adams and H.L. Garrett, Op. Cit., p. 549.

2/C.A. Foster, "Correlation of the Marks of Certain High School Subjects with those in College Physics and College Chemistry", School Science and Mathematics, (October, 1938), 38:743-746.

scores.

The results of one study seemed to indicate that a test in the subject material given before a course is a good indicator of success in that test after the course.

The implications seem to be that more research is needed in the field of correlating mathematics and physics; that no work has been done in discerning a relationship between general science and physics; and that other studies should be carried out to verify the pretest-test idea of Hurd.

CHAPTER III

PROCEDURE

1. Plan Followed in Testing

The Read General Science Test was administered to 104 pupils enrolled in the physics courses at Brookline High School in September, 1956. Care was taken to follow the procedure of administration suggested by the manual of this test. About one week later, the Cooperative Algebra Test was administered to the same group. The procedure of administration advised in the manual of this test was also followed with care. A special key was prepared so that the number of physics items on the Read General Science Test could be scored. The results of these tests were obtained and catalogued. In the middle of May, 1957, the Cooperative Physics Test was administered. The results of this test were compared with the results of the other two tests and the scores of the physics items of the Read General Science Test. Using these four scores, the statistical procedures of the study were carried out.

2. Description of the Read General Science Test[1]

The Read General Science Test is composed of seventy-five multiple choice items, with a selection of five responses for each question. Reusable test booklets with separate answer sheets are incorporated in this test. The answer sheets may be scored by machine or by hand. The score is the number of correct responses and is obtained by using the punched key which is supplied with the test booklets.

The items of the test were composed after a thorough analysis of varied instructional materials and authoritative pronouncements in the field of science. The final forms were constructed after a preliminary tryout. Statistical evidences of suitable difficulty and validity and the construction of a test from the point of view of content were given consideration in selecting material for the final forms for this test. The relative emphasis given each of the fields covered is as follows: physics 42%; biology 28%; chemistry 4%; and others 26%.

The corrected split-half reliability coefficient obtained for the Read General Science Test was 0.88, based on 179 general science students. An alternate-form reliability of Forms AM and BM was 0.85, when administered to 166 students.

1/John G. Read, Op. Cit.

The second form was administered only one week after the first.

The author of the Read General Science Test states that the test may be used to evaluate individual achievement, to help in individual guidance, and to evaluate group achievement.

3. Description of the Cooperative Algebra Test 1/

The Cooperative Algebra Test is designed to "evaluate genuine understanding of processes and relationships through the ability to apply skills and information to appropriate problems". 2/ The raw score can be converted to a scaled score or be compared to other students in high school algebra classes on a percentile basis. A correction formula is applied to the number of correct responses to eliminate the possibility of guessing. The test is composed of 63 multiple choice items with a choice of five answers for each item. Reusable test booklets and separate answer sheets are utilized with the Cooperative tests.

Care has been taken to standardize these tests. First, the content of the typical course of algebra was determined; items were designed to test this content; the test was administered; an item analysis was performed; the final test was

1/Educational Testing Service, Op. Cit.

2/Educational Testing Service, Catalog of Cooperative Tests, 20 Nassau St., Princeton, N.J., 1954, p. 45.

then given. Norms were obtained, and the test was then ready to administer in the classroom.

4. Description of the Cooperative Physics Test[1]

The Cooperative Physics Test is similar to the Cooperative Algebra Test as far as the method of construction. Scaled scores are provided and percentile tables for high school physics classes are available. This test covers the material taught in standard courses. It is primarily suited to measure end-of-course achievement. The test is composed of 77 multiple choice items with a choice of five responses for each item. A correction formula is used to eliminate the effects of guessing.

The Cooperative Physics Test is designed to test the ability of the student to apply information, and the acquaintance of the student with fundamental facts and principles.[2]

5. Description of Statistical Procedures Used

To determine the coefficient of correlation between the Read General Science Test and the Cooperative Physics Test, between the Cooperative Algebra Test and the Cooperative Physics Test, and the physics items of the Read General Science Test and the Cooperative Physics Test, the scatter

1/Educational Testing Service, Op. Cit.

2/Educational Testing Service, (Catalog), Op. Cit., p. 51.

diagram or correlation diagram will be used. After the raw scores have been obtained they will be divided so that no less than ten nor more than twenty class intervals will exist. Each individual is located in his proper cell. When the procedure has been accomplished, the formula

$$r_{xy} = \frac{\frac{x'y'}{N} - (c_x c'_y)}{(\ '_x)(\ '_y)}$$

as suggested by Guilford[1] will be used to determine the Pearson product-moment r. These correlations will be evaluated to determine if any relationship exists between the results of the Read General Science Test and the results of the Cooperative Physics Test; between the results of the Cooperative Algebra Test and the results of the Cooperative Physics Test; and between the results of the physics items of the Read General Science Test and the results of the Cooperative Physics Test.

The means and standard deviations of each of these four groups will be computed and evaluated from a statistical point of view to determine the type of sampling obtained.

6. Description of the Group Tested

The group consisted of 104 physics pupils enrolled in the classes of Brookline High School. Brookline High School

1/J.P. Guilford, _Fundamental Statistics in Psychology and Education_, McGraw-Hill, New York, 1950, p. 162.

has a free elective system, but the pupils are expected to consult their teachers and parents, as well as members of the guidance department. The group on which the study was made may be divided into two sub-groups. Thirty seven of these pupils are taking a course called Standard Physics, which "includes a study of sound, light, heat and electricity. It explains the scientific principles... Physics also explains the operation of appliances and machines...used in the home and industry."1/ The other group consisted of 67 pupils taking a course called Honor Physics. "Honor Physics consists of an <u>intensive</u> study of heat, sound, light, electricity, mechanics, and atomic energy... It is definitely for pupils who are looking forward to a professional career that requires a high scientific background."2/ Students who elect Honor Physics are expecting to take College Entrance Achievement Tests. Another physics course, called Advanced Placement Physics, is taken by students who have been carefully selected on the basis of aptitude tests and scholastic achievement. Since this group is so small, it has been considered the upper part of the group taking Honor Physics.

1/Brookline High School, <u>Program of Studies</u>, 1957-58, Science: p. 2.

2/Ibid., p. 3.

7. The Scores of the Advanced Placement Students

Nine pupils of Brookline High School were admitted to the advanced placement class in September of 1956. Eight of these students took the three tests. The ninth was absent when one of the tests was given, and was unable to take it at a later date. One of these students transferred from the advanced course to the course in Honor Physics. The failure of this one student to succeed is by no means a criterion for failure. The success of seven pupils and the failure of one may show the outline of a pattern that can be used when more research has been done on this problem of choosing pupils to take the advanced course in physics at Brookline High School.

8. Summary of Procedures

1. Three tests were administered to the physics pupils of Brookline High School during the year 1956-1957. These tests were the Cooperative Algebra Test, the Read General Science Test, and the Cooperative Physics Test.

2. Statistical descriptions of the central tendency and variability will be given.

3. Correlation coefficients will be run between the scores obtained on the Read General Science Test and the scores obtained on the Cooperative Physics Test, between the

scores obtained on the Cooperative Algebra Test and the scores obtained on the Cooperative Physics Test, and between the scores obtained on the physics items of the Read General Science Test and the scores obtained on the Cooperative Physics Test.

4. These correlations will be analyzed to determine whether a relationship exists between any of the above groups of items.

5. The scores of the advanced placement class will be examined to determine if an outline of a pattern exists that could help to choose from among the applicants the few that will be most successful in advanced placement physics.

CHAPTER IV

ANALYSIS OF DATA

Central Tendencies and Variability.-- Figures 1, 2, 3, and 4 give a graphic picture of the raw scores obtained in this study. Both Figure 2 and Figure 3 show a bimodal distribution while Figures 1 and 4 show a more normal distribution. The bimodal tendency for Figures 2 and 3 seem to be caused by the differences of the two groups tested, as well as by the specialized fields of algebra and physics. For example, in algebra, some of the pupils tested have a strong mathematical background, while others have completed only their first year of algebra. The make-up of two sub-groups has already been mentioned.

The means, standard deviations, and standard error of the means for the three tests and one sub-test are summarized in Table 2. The mean for the Read General Science Test was 50.18, with a standard deviation of 11.2 and a standard error of the mean of 1.10. The mean for the Cooperative Algebra Test was 37.44, with a standard deviation of 17.5 and a standard error of the mean of 1.72. The Mean of the Cooperative Physics Test was 30.99, with a standard deviation of 17.7 and a standard error of the mean of 1.75. The mean of the 37 physics items of the Read General Science Test was 24.73,

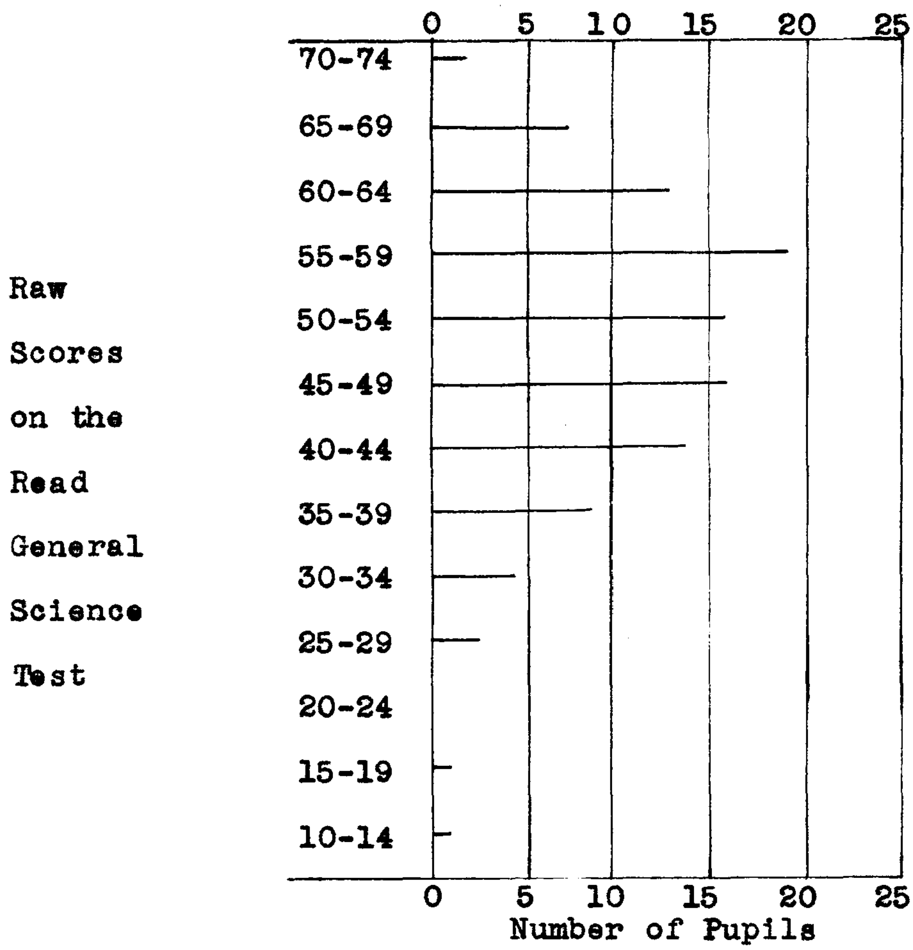

Figure 1. The Frequency for each Interval of the Read General Science Test, Obtained with 104 Pupils at Brookline High School

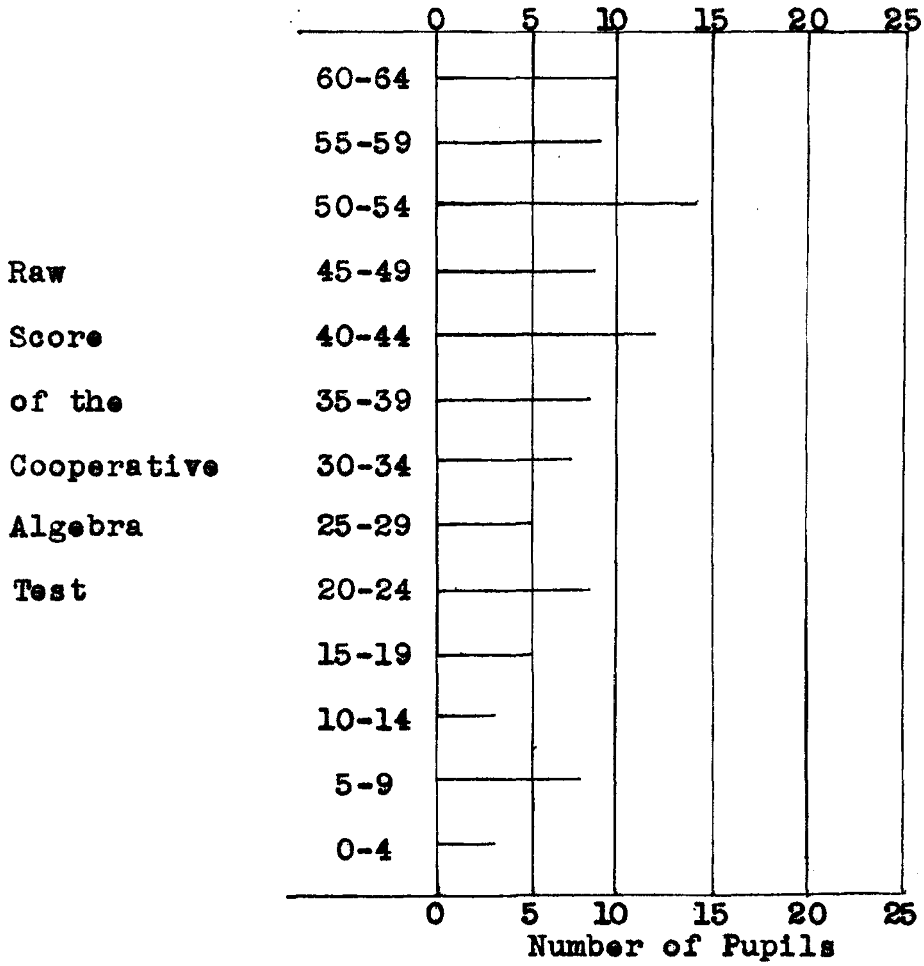

Figure 2. The Frequency for each Interval of the Cooperative Algebra Test Obtained with 104 Pupils at Brookline High School

Table 2. The Means, Standard Deviations, and Standard Error of the Mean of the Read General Science Test, The Cooperative Algebra Test, The Cooperative Physics Test, and The Physics Items of the Read General Science Test

Test	Mean	σ	σ_M
(1)	(2)	(3)	(4)
Read General Science Test.	50.18	11.2	1.10
Cooperative Physics Test..	30.99	17.7	1.75
Cooperative Algebra Test..	37.44	17.5	1.72
Physics items of the Read General Science Test....	24.73	5.54	0.55

with a standard deviation of 5.54 and a standard error of the mean of 0.55.

These results indicate that the variability of the Cooperative Algebra Test and the Cooperative Physics Test is greater than the variability of the Read General Science Test and the physics items of the Read General Science Test. This can be seen clearly by examining the bar graphs of the results of these tests, in Figures 1, 2, 3, and 4. Because of the size of the group on which this study was made, the standard error of the mean in all cases is quite low. The results of the Read General Science Test and the physics items of the Read General Science Test tend toward a normal distribution, while the results of the Cooperative Algebra Test and the Cooperative Physics Test show a bimodal distribution.

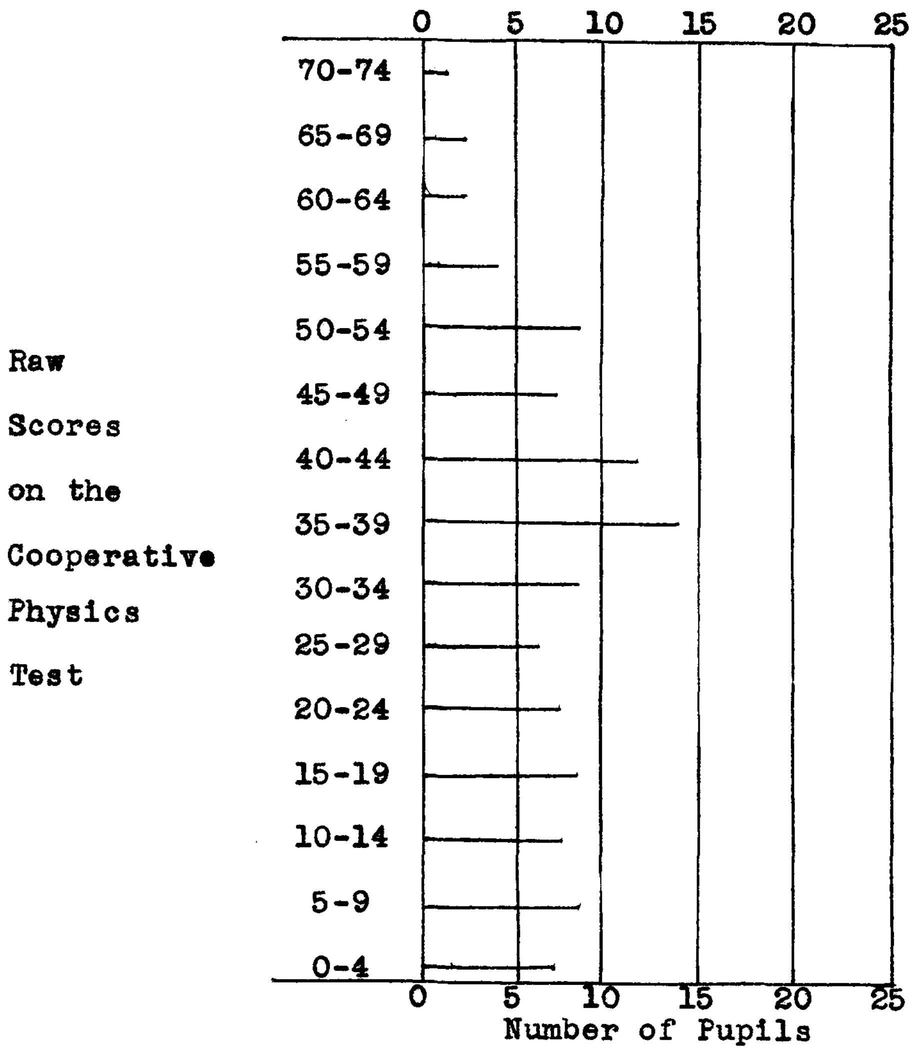

Figure 3. The Frequency for each Interval of the Cooperative Physics Test, Obtained with 104 Pupils at Brookline High School

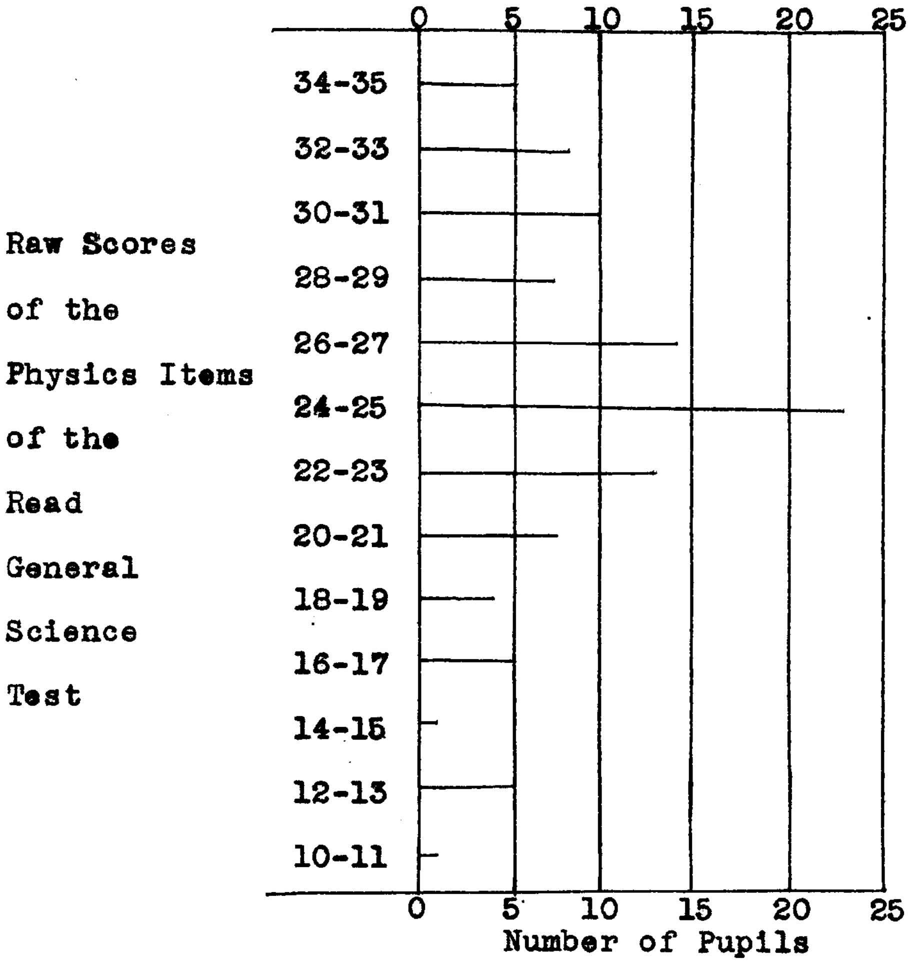

Figure 4. The Frequency of each Interval of the physics items of the Read General Science Test, Obtained with 104 Pupils at Brookline High School

This bimodal distribution seems to be caused by the more specialized talents required by algebra and physics, as compared with general science and the general physics items in the Read General Science Test.

Statistical Description of Correlations.-- A summary of the coefficients of correlation for the Read General Science Test, for the Cooperative Physics Test; and for the Cooperative Algebra Test and the Cooperative Physics Test; and for the physics items of the Read General Science Test and the Cooperative Physics Test, appear in Table 3, as well as the standard error of the coefficient of correlation.

Table 3. Coefficients of Correlation and Standard Errors of Coefficients of Correlation Obtained from the Scores of the Read General Science Test, the Cooperative Algebra Test, and the Cooperative Physics Test

Tests	r	σ_r
(1)	(2)	(3)
Physics-Algebra..........	0.75	0.043
Physics-General Science..	0.69	0.052
Physics-physics items of General Science........	0.64	0.058

These three correlations show a definite positive relationship. However, the correlation between the algebra and physics items is highest. The correlation between the general science scores and physics scores is higher than the correlation between physics items of the general science test and the physics scores.

In other words, the scores on the Cooperative Algebra Test are the best predictors of scores on the Cooperative Physics, as indicated by this study. The scores on the Read General Science Test are better predictors of scores on the Cooperative Physics Test than the scores of the physics items of the Read General Science Test.

Outline of Pattern of Advanced Placement Students.-- If a pattern exists that could determine success in advanced physics in Brookline High School, it may show in the results of the eight pupils who were chosen to take the advanced standing course. However, nothing definite can be determined from such a small group. The results of the Cooperative Algebra Test may be found in Table 7 and 8 in the appendix. These results show that the seven successful students obtain no score below 60 (63 is the highest possible score). The one unsuccessful student obtained a score of 52. Only 10 pupils in the total group received a score of 60 or above.

Although the unsuccessful pupil obtained a score of 50, on the Read General Science Test, and the lowest score of the successful group was 55, no positive statement can be made; for forty-one pupils in the total group scored 55 or above. The Read General Science Test may indicate something; but the results of this study are inconclusive.

The results of the scores of the physics items of the Read General Science Test are also inconclusive in respect to this pattern.

The results of the Cooperative Physics Test indicate that the program of advanced physics has been successful in most cases, for results of the pupils who took advanced physics were higher than most of the other results.

The pattern, if it can be called that, seems to indicate that a very high score on the Cooperative Algebra Test may be used as one of the criteria of success in the advanced physics course.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

1. Summary of the Study and Implications of Results

Restatement of Problem.-- The purpose of this study is to determine the value of the Read General Science Test and the Cooperative Algebra Test for predicting success in high school physics. Success in high school physics was determined by the score obtained on the Cooperative Physics Test.

Summary of Findings.-- The results, as determined from 104 students enrolled in the physics courses at Brookline High School in the school year 1956-57 are as follows:

1. The scores of the Cooperative Algebra Test correlate highly with the results of the Cooperative Physics Test and therefore are a good predictor of success in physics.
2. The scores of the Read General Science Test correlate highly with the results of the Cooperative Physics Test, but the correlation is not high enough to warrant use in prognosis. However, if other factors are lacking, the results of this test may be used, but with extreme caution.
3. The scores of the physics items of the Read General

Science Test correlate positively with the scores of the Cooperative Physics Test but are not as good predictors as the scores of the Cooperative Algebra Test or the Read General Science Test.

4. If a pattern of abilities does exist for the more able pupils who wish to take the advanced placement physics course, one of the factors will be a very high score on the Cooperative Algebra Test.

Implications.-- The implications are that scores on the Cooperative Algebra Test are a better predictor of success in physics than are scores on the Read General Science or scores on the physics items of the Read General Science Test. The correlation between the Cooperative Algebra Test and the Cooperative Physics Test is high enough so that scores on the Cooperative Algebra Test may be used to aid in guidance.

The scores on the Read General Science Test may be used if other factors are not available; but caution should be used if the scores on the Read General Science Test are used.

The scores on the physics items of the Read General Science Test are of less use for guidance than are the scores of the Read General Science Test.

2. Suggestion for Further Study

With our crowded school conditions, principals, teachers, and guidance personnel, as well as parents, are searching for "sign-posts" to use in guidance. Any study that is designed to verify the procedures now used or to test the practicability of new methods or procedures will be of help to these persons.

Further studies similar to this one should be performed at schools other than Brookline High School. These studies would check the sampling of the group at Brookline, as well as check the results of this study.

More work should be done with the Read General Science Test. For instance, how do the scores on the chemistry items compare with success in high school physics and high school chemistry? Another study could devote some study to the exact items responded to correctly by those pupils who were successful in the study of physics. These further studies would assist in answering the questions raised or partially answered by this paper.

APPENDIX

APPENDIX

STATISTICAL PROCEDURES USED IN THIS STUDY

<u>Basic Procedure</u>.-- The basic statistical procedure in this study is the building of three scatter diagrams.[1] From these scatter diagrams, the product-moment coefficients of correlation, the standard error of the coefficients of correlation, may be determined. Also the mean, standard deviation, and standard error of the mean for each test may be determined from the scatter diagrams.

<u>The Product-Moment Coefficient of Correlation</u>.-- The formula for determining this coefficient of correlation has already been mentioned. It is[2]

$$r_{xy} = \frac{\frac{x'y'}{N} - (c'_x c'_y)}{(\ '_x)(\ '_y)}$$

"where x' and y' = deviation from the guessed mean in terms of the class interval as the unit,

c'_x and c'_y = correction in x and y in class-interval units,

$'_x$ and $'_y$ = standard deviations in x and y in terms of the class interval as the unit."[3]

1/J.P. Guilford, Op. Cit., pp. 162-164.

2/Ibid., p. 162.

3/Ibid., p. 162.

The Mean.-- The mean will be determined by the short method suggested by Guilford.[1] The mean is first guessed. The correction for the guessed mean is then determined and applied.

$$M = M + c; \quad c = i \left(\frac{fx'}{N}\right)$$

Where:

M = mean

M' = guessed mean

c = correction for the guessed mean

i = size of class interval

x' = deviation of a class interval from guessed mean in terms of i as the unit

f = frequency within a class interval

N = total number of measurements[2]

Standard Deviation.-- To determine the standard deviation, the formula that will be used will be[3]

$$= i - \sqrt{\frac{fx^2}{N} - c'^2}$$

"Where: i = size of class interval
x' = deviation from guessed mean in terms of the class interval as the temporary unit
c' = correction in the guessed mean, also in terms of the class interval as the unit."[4]

1/Ibid., p. 61-64.

2/Ibid., p. 63.

3/Ibid., p. 102-104.

4/Ibid., p. 102.

The Standard Error of the Mean.-- The standard error of the mean will be estimated from the standard deviation. The formula suggested by Guilford[1/] is

$$M = \frac{\qquad}{-\sqrt{N - 1}}$$

"where

M = what is ordinarily called the standard error of a mean (as estimated from).
= standard deviation of the sample."
N = number of cases in the sample." [2/]

The Standard Error of the Coefficient of Correlation.-- To determine the standard error of the coefficient of correlation the formula is

$$r = \frac{\qquad}{-\sqrt{N - 1}}$$

"where

r = the standard error of the product-moment coefficient of correlation
r = product-moment coefficient of correlation
N = number of cases in the sample."[3/]

1/Ibid., p. 184.

2/Loc. Cit.

3/Op. Cit., p. 205

Table 4. Scatter diagram of the scores of the Read General Science Test and the scores of the Cooperative Physics Test

Physics Raw Scores

General Science Scores	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	fy	y'	fy'	fy'^{2}	Σx'y' +	Σx'y' -
70-74												20 1 20		28 1 28		2	+4	8	32	48	
65-69							1			9 3 27	12 2 24	15 1 15				7	+3	21	63	66	
60-64		-10 1 -10	-8	-6 1 -6	-4 1 -4	-2		2 1 2	4 1 4	6 2 12	8 2 16	10 1 10	12 1 12	14 1 14	16 1 16	13	+2	26	52	86	20
55-59	-6	-5 1 -5	-4	-3 2 -6	-2 2 -4	-1	1	1 4 4	2 6 12	3	4 2 8	5	6 1 6			19	+1	19	19	30	15
50-54	1			1	1	1	1	4	3	1	1	1				16	0				
45-49			+4 4 16	+3 1 3	+2	+1 2 2	3	-1 3 -3	-2 1 -2	-3 1 -3	-4 1 -4					16	-1	-16	16	21	12
40-44	+12 1 12	+10 1 10	+8 2 16	+6 3 18	+4 2 8	+2 2 4	1	-2 1 -2	-4 1 -4							14	-2	-28	56	68	6
35-39	18 1 18	15 4 60	12 1 12	9 1 9	6	3 1 3		-3 1 -3								9	-3	-27	81	102	3
30-34	20 1 24	20 1 20	16 1 16	12	8 1 8											4	-4	±16	64	68	
25-29	30 2 60															2	-5	-10	50	60	
20-24																0	-6				
15-19		35 1 35														1	-7	-7	49	35	
10-14	48 1 48															1	-8	-8	64	48	
5-9																					
0-4																					
fx	7	9	8	9	7	6	8	14	12	7	8	4	2	2	1	104		-38	546	632	56
x'	-6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8						
fx'	-42	-45	-32	-27	-14	-6		14	24	21	32	20	12	14	8	-21					
fx'^{2}	252	225	128	81	28	6		14	48	63	128	100	72	98	64	1307					
Σx'y' +	162	125	60	30	16	9		6	16	39	48	45	18	42	16	632					
Σx'y' -		15		12	18			8	6	3	4					56					

$\Sigma x'y' = 576$

$r_{xy} = .69$

Determining the mean, standard deviation, and the standard error of the mean for the Cooperative Physics Test.

$$M = M' + c = M' + i\left(\frac{fx'}{N}\right) =$$

$$32 + 5(-0.202)$$

$$M = 30.99$$

$$= i - \sqrt{\frac{fx^2}{N} - c'^2}$$

$$= 5 - \sqrt{\frac{1307}{104} - 0.0408}$$

$$= 17.7$$

$$M = \frac{\qquad}{\sqrt{N - 1}}$$

$$= \frac{17.7}{10.14}$$

$$M = 1.75$$

Determining the mean, standard deviation, and the standard error of the mean for the Read General Science Test.

$$M = M' \neq c = M' \neq i \left(\frac{\Sigma fx'}{N}\right) =$$

$$52 \neq 5\ (-0.365)$$

$$M = 50.18$$

$$\sigma = i \sqrt{\frac{\Sigma fx^2}{N} - c^{12}}$$

$$\sigma = 5 \sqrt{\frac{536}{104} - 0.1332}$$

$$\sigma = 11.2$$

$$\sigma_M = \frac{\sigma}{\sqrt{N - 1}}$$

$$\sigma_M = \frac{11.2}{10.14}$$

$$\sigma_M = 1.10$$

Determining the product-moment coefficient of correlation and the standard error of the coefficient of correlation for the scores on the Cooperative Physics Test and the scores on the Read General Science Test.

$$r_{xy} = \frac{\frac{\sum x'y'}{N} - c'_x c'_y}{(\sigma'_x)(\sigma'_y)} =$$

$$\frac{\frac{648}{104} - (-0.202)(0.115)}{(3.54)(2.77)} =$$

$$\frac{6.2540}{9.8058} =$$

$$r_{xy} = 0.64$$

$$\sigma_r = \frac{1 - r^2}{\sqrt{N - 1}} = \frac{1 - 0.4096}{10.14} = \frac{0.5904}{10.14}$$

$$\sigma_r = 0.058$$

Table 5. Scatter diagram of the scores of the Physics Items of the Read General Science and the Scores of the Cooperative Physics Test

Physics Raw Scores

Physics Items of the Read General Science Test

	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	fy	y'	fy'	fy'^{2}	$\Sigma x'y'$ +	$\Sigma x'y'$ -
36-37																					
34-35										15 3 15		25 1 25		35 1 35		5	+5	25	125	75	
32-33							1			12 1 12	16 3 48	20 1 20	24 1 24	28 1 28		8	+4	32	128	132	
30-31		-15 1 -15		-9 1 -9	-6 1 -6			3 1 3	6 2 12	9 1 9	12 2 24	15 1 15				10	+3	30	90	63	30
28-29				-6 1 -6	-4 1 -4			2 1 2	4 2 8		8 1 8				16 1 16	7	+2	14	27	34	10
26-27		-5 1 -5		-3 1 -3	-2 1 -2		1	1 5 5	2 4 8				6 1 6			14	+1	14	14	19	10
24-25	1	1	2	3	2	2	3	5		2	1	1				23	0				
22-23		5 1 5	4 3 12	3 2 6	2	1 1 1	2	-1 1 -1	-2 2 -4		-4 1 -4					13	-1	-13	+13	24	9
20-21		10	8 1 8	6 1 6	4	2 2 4	1	-2 1 -2	-4 2 -8							8	-2	-16	+32	18	10
18-19	18 1 18	15 2 30	12		6 1 6	3										4	-3	-12	+36	54	
16-17	20	20 2 40	16 2 32		8	4 1 4										5	-4	-20	+80	76	
14-15	30 1 30	25			10											1	-5	-5	+25	30	
12-13	36 4 18	30 1 30			12 1 12											5	-6	-30	+180	150	
10-11	42 1 42															1	-7	-7	+49	42	
8-9																					
fx	7	9	8	9	7	6	8	14	12	7	8	4	2	2	1	104		+12	799	717	69
x'	-6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8						
fx'	-42	-45	-32	-27	-14	-6	0	14	24	21	32	20	12	14	8	-21					
fx'^{2}	252	225	128	81	28	6	0	14	48	63	128	100	72	98	64	1307					
$\Sigma x'y'$ +	198	105	52	12	18	9		10	28	36	80	60	30	63	16	717					
$\Sigma x'y'$ -		20		-18	-12			-3	-12		-4					-69					

$\Sigma x'y' = 648$

$r_{xy} = 0.64$

Determining the mean, standard deviation, and the standard error of the mean for the physics items of the Read General Science Test.

$$M = M' + c = M' + i\left(\frac{\Sigma fx'}{N}\right) =$$

$$24.5 + 2\left(\frac{12}{104}\right) = 24.5 + 2(0.115)$$

$$M = 24.73$$

$$\sigma = i\sqrt{\frac{\Sigma fx^2}{N} - c'^2}$$

$$\sigma = 2\sqrt{\frac{799}{104} - 0.0132}$$

$$\sigma = 5.54$$

$$\sigma_M = \frac{\sigma}{\sqrt{N - 1}}$$

$$= \frac{5.54}{10.14}$$

$$\sigma_M = 0.55$$

Determining the product-moment coefficient of correlation and the standard error of the coefficient of correlation for the scores on the Cooperative Physics Test and the scores on the physics items of the Read General Science Test.

$$r_{xy} = \frac{\frac{\sum x'y'}{N} - c'_x c'_y}{(\sigma'_x)(\sigma'_y)} =$$

$$\frac{\frac{576}{104} - (-0.202)(-0.365)}{(3.54)(2.24)} =$$

$$\frac{5.4648}{7.9276}$$

$$r_{xy} = 0.69$$

$$\sigma_r = \frac{1 - r^2}{\sqrt{N - 1}} = \frac{1 - 0.4761}{10.14} = \frac{0.5239}{10.14}$$

$$\sigma_r = 0.052$$

Table 6. Scatter diagram of the Scores of the Cooperative Algebra Test and the Scores of the Cooperative Physics Test

Physics Raw Scores

The Cooperative Algebra Test

	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	fy	y'	fy'	fy'^{2}	$\Sigma x'y'$ +	$\Sigma x'y'$ -
60-64								5 1 5	10 3 30		20 2 40	25 1 25		35 2 70	40 1 40	10	+5	50	250	210	
55-59							1	4 2 8	8 3 24	12	16 1 16	20 1 20	24 1 24			9	+4	36	144	92	
50-54	-18 1 -18						2	3 3 9	6 1 6	9 3 27	12 2 24	15 1 15	18 1 18			14	+3	42	126	99	18
45-49					-4 1 -4	-2 3 -6	1	2 2 +4	4	6 1 6	8 1 8					9	+2	18	36	18	10
40-44					-2 3 -6		3	1 1 1	2 3 6	3 2 6	4					12	+1	12	12	13	6
35-39			1	1		2	1	2		1	1					9	0				
30-34			4 1 4	3 3 9	2 1 2			-1 2 -2				-5 1 -5				8	-1	-8	8	15	7
25-29		10 3 30						-2 1 -2			-8 1 -8					5	-2	-10	20	30	10
20-24		15 2 30	12 3 36	9 1 9	6 1 6				-6 2 -12							9	-3	-27	81	81	12
15-19	24 2 48	20	16	12 1 12	8 1 8	4 1 4										5	-4	-20	80	72	
10-14	30 1 30	25	20	15 2 30												3	-5	-15	75	60	
5-9	36 2 72	30 3 90	24 2 48	18 1 18												8	-6	-48	288	228	
0-4	42 1 42	35 1 35	28 1 28													3	-7	-21	147	105	
fx	7	9	8	9	7	6	8	14	12	7	8	4	2	2	1	104		+9	1267	1023	63
x'	-6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8						
fx'	-42	-45	-32	-27	-14	-6		14	24	21	32	20	12	12	14	-21					
fx'^{2}	252	225	128	81	28	6		14	48	63	128	100	72	98	64	1307					
$\Sigma x'y'$ +	192	185	116	78	16	4		27	66	39	88	60	42	70	40	1023					
$\Sigma x'y'$ -	18				10	6		4	12		8	5				-63					

$\sum x'y' = 960$

$r_{xy} = .75$

Determining the mean, standard deviation, and the standard error of the mean for the Cooperative Algebra Test.

$$M = M' + c = M' + i\left(\frac{\Sigma fx'}{N}\right) =$$

$$37 + 5\left(\frac{9}{104}\right) = 37 + 5\ (0.087)$$

$$M = 37.44$$

$$\sigma = i\sqrt{\frac{\Sigma fx'^2}{N} - c'^2}$$

$$\sigma = 5\sqrt{\frac{1267}{104} - 0.0076}$$

$$\sigma = 17.5$$

$$\sigma_M = \frac{\sigma}{\sqrt{N - 1}}$$

$$= \frac{17.5}{10.14}$$

$$\sigma_M = 1.72$$

Determining the product-moment coefficient of correlation and the standard error of the coefficient of correlation for the scores on the Cooperative Physics Test and the scores on the Cooperative Algebra Test.

$$r_{xy} = \frac{\frac{\Sigma x'y'}{N} - c'_x c'_y}{(\sigma'_x)(\sigma'_y)}$$

$$= \frac{\frac{960}{104} - (-0.202)(0.087)}{(3.54)(3.49)} =$$

$$\frac{9.2308 + 0.0176}{12.3546} = \frac{9.2484}{12.3546}$$

$$r_{xy} = 0.75$$

$$\sigma_r = \frac{1 - r^2}{\sqrt{N - 1}} = \frac{1 - 0.5625}{10.14} = \frac{0.4375}{10.14}$$

$$\sigma_r = 0.043$$

Table 7. The scores Obtained by Seven Pupils Who Enrolled in and Completed the Advanced Physics Course

Individual Case	Scores on			
	Science	Algebra	Physics	Physics Items
(1)	(2)	(3)	(4)	(5)
1	62	63	68	33
2	65	60	53	32
3	55	62	61	28
4	70	63	66	34
5	55	62	62	27
6	64	60	71	29
7	60	60	66	27

Table 8. The scores Obtained by the one Pupil Who found it Advisable to Transfer from the Advanced Physics Class to an Honor Physics Class

Individual Case	Score on			
	Science	Algebra	Physics	Physics Items
(1)	(2)	(3)	(4)	(5)
1	50	52	49	23

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BOSTON UNIVERSITY

GRADUATE SCHOOL

ABSTRACT - THE VALUE OF THE READ GENERAL SCIENCE TEST AND OF THE COOPERATIVE ALGEBRA TEST FOR PREDICTING SUCCESS IN HIGH SCHOOL PHYSICS

Submitted by

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ABSTRACT

The purpose of this study was to determine the value of the Read General Science Test and the Cooperative Algebra Test for predicting success in high school physics. Success in high school physics was determined by the score obtained on the Cooperative Physics Test. An additional observation was made on the results of the students taking advanced standing physics to determine if a special pattern of abilities existed for these students.

The Read General Science Test and the Cooperative Algebra Test were administered to 104 physics students at Brookline High School during September, 1956. In May, 1957, the Cooperative Physics Test was administered to the same group. The scores on the Read General Science Test and the scores on the Cooperative Algebra Test were correlated with the scores on the Cooperative Physics Test. In addition, the scores obtained on the physics items of the Read General Science Test were correlated with the scores obtained on the Cooperative Physics Test.

The results of the correlations were as follows:

	r	σ_r
Physics - Algebra........	0.75	0.043
Physics-General Science..	0.69	0.052
Physics-physics items of General Science........	0.64	0.058

These results indicate that:

1. The scores on the Cooperative Algebra Test are good predictors of success in physics.
2. The Read General Science Test scores correlate with the Cooperative Physics Test scores, but the correlation is not high enough to warrent use in prognosis. However, if other factors are lacking, the results of this test may be used with extreme caution.
3. The scores of the physics items of the Read General Science Test correlate with the scores of the Cooperative Physics Test but are not as good predictors as the scores of the Cooperative Algebra Test or the Read General Science Test.
4. If a pattern of abilties does exist for the more able pupils who wish to take a course in advanced placement physics, one of the factors will be a very high score on the Cooperative Algebra Test.

Other studies similar to this study should be preformed to check the sampling and the results of this study. Also, more work should be done on the items of the Read General Science Test in relation to success in chemistry and physics.