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TITLE AN INVESTIGATION OF THE RELATIONSHI[P] BETWEEN THE SCIENCE INFORMATION POSSESSED BY NINTH GRADE GENERAL SCIENCE STUDENTS AND CERTAIN SCHOOL AND OUT-OF-SCHOOL SCIENCE EXPERIENCE

AUTHOR JOHN HENRY WOODBURN

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AN INVESTIGATION OF THE RELATIONSHIP BETWEEN THE SCIENCE INFORMATION POSSESSED BY NINTH GRADE GENERAL SCIENCE STUDENTS AND CERTAIN SCHOOL AND OUT-OF-SCHOOL SCIENCE EXPERIENCES

By

John H. Woodburn

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CHAPTER I

THE PROBLEM AND DEFINITIONS OF TERMS USED

The science program of the public schools in our nation has certain dynamic and evolving characteristics. This program cannot help being affected by the changing student population and the society from which these students come. Changes in thinking concerning the growth and development of secondary school youth as well as new insight into the nature of the basic learning process prompts constant reexamination of the school science program. Often this reexamination brings changes, changes described by Johnson[1] in such terms as:

> . . . expansion of science at elementary levels, general science and health science at junior high school levels, science within core courses, general biology at the lower senior high school levels, and various attempts to generalize the physical sciences at the upper senior high school levels.

"Findings from a Common Learnings Course Involving Science," "Meeting Students' Needs," and "Experiences in Program Modifications in Science" are typical topics being discussed whenever science teachers convene to discuss professional problems. These particular titles were included

[1]Philip G. Johnson, "Some Developments in Science Teaching and Testing," School Science and Mathematics, 50:183, March, 1950.

in the program of the 1950 meeting of the Psychology and Education section of the Illinois State Academy of Science.

In some schools, particularly in Illinois, the ninth grade general science course is being replaced by a "Freshman Problems" course. This change follows the judgment of teachers and administrators.

I. THE PROBLEM

Statement of the problem. It is the purpose of this study to examine relationships, if they exist, between the possession of science information by ninth grade students and certain pre-ninth grade school and out-of-school factors.

An attempt is made to identify any relationships between the possession and acquisition of science information and variations in home background, variations in terms of rural, village, or city environment as well as variations in the general social and economic conditions prevailing within the students' homes.

The relationship between differences in sex and the possession and acquisition of science information is examined.

An attempt is made to evaluate the relationship between membership in 4-H Clubs and Scouts and the possession and acquisition of science information.

Whether or not those students who report markedly greater interest in reading science books and books about science tend to possess and acquire more science information than those who report little such interest is another relationship explored in this study.

The relationship between the amount of school science instruction prior to the ninth grade and the possession and acquisition of science information is examined.

This study was designed to consider the amount of science information possessed by students upon entering the ninth grade general science course as well as the amount acquired during the course. This design was implemented by giving a general science test to groups of students as they entered the ninth grade and then repeating with a different form of the same test at the end of the ninth grade. The difference between final and initial test scores thus provides an estimate of the science information gained through the ninth grade.

Limitations of the problem. This study will be limited to the consideration of the factors listed above. The author is aware that other investigators might have chosen other factors and have been equally reasonable in suspecting them of affecting the possession and acquisition of science information by ninth grade students.

The measuring instrument used in this study imposes a second limitation. Only that science information which enables or aids a student to respond successfully to the items on the Read General Science Test[2] will be included in this investigation. The author concedes that many of the objectives and accomplishments claimed by general science teachers would require other means of identification and measurement.

Although the Read Test is described in greater detail under that portion of this thesis entitled "Materials Used and Groups Studied," it may be noted here that this test is composed of seventy-five multiple choice items. The pattern underlying the design of the items is such that a student's correct response hinges on his ability to recall and apply information such as is customarily developed in general science textbooks and discussed in science classes.

The Read Test becomes particularly suited in several ways to a study of the type reported in this thesis. The predominant pattern underlying the students' responses is sufficiently clear-cut to aid in the interpretation of results obtained from it. Regardless of what other

[2]John G. Read, The Read General Science Test, (New York: World Book Co., 1950).

experiences a teacher may choose to include in his course, this test gives a reliable and valid measure of the achievement of his students in respect to their ability to handle the information customarily included in the more widely accepted general science textbooks.

Sufficient statistical analysis of the probable performance of each item accompanied the composition of this test to enable its author to assemble the complete test in such a way that it would have a high degree of internal consistency and a minimum number of items with low discriminatory power. Of the forty-five minutes devoted to the marking of this test by the student, a minimum amount of time is spent answering items which fail to separate those who possess science information from those who do not.

__The importance of the problem.__ No single course in the total science program of many school systems is as universally required as the general science course offered either during the eighth or ninth grade. In many schools, due to the opportunity for students to elect their second science course, the general science course provides the only common science experience to be shared by all of the students who may enrol in the school. In a few cases this course is the only contact with science instruction which the administrator of the school insures each student will experience prior to graduation. It is increasingly becoming the only formal contact of many students with instruction in the physical and earth sciences. These observations stem from the common knowledge of people directly connected with the public school science program. Certain data, however, may be cited to support these observations. In the United States Office of Education study which was reported by Johnson[3] in 1950, during the school year 1947-48, ". . . 66.2 percent of the ninth-grade pupils were enrolled in general science."[4] This same report indicated that ". . . during the first term of 1947-48, a number equal to 74.9 percent of the tenth-grade pupils were enrolled in biology."[5] Referring to the same school year, Johnson reports further:

> Since the chemistry pupils came almost equally from the eleventh and twelfth grades, it is of some significance to indicate that about one-fifth of the pupils enrolled in these grades represented the number enrolled in chemistry. . . . The number of pupils enrolled in physics represents about 13.3 percent of the number of pupils in the eleventh and twelfth grades.[6]

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[3]Philip G. Johnson, "The Teaching of Science in Public High Schools," United States Office of Education Bulletin, 9:1-18, 1950.

[4]Ibid., p. 12.

[5]Loc. cit.

[6]Ibid., pp. 15-18.

Data supplied by the registrar of one of the universities* located in the area in which this study was conducted indicate that 36 per cent of the students entering the university had taken the ninth grade general science course with or without other sciences and for 11 per cent of the students it was the only science course included in their high school program. Seventy-five per cent of these students had biology courses, 42 per cent chemistry courses, and 26 per cent had had courses in physics. It is conceded that this college-entering group cannot be considered a sample that would be entirely representative of the students graduating from the high schools in the area.

Another factor affecting the importance of this study is the position the ninth grade general science course occupies in the total school science program of boys and girls. Through his experiences during earlier years of teaching the general science course and later while working with the specialized science courses at both the high school and college levels, the author has come to look upon this course as occupying a strategic position in the total science program. The extreme interpretation of this position might be that the students are so impressionable at the junior high school age as to allow their whole life interest in and attitude toward the total science enterprise

*Illinois State Normal University

to be influenced by enrollment in the general science course.

Expressed in operational terms, the importance of this study hinges on determining whether or not the content and level of the experiences offered the students in the ninth grade general science course should be adjusted according to the extent to which these students have participated in other experiences prior to being enrolled in the course.

The author believes that each school and each teacher rightfully retains the responsibility of interpreting what experiences shall be most meaningful to each youngster under guidance. This study intends merely to provide evidence of a sort which ought to aid school administrative officers and classroom teachers in formulating these interpretative decisions.

Living as we do in a world in which the impact of science on even our most insignificant experience is becoming strikingly evident, the author deems it unnecessary to do more than cite the increasing responsibility of all schools to aid their students in understanding the realm of science and appreciating the functioning of the whole science enterprise.

II. DEFINITIONS OF TERMS USED

Few of the terms used in this study are intended to carry meanings other than ordinarily ascribed to them in usual usage. It may be well, though, to provide definitions of these terms and, in addition, review the meanings of the statistical functions used in the analysis of the data.

Terms peculiarly used in this study.

1. Students from the "best" home backgrounds. This term is used in connection with the social-economic home conditions of the students. When so applied it refers to the approximately 10 per cent of their students whom the teachers identified as coming from "the kind of home that would give the student the best chance to acquire science information."

2. Students from the "poorest" home backgrounds. This term is used in connection with the social-economic home conditions of the students also but with opposing meaning to those described in "1" above.

3. Students with 4-H Club experience. Students who replied on the personal information form that they had been members of the 4-H Clubs for at least one year.

4. Students with high interest in reading science books. Students who indicated that they had read more than four books about science during the past two or three years.

5. Students with low interest in reading science books. Students who indicated that they had read less than two science books during the past two or three years.

6. Students with rural, village, city, or mixed home backgrounds. Students who indicated that they had spent the last five years in the identified category. If the last five years had been divided between two or more categories the students so indicating were identified as coming from a mixed home background.

7. Students with Scout experience. Students who indicated that they had been members of either the Boy or Girl Scouts for at least one year.

8. Total number of science classes per week through the 6th, 7th, and 8th grades. This rather awkward expression may be interpreted from the following example. If a student reported that he had science classes three days a week through the sixth grade, none through the seventh, and science classes five days a week through the eighth grade he would be identified as having had a total of eight science classes per week through the 6th, 7th, and 8th grades.

A review of the terms used in the statistical analysis of the data. The symbols in the parentheses are used for abbreviations.

1. Attenuation. The reduction of the correlation between two tests associated with the unreliability of the tests.

2. Biserial Coefficient of Correlation. The correlation between two variables one of which, for calculation

purposes, has been reduced to two categories. (r_{bi})

3. Biserial Coefficient of Correlation from Widespread Cases. The correlation between two variables one of which, for calculation purposes, has been reduced to two categories and only the extreme measurements in these two categories are considered. (r_{biw})

4. Centile. A value on a scale below which the specified number of cases may be expected to fall.

5. Coefficient of Alienation. An estimate of the proportion of chance remaining in any prediction based on a coefficient of correlation.

6. Coefficient of Correlation. A quantitative expression of the tendency of one factor to vary concurrently with variations in a related factor. (r)

7. Coefficient of Determination. The proportion of the total variance in the distribution of one variable that may be attributable to a second factor that is correlated with it.

8. Coefficient of Multiple Correlation. The degree of correlation between a dependent variable and two or more other variables acting simultaneously. (R)

9. Correlation Ratio. An estimate of the degree of correlation between two variables which may not be linearly related. (Eta)

10. Explained Variance. The value of the square of the deviation from their own mean of the estimated values of a variable obtained by the use of a correlated variable.

11. Mean. The arithmetical average. (M)

12. Median. The point on a scale of a distribution of scores above which are exactly one half of the scores. (Med)

13. Normal Distribution. A distribution of measurements which, when plotted, will form a curve that can be described by the equation:

$$y = \frac{N}{SD\sqrt{2\pi}} e^{\frac{-x^2}{2SD^2}}$$

14. Pearson Product-Moment Coefficient of Correlation. An estimate of the degree of correlation between two variables. This method of calculation is based on the deviations of the scores in the two distributions from their respective means. (r)

15. Range. A rough estimate of the variation within a group. This is based on the difference between the highest and lowest scores.

16. Regression Coefficient. A constant value that when added to the mean of a set of predicted values of a dependent variable will yield a sum equal to the mean of a correlated independent variable. (b_{xy})

17. Regression Equation. An estimating equation based

on the correlation between two variables and which describes the functional relationship between the two variables.

18. Semi-interquartile Range. One half of the range of the middle one half of the scores. (Q)

19. Standard Deviation. The square root of the mean of the squared deviations of measurements from their mean. (SD)

20. Standard Error. An estimate of the degree of probability that an observed measurement is applicable to the total population.

21. Standard Error of Estimate. The square root of the mean squared deviations of estimated values from their true values.

22. Standard Score. The deviation between a raw score and the mean of the total distribution divided by the standard deviation of the distribution. (z)

23. Statistical Significance. An arbitrarily arrived at understanding of the degree of assurance that must be maintained regarding the probability that an observed value will not deviate from the true value within the total population. In this study it will be generally understood that a quantity will be judged significant or insignificant according to the "t-ratio" technique.

24. Tetrachoric Correlation. The correlation between two variables both of which for calculation purposes have been reduced to two categories. (r_{tet})

25. T-ratio. The ratio between a quantity and its standard error. (t)

26. T-Score. Any raw score converted to the value it would have if it occupied a similar rank in a distribution with a mean of 50 and a standard deviation of 10.

27. Unexplained Variance. The difference between the total variance and the explained variance.

28. Variance. The mean square of the deviations of the measurements of a variable from their mean.

III. ORGANIZATION OF THE REMAINDER OF THE THESIS

There are four chapters remaining in this thesis. Chapter II presents a review of the literature related to the subject matter of this thesis. The review is organized in sections roughly comparable to the phases of this total study.

Chapter III includes a description of the test and personal information form used to gather the data for this study. The characteristics of the groups of students from whom these data were gathered are discussed in this chapter along with the practices used in the collection and organization of the data.

Chapter IV, the major section of the thesis, presents the data of the study and brief guides to their interpretation. Basically, the study is focused on the identification of concomitance[7] of factors and the determination of estimates of the degree of this concomitance. If two groups, the members of which differ in some respect to some factor, also show statistically significant differences in mean scores on the Read Test, this is used as evidence of concomitance between that factor in which the two groups differ and the ability to respond to the items on the Read Test.

Degrees of correlation are interpreted as degrees of concomitance.

In anticipation of this thesis being read by readers with varying degrees of experience with such data, scores are reported both in terms of raw scores and standard deviations and in terms of deviation score units. Gains are also reported, where applicable, in mean differences between individual T-scores and in terms of per cent of gain possible. The author identifies any instances where inperpretations based on raw scores would be misleading due to differences between the standard deviations of the groups being compared.

Section I of Chapter IV reports the data obtained from groups differing in respect to being taught or not being

[7]Florence L. Goodenough, Mental Testing, Its History, Principles, and Applications, (New York: Rinehart and Co., 1949), pp. 251-253.

taught general science in the ninth grade.

Section II considers the data obtained from groups differing in intelligence.

Section III considers the differences associated with differences in sex.

Section IV reports the data obtained from groups differing in respect to membership in Scout organizations and 4-H Clubs. These data provide a typical illustration of the problems involved in attempting to parcel out the exclusive degree of concomitance between two factors acting simultaneously with several others.

Section V cites the data gathered in an attempt to estimate the relationship between students' degrees of interest in reading science books and their possession of science information.

Section VI reports the data drawn from groups differing in respect to certain home background factors.

Section VII, the final section of this chapter, reports the differences associated with varying amounts of instruction in science through the sixth, seventh, and eighth grades.

The data of this study are summarized, section by section, in Chapter V. This chapter also includes those generalizations which, in the mind of the author, may be reliably extended from the data of the study.

As this study proceeded toward completion, certain questions arose which were beyond the immediate scope of this investigation. These questions, discussed in Chapter VI, may well indicate topics for future studies.

CHAPTER II

PREVIOUS RESEARCH RELATED TO THE STUDY

The reports of investigations already completed which involve the questions explored in this study will be referred to under the following headings:

1. Effect of previous instruction in science upon achievement in subsequent science courses.

2. Correlations between achievement in science and intelligence.

3. Differences in achievement associated with membership in science clubs, 4-H Clubs, and Scouts.

4. Differences in achievement associated with the social-economic backgrounds of students.

In order to gain additional perspective of the whole problem of the significance of the ninth grade general science course in the school program, brief reference will be made to other but less closely related studies. These studies involve such questions as the degree of retention of the information taught in the ninth grade general science course, the degree of duplication of content in series of general science textbooks and between general science and the specialized science courses, and differences in achievement in general science associated with the differences in the degree of interest displayed by students in the course.

Effect of previous instruction in general science upon the achievement of students in subsequent general science courses. Cramer[1] used the Ruch-Popenoe[2] General Science Test to gather data on two groups of students in the high schools of Kansas City, Missouri during 1924-25. The two groups had the same median IQ. The group which was taught general science through the ninth grade scored 12.4 points higher (median) on Form B of the test given in the spring than on Form A given in the beginning of the school year. The second group to which no general science was taught scored 1.3 points higher on Form B than on Form A. There were 115 items on this test.

In connection with the standardization of his General Science Test and Scales, Dvorak[3] explored the differences between the scores of students with different amounts of

[1] W. F. Cramer, "A Study of Some Achievements of Pupils in the Special Sciences," Science Education, 14:505-17, March, 1930.

[2] Giles M. Ruch and Herbert E. Popenoe, Ruch-Popenoe General Science Test, (New York: World Book Co., 1923).

[3] August A. Dvorak, "A Study of Achievement and Subject Matter in General Science," General Science Quarterly, 10:289-310, 367-396, 445-474, 525-542, November, 1925 through May, 1926.

prior science instruction. His results are summarized in Table I. The total score possible on these tests was 300 and Dvorak states that a difference between medians of more than 5.2 indicates with practical certainty that the difference is not a result of chance distributions in two series.

These data of Dvorak's show that there is a tendency for students to acquire science information through maturity as well as through formal instruction in science classes. His interpretation is that:

> . . . the decided superiority of achievement on the part of pupils who had not taken General Science and have reached the 12th grade, over the respective medians of their 8th grades has at least two explanations. (1)Sciences other than General Science taken by the pupil have accounted for this growth. (2)Elimination of the less capable pupils might account for apparent growth. The latter explanation, however, is subject to two criticisms--(a)The correlation between scores and time of doing the test, which usually has a positive correlation with intelligence test scores, was practically zero, and (b)likewise the correlation between chronological age and scores was near zero. Both these correlations show that the less capable pupils were in the groups taking the test, at least in some numbers.[4]

In addition to the inferences which may be drawn from the data of Dvorak already cited, the following of his conclusions are particularly significant:

> 6. The annual increase in achievement in General Science due to teaching as measured by the General

[4] *Ibid.*, p. 474.

TABLE I

THE 50TH PERCENTILE SCORE ESTABLISHED AMONG 6053 CASES FOR DIFFERENT GROUPS ON DVORAK'S GENERAL SCIENCE TEST

Group	With prior instruction in General Science	Without Prior Instruction in General Science
8th grade girls	131	114
9th grade girls	150	126
10th grade girls	157	135
11th grade girls	158	150
12th grade girls	175	162
8th grade boys	155	127
9th grade boys	162	135
10th grade boys	163	150
11th grade boys	183	172
12th grade boys	190	190

(Adapted from August A. Dvorak, Ibid., p. 465.)

Science Scale, is small, namely .539 P.E. or 5.39 scale points. . . . 7. There is a wide variation of achievement in General Science among different schools. 8. The difference in test points between median scores of the 8th grade pupils who have and who have not had General Science, is equal to the difference between the median scores of the 9th grade pupils who have not had General Science. This indicates that 8th grade pupils profit approximately as much by instruction in General Science as do 9th grade pupils. . . . 13. Performance on the General Science Scale shows for each sex a definite, direct relationship to the number of science courses the pupil has taken. 14. Any two of the five grades studied show considerable overlapping of achievement, even in the case of 8th and 12th grade pupils.[5]

A final conclusion reached by Dvorak is significant.

The General Science test given before the study of a subject, gave a correlation of .62 between test scores and school marks for the first two quarters. This would seem to indicate that the amount that pupils knew of a subject before studying it, is an important factor in conditioning the achievement which they will receive in the subject when they study it, if school marks are any measure of achievement.[6]

Miller[7] conducted a study in which he designed a test of the free-response type organized in three sections. There were 167, 167, and 175 items in the three sections. The 509 items were focused on concepts chosen as common to ninth grade general science courses of study. The test

[5]Ibid., pp. 539-540.

[6]Ibid., pp. 533-534.

[7]Earl A. Miller, "Science Concepts Acquired by Junior High School Pupils Previous to Entering a Course in General Science, (unpublished Master's thesis, University of Iowa, Iowa City, Iowa, 1931), 104 pp.

was given to eighth grade pupils at the close of the school year. These pupils were enrolled in 23 schools located in 23 communities and had been taught no science through the eight elementary grades. He obtained scores from 901 pupils on sections one and two and 367 scores on section three.

Miller further concluded that untrained students were able to show familiarity with concepts in the following subject matter groups arranged in the order of highest to lowest ability--(1)Food and the Human Body, (2)Water, (3)Animal Life, (4)Stars, Sun, Planets, and Earth, (5)Heat, Combustion, and Fuel, (6)Matter, (7)Weather and Climate, (8)Plant Life, (9)Machines for Doing Work, (10)Metric System, (11)Earth's Atmosphere, (12)Magnetism and Electricity, (13)Rocks and Soil, (14)Light and its Relation to Plant Life, and (15)Energy.

The ranking method used by Miller to report his findings does not lend itself to comparison with related studies. His data, therefor, were reworked toward determining the per cent of possible correct responses received from each of the fifteen groups of items in the three tests. These values are presented in Table II.

These data show but slight disagreement with the rank order established by Miller and, in addition, provide an estimate of the quantitative relationships among the degrees

TABLE II

A PORTION OF MILLER'S DATA RECALCULATED TO SHOW PER CENT OF POSSIBLE CORRECT ANSWERS TO FIFTEEN GROUPS OF ITEMS

Group	% of possible correct answers	Rank	Number of items in group
Food and the body	33.2	1	32
Animal life	31.0	2	40
Water	25.1	3	31
Heat, combustion, fuel	22.3	4	59
Stars, sun, planets, etc.	21.8	5	60
Weather and climate	19.2	6	26
Machines for doing work	15.3	7	15
Metric system	13.9	8	8
Matter	13.8	9	27
Earth's atmosphere	13.1	10	47
Plant life	12.8	11	41
Magnetism and electricity	11.8	12	39
Light	11.4	13	33
Rocks and soil	11.3	14	30
Energy	6.6	15	21

(Adapted from Earl A. Miller, Ibid., pp. 48-51.)

to which untrained beginning ninth grade students may be familiar with concepts in the various branches of natural science. It may be further noted that the 113 items from the general area of the life sciences showed a per cent of possible correct responses of 25.0 whereas the 163 items from the earth science area averaged 17.0 per cent correct and the 233 physical science items averaged 16.2 per cent.

In 1931 Ashbaugh[8] gave the Powers General Science Test[9] to 124 matched pairs of students early in the ninth grade. The students in each pair were matched for intelligence but one student in each pair had a year of science in the Columbus, Ohio city schools while in the eighth grade with the other student having come from schools outside of Columbus in which no science had been taught through the eighth grade. The Powers test consists of 100 items. The median score of the Columbus students was 39.1. Although this was 6 points higher than the median score of the out-of-Columbus students it was not a statistically significant difference according to Ashbaugh's interpretation.

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[8] E. J. Ashbaugh, "General Science in the Eighth Grade or Not," Science Education, 16:24-28, October, 1931.

[9] S. R. Powers, Powers General Science Test, (New York: Bureau of Publications, Teachers College, Columbia University, 1927).

In addition Ashbaugh gave the Ruch-Popenoe General Science Test to the same pupils. This test consists of 50 multiple-choice and 65 completion items. The median score of the Columbus students on this test was 0.7 of a point lower than the median score of the out-of-Columbus students.

As a result of his study Ashbaugh observes that:

> In view of these findings a number of questions may be legitimately raised. First, does the test measure knowledge of significant science material which children ought to learn? Second, should we expect children to learn this material more effectively in a course in general science than in courses in geography, physiology, and hygiene? Third, was the information upon which one group excelled the other learned in their school work or outside in their contacts with life? Fourth, are there desirable attitudes, habits, and the like secured in a course in general science which are not secured in other courses? If so, what are they, and what is the evidence that they have been attained in general science work? Fifth, what is the value of attitudes if they do not bear fruit in additional knowledge? Sixth, is it safe to assume that these habits and attitudes are secured in the general science courses without objective measurement to prove their existence.[10]

Howard[11] in 1931 conducted a study with 400 seventh grade pupils in which he used a 100 item test composed of 50 completion, 25 true-false, and 25 multiple-choice items. The test was composed from the experiences of several general

[10] Ashbaugh, <u>op</u>. <u>cit</u>., p. 27.

[11] Lester R. Howard, "A Study of the Initial Status and Improvement in the General Science Knowledge of Seventh Grade Pupils," (unpublished Master's thesis, University of Colorado, Boulder, Colorado, 1932), 72pp.

science classes. The same form was used at the beginning and at the end of the course. Howard found his students making initial scores ranging between 8 and 59 with the median score falling at 33.9. The final scores ranged between 27 and 99 with 82.07 being the median.

By reworking Howard's data it was possible to show that the 60 items from the area of life science showed 40.5 per cent of correct responses on the initial test and 73.9 per cent correct on the final test. The 40 physical science items revealed 23.6 per cent correct responses on the initial and 75.2 per cent correct on the final test.

The Third Iowa Academic Every-Pupil Test in General Science for 1931 was used by Hack[12] to compare the achievement of 300 ninth grade students who had received no instruction in general science through the ninth grade with the achievement of 244 similar students except that they were taught science through the ninth grade. The mean score of the former group was 31.9 and for the latter group 41.9. A t-ratio of 9.52 indicates the reliability of this difference. The test used had a possible score of 140.

In connection with determining the practical scientific

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[12] Walter Hack, "A Study of Incidental Learning in General Science," (unpublished Master's thesis, University of Iowa, Iowa City, Iowa, 1932), 40pp.

knowledge possessed by rural and city children Scheuss[13] found that 151 children with prior training in general science made a mean score of 110 on a test on which 46 children without such training made a mean score of 101.7. She describes this test as consisting of 156 multiple response objective type items including 46 biology questions, 25 agricultural questions, 24 physiology questions, 32 physics questions, 16 chemistry questions and 22 questions of a miscelleanous nature. To eliminate the influence of technical scientific knowledge, questions of such nature were used that the children would be able to answer through their own observations of environmental phenomena.

Matteson[14] designed a test of 199 items of the free response type that was designed to cover the materials most readily available to elementary school pupils, availability being defined as being found in elementary science textbooks. In this test for the most part, technical questions were avoided, and all questions used deal with the broader concepts discussed in the elementary and

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[13] Mabel Scheuss, "A Comparative Study of Practical Scientific Knowledge Possessed by Rural and City Children," (unpublished Master's thesis, Indiana State Teachers College, Terre Haute, Indiana, 1936), 66pp.

[14] Harvey D. Matteson, "Concepts of Science Possessed by Pupils Entering Seventh Grade," (unpublished Master's thesis, State University of Iowa, Iowa City, Iowa, 1939), 47pp.

junior high school texts currently in use at the time the study was done.

The test was given to 315 students as they entered the seventh grade in a school system in which the students had received usually two periods of about forty-five minutes per week of science instruction in grades two through six. At the same time the same test was given to 258 seventh grade students as they entered the seventh grade in three schools that had no formal teaching of the subject, and any science material discussed is incidental to the teaching of some other subject.

The divisions of Matteson's test and the per cents of correct responses of his groups are shown in Table III.

Some of Matteson's conclusions that are particularly related to this study read:

> 1. There is little difference between the scores of the pupils who were taught courses in general science in the elementary grades and those who were not. 2. There is very little gain in any of the subject matter topics because of the teaching of that particular topic. . . . 6. The total average gain shown from teaching general science in the elementary schools was 4.1 per cent. . . . 9. The average per cent of correct responses for the entire test was 17.3.[15]

Borofsky[16] used the 334 pupils enrolling in the ninth

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[15] Ibid., pp. 33-34.

[16] Arnold J. Borofsky, "Factors Associated with Pupils Whose Achievement in Grade Nine Science Differs Greatly from that Indicated by Their Level of Intelligence," (unpublished Master's thesis, Boston University, Boston, Massachusetts, 1949), 230pp.

TABLE III

SUMMARY OF A PORTION OF MATTESON'S DATA

Division	Trained	Untrained	Combined
1. Air and water	25.6	22.4	24.1
2. Universe	28.9	25.1	27.2
3. Heat	19.3	23.1	21.0
4. Light	15.3	15.2	15.2
5. Electricity and magnetism	13.5	10.1	12.0
6. Foods and health	13.2	21.4	19.7
7. Weather and climate	13.4	20.5	16.6
8. Rocks and soils	10.6	9.5	10.1
9. Chemical reactions	4.8	3.5	4.2
10. Plant and animal life	11.1	7.6	9.5
11. Nature study	32.2	29.3	30.9

(Adapted from Harvey D. Matteson, op. cit., p. 47.)

grade general science classes in one high school through the three years between 1946 and 1949 as his experimental group. On the basis of the Otis Classification Test he divided these pupils into five groups. These same pupils were placed in five other groups on the basis of their scores on a teacher-made general science achievement test. From this grouping he found 36 pupils whose achievement grouping placed them in an intelligence grouping at least two standard deviations higher or lower than their achievement grouping, 17 being higher and 19 lower. Each of these cases then became a case study to determine what factors were associated with the apparent discrepancy between ability and achievement.

Of particular relatedness to this portion of this study was Borofsky's observation that:

> . . . in science courses in grades seven and eight, none of the low achievers, but more than 10 per cent of the high achievers failed to pass. On other achievement levels, the marks achieved in junior-high-school science by the two groups of cases are roughly similar.[17]

Related studies involving correlation between achievement in science and intelligence. Pruitt[18] gave both forms of the Powers General Science Test[19] to the pupils in eleven

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[17] Ibid., p. 210.

[18] Clarence M. Pruitt, "Objective Measurement in General Science," General Science Quarterly, 12:517-524, May, 1928.

[19] S. R. Powers, op. cit.

selected school systems. He found the correlation between the scores he obtained and intelligence to range between .47 ± .05 and .57 ± .05.

Hecht[20] found in his study, using tests of his own design to measure achievement in science, a correlation with intelligence of .56.

In 1931, Atkinson[21] found correlation between scores of 119 pupils on eight tests of the true-false type based in part on the contents of the textbooks in use and in part on a series of laboratory experiments carried out as individual projects and scores on the Terman intelligence test as follows: These values were for all pupils, boys and girls, .46, P.E. ± .05; for the boys only, .42, P.E. ± .07; and for the girls only it was .51, P.E. ± .06. The mean on the test used by Atkinson was 83.16.

Howard[22] found the correlation between achievement on his 100 item general science test and intelligence as measured by the Otis Advanced Group Intelligence Test to be .364 ± .044 in so far as initial science knowledge was concerned. The correlation between intelligence and improvement scores was found to be .48 ± .0254.

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[20] Milton Hecht, "Prognostic Measures of Achievement in Ninth-Year Science," (unpublished Doctor's dissertation, Cornell University, Ithaca, New York, 1941)

[21] Carroll Atkinson, "The Effect of Sex Differences in the Study of General Science," Journal of Educational Research, 24:61-66, June, 1931.

[22] Lester R. Howard, op. cit., p. 56.

In a study involving the correlates of ability in general science, Barish[23] used a test written and administered by the Division of Research of the Philadelphia City Schools. This test contained 25 biology, 25 biology and nature study, 30 chemistry, and 20 mathematics items. It was based on the minimum essentials of that semester of science; all questions were of the multiple choice type. The intelligence quotients of his experimental group members were determined by the Philadelphia Mental Ability Test. With intelligence and achievement thus determined, Barish found a correlation of .62 ± .03. Barish referred to two studies done prior to his by Bardy[24] and Tamagni[25] in which they found correlations between general science test scores and intelligence of .539 and .503 respectively.

<u>The findings of related studies regarding differences in achievement associated with differences in sex.</u> Dvorak[26]

23William Barish, "Correlates of Ability in General Science as Revealed in a Survey at the Roosevelt Junior High School of Philadelphia," (unpublished Master's thesis, Temple University, Philadelphia, Pennsylvania, 1937), pp. 2 & 18.

24Joseph Bardy, "An Investigation of the Written Examination as a Measure of Achievement with Particular Reference to General Science," (unpublished Doctor's dissertation, University of Pennsylvania, Philadelphia, Pennsylvania, 1923), cited by William Barish, op. cit., p. 12.

25Joseph N. Tamagni, "A Study of the Science Scores in the Carnegie Examinations of 1930 and 1932 at Temple University," (unpublished Master's thesis, Temple University, Philadelphia, Pennsylvania, May, 1934), cited by William Barish, op. cit., p. 12.

26Dvorak, op cit., p. 535.

found significant differences between the scores of boys and girls in connection with the standardization of his general science test. This was consistently so with all of his groups, students in the eighth through the twelfth grades. Wherein he compared the scores of his trained groups with the scores of his untrained groups, grade level by grade level, there were no significant differences consistently in favor of either sex.

> . . . the rank orders of the items for the untaught girls and the untaught boys were more alike than were the rank order of the items for the girls before and after taking General Science.[27]

The same was found to be true for the boys. This prompted the following observation by Dvorak:

> . . . that not parts of General Science were more difficult for girls than for boys but that relatively <u>all</u> of General Science was as much more difficult for girls than for boys as is indicated by the difference in the medians.[28]

Atkinson[29] did not find significant differences between the mean scores of the boys and girls who were included in her study. The distribution of the boys scores did, however, show a greater standard deviation than did the distribution of the scores of the girls.

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[27] *Ibid.*, p. 533.

[28] *Ibid.*, p. 533-539.

[29] Carroll Atkinson, *op. cit.*, p. 65

The data obtained by Howard[30] reported 180 boys with a median of 35.00 on the initial test where the girls' median was 31.84. On the improvement score basis the girls' median was 46.76 whereas the boys' median was 45.25. The first difference was significant at the t-ratio level of three, whereas the second or improvement score difference was not.

When Howard divided his students into three groups on the basis of their intelligence and expressed improvement as per cent of original score he obtained the data summarized in Table IV.

After examination of ten commonly adopted general science textbooks, Smith composed a completion type test covering the subject matter predominating in these textbooks. He used this test to compare the achievement in science of 300 boys and girls in six northern states. He concluded:

> Material generally covered in biology shows no sex differences in general, but the subdivisions show slight differences.
>
> Physiography material shows no sex difference.
>
> Chemistry material shows significant difference in favor of the boys.
>
> Physics material is much easier for boys than for girls, the median difference on subtopics ranging from 4 to 22 per cent.

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[30]Lester R. Howard, _op. cit._, p. 56.

TABLE IV

SUMMARY OF A PORTION OF HOWARD'S DATA REGARDING DIFFERENCES OF ACHIEVEMENT ASSOCIATED WITH SEX

	Initial score	Improvement score	Per cent of improvement	*Per cent of improvement possible
Girls				
High IQ	35.60	52.60	147.75	26.4
Middle IQ	31.90	46.83	147.12	21.9
Low IQ	26.45	30.00	113.40	4.8
Total	31.34	46.76	147.50	21.9
Boys				
High IQ	41.00	49.40	120.50	14.2
Middle IQ	34.66	44.54	123.50	15.2
Low IQ	28.25	37.20	131.65	12.5
Total	35.00	45.25	129.30	15.8

*This column was calculated by the author of this study in the hope of making Howard's data more readily compared with those from related studies.

(Adapted from Lester R. Howard, op. cit., p. 52.)

The subject as a whole is much easier for boys than for girls.[31]

Barish[32] found no significant differences between the scores of the boys and girls included in his study. He found, however, as did Atkinson[33], a difference in the standard deviations of the two groups. In Barish's study the girls showed the greater variability, 15.4 as compared with 13.4. By an analysis of Barish's data, however, it is possible to determine that this difference has a t-ratio of 1.2.

Working with 43 boys and 45 girls, Woods[34] compared the scores of the boys with those of the girls on seventeen unit tests designed to accompany Peiper and Beauchamp's Everyday Problems in Science. The mean score of the boys was found to be 1,136.55 and the girls 1,100.50. This gave a difference in favor of the boys of 36.05 with a t-ratio of 1.827. Miss Woods observed that:

> On only one of the tests, that relating to clothing, were the girls superior to the boys. On five of the tests, those relating to the study of heavenly bodies, water supply, complex machinery, communication, and transportation, the boys were superior to the girls.

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[31]Virton C. Smith, "Sex Differences in the Study of General Science," Science, 75:55-57, January 8, 1932.

[32]William Barish, op. cit., p. 63.

[33]Carroll Atkinson, op. cit., p. 65.

[34]Lela Glaphyra Woods, "Sex Differences in Achievement and Interests in General Science and Their Bearing on the Classification and Instruction of Pupils," (unpublished Master's thesis, University of Chicago, Chicago, Ill., 1937), 76pp.

On the other eleven tests the two groups were about equal in achievement.[35]

Related studies regarding differences in achievement associated with membership in 4-H clubs, and Scouts. Only a few investigations have been done in this area and they do not provide a consistent pattern of results. Farnum's[36] study provides data regarding the relationship between participation in Boy Scout activities and achievement in general science. His experimental groups consisted of 53 Boy Scouts and 53 non-Scouts. The groups were partially matched for intelligence as determined by the Otis Self-Administering Test, Form B. Farnum also used the marks assigned by teachers of English to these students as an additional check on his study. A portion of his data appears in Table V.[37]

Farnum observed that although the Scouts lost ground in their English course they gained in their natural science marks between the eighth and tenth grades. An interpretation of his data is made more difficult due to incomplete matching of the two groups for intelligence. The median intelligence

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35 Ibid., p. 32.

36 Don E. Farnum, "A Comparison of the Success in Tenth Grade Natural Science of 53 Boy Scouts and 53 Non-Scouts as Related to Their Success in Eighth Grade Natural Science," (unpublished Master's thesis, University of Michigan, Ann Arbor, Michigan, 1940), 47 pp.

37 Ibid., pp. 33-34.

TABLE V

A PORTION OF FARNUM'S DATA COMPARING SCOUTS AND NON-SCOUTS

Subject	Scouts' average	Non-Scouts' average
8th grade English	2.33	2.38
10th grade English	2.15	2.01
8th grade natural science	2.55	2.63
10th grade natural science	2.63	2.41

(Adapted from Don E. Farnum, Ibid. pp. 33-34.

quotient of the Scouts being 2.98 points higher than the non-Scouts may have been significantly related to the differences between the performance of the two groups.

Farnum cites the additional studies of Ridenour[38], Farnsworth[39], Monson[40], and Wyland[41]. The results of all of these studies form a rather consistent pattern. The Scouts excell in achievement but at the same time it is observed that they enjoy a degree of superiority in intelligence, a factor that has already been shown to bear a positive correlation with achievement in general science. In Monson's[42] study he used 161 pairs matched in age, mental test score, grade in school, and occupation of father. Under these conditions he found a difference in the favor

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[38] Gordon M. Ridenour, "Boy Scouts versus Non-Boy Scouts in School," (unpublished manuscript in the files of the Boy Scouts of America, 1925), cited by Farnum, op. cit., p. 10.

[39] Philo T. Farnsworth, "Unpublished Study by the Supervisor of Grammar Grades and Junior High Schools of Granite School District," Salt Lake City, 1932, cited by Farnum, op. cit., p. 13.

[40] Albert R. Monson, "The Effect of Participation in Boy Scout Work on School Records, Leadership, Participation in Student Activities, and Development in Character," (unpublished Master's thesis, University of Minnesota, Minneapolis, Minnesota, 1935), cited by Farnum, op. cit., p. 14.

[41] Ray O. Wyland, Scouting in the Schools, (New York: Columbia University Press, 1934), cited by Farnum, op. cit., p. 16.

[42] Monson, op. cit.

of the Scouts, a difference that 66 chances in 100 would be true difference greater than zero.

Prior studies concerned with differences in achievement in general science associated with the social-economic backgrounds of students. When Hack[43] used the Third Iowa Academic Every-Pupil Test in General Science for 1931 in his investigation he found no significant differences between the scores of rural and urban students. This was the case for both groups of students, those with general science through the ninth grade and those without.

In connection with Howard's[44] study involving seventh grade pupils he divided the pupils into two socio-economic groups. He identified the group of higher status as the subsistence group and the lower as the poverty group. Some of his data which are related to this area of the study are that the initial scores of the 149 students in the poverty group had a median score of 28.73 whereas the 269 students in the subsistence group established a median of 35.70. The t-ratio for this difference being 7.56. On an improvement basis, the gap narrowed with 43.38 and 47.04 representing the medians. The t-ratio for the difference being 2.84.

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[43] Walter Hack, op. cit., pp. 31 and 32.

[44] Howard, op. cit., p. 46.

When Howard compared the scores of the poverty and subsistence groups in the upper ability (IQ percentile ranks above 60) the difference in favor of the subsistence group was maintained. The differences in the middle IQ ability group and lower IQ ability group were still in favor of the subsistence group but reduced below the level of statistical significance, the t-ratios for these differences proving to be .177 and .745.

Howard also grouped his students according to the occupational level of the father by a method suggested by Taussig.[45] The groups represented five levels of occupational status. On the initial test with median scores ranging around 30 the differences between any successive levels of occupational status range between 1.5 and 5.6 with corresponding t-ratios between 1.2 and 3.1. The differences were all in favor of the higher status. When occupational levels one and five were compared a difference between medians of 9.36 was found with a t-ratio of 4.35. In general, the same degree of differences and reliability was maintained when the improvement scores were given the same analysis.

Using a test described in a previous section of this

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[45] Frank W. Taussig, Principles of Economics, Volume II, (New York: Macmillan Co., 1911), pp. 134-142, cited by Howard, ibid., p. 49.

report, Schauss[46] found country children made a mean score of 112.85 as compared with a mean score of 106.5 established by city children. This difference was found to show a t-ratio of 3.34. The magnitude of this difference was enhanced when it was observed that these city children enjoyed a 1.85 difference in mean IQ as determined by the Otis test. Miss Schauss reported that the country children were found to make consistently higher scores on the biology, physiology, and agricultural questions. No reliable differences were found for the physics and chemistry scores. Scores on the miscelleanous items tended to be consistently in favor of the country children.

Barish[47] in his study divided his students into five groups on the basis of the occupational level of the father. His data show a ranking in intelligence of his groups in this order: professional, business-clerical, skilled labor, and unskilled labor. When ranked in the order of mean science score a smiliar order appeared except skilled labor and semi-skilled labor were interchanged. His groups were small, between 10 and 54, and the differences in IQ points between the high and low groups was less than 12. The greatest difference between mean science scores was 15.50.

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[46] Schauss, op. cit., p. 27.

[47] Barish, op. cit., p. 74.

By the use of questionnaires, consultations, and interviews, Johnson[43] was able to gather extensive data regarding pupil social and economic experiences that would be suspected of having elements of significance to science. Although his study was limited to the students in grades seven, eight, and nine in one Washington, D. C. school, some 1,500 pupils became involved. Approximately one hundred separate first-order correlations were calculated regarding the relations of such variables as (1)intelligence quotients and the kind and number of contacts with industries and institutions of a scientific nature, (2)socio-economic status of the pupils and the kind and number of contacts with industries and institutions of a scientific nature, (3)science marks and contacts with institutions and industries as in 2 and 3, (4)intelligence quotients and kinds and number of contacts with movies and radio programs, (6)science marks and contacts with radio and movies as in 5 and 6, (7)intelligence quotients and kinds and number of contacts with encyclopedias, magazines, and books devoted to science, (8)socio-economic status and contacts with references as in 7, (9)science marks and references as in 7, (10)intelligence quotients, (11)socio-

[43]Keith C. Johnson, "Out-of-School Science Experiences of Pupils in the Three Grades of Junior High School," (unpublished Master's thesis, George Washington University, Washington, D. C., 1941), p. 76.

economic status, and (12) science marks and kinds and number of contacts with home experiences of a scientific nature.

Having been confronted with this wide array of correlation coefficients only a very few of which went above .20 and nearly three-fourths of which were less than ± .10, Johnson concluded that:

> The environment, rich or poor in opportunities, cannot be used to predict the richness or dirth of the experiential background as far as science is concerned. . . . The opportunities for science experiences seem to be independent of the socio-economic status of the home and seem to be participated in nearly equally by children of all levels of socio-economic status and intelligence. . . . Those pupils with low science marks are as likely to have experienced a large number of contacts with science outside of school as have those pupils with higher science marks.[49]

Borofsky[50] by using his "case study" approach concluded that:

> A greater percentage of the low achievers than of the high achievers were born in the town in which they now live. . . . A greater percentage of broken homes is found among the low achievers than among the high achievers. There are no significant differences in the education which the parents of the cases received, nor in the classes of occupations in which the fathers of the cases are engaged. . . . The low achievers as a group live in slightly better neighborhoods. A greater percentage of the parents of the high achievers than the parents of the low achievers own their own homes and speak a foreign language at home. The average number of books in the homes of the

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49 *Ibid.*, pp. 52-54.

50 Borofsky, *op. cit.*, pp. 207-208.

high achievers is approximately equal to the average number of books in the homes of the low achievers.[51]

In an investigation of the out-of-school activities of junior high school pupils, Cressman concluded that:

> 4. The general agreement of choices of activities made by pupils of different intelligence levels indicates that intelligence is not an important factor in determining the choice of an activity. . . . 5. The general agreement of choices of activities made by pupils of different socio-economic status indicates that socio-economic status is not an important factor in making a choice of activities.[52]

<u>Prior research exploring miscelleanous questions related to the content of this study</u>. Leker found that students who took general science will ". . . have already had 34.5% of the biology, 25% of the chemistry, and 41.4% of the physics that is being offered by the teacher."[53]

The following observation of Foster's is based on a research project completed in 1940.

> A study of the subject content of the material presented in series texts shows a possible effect on the senior high school program. When series texts are used in the junior high school level the basic science concepts are repeated to such an extent it would seem that the pupils should be given more advanced subject matter at the secondary level or an

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[51]*Ibid.*, pp. 207-208.

[52]Elmer W. Cressman, "The Out-of-School Activities of Junior High School Pupils in Relation to Intelligence and Socio-Economic Status," (unpublished Doctor's dissertation, Pennsylvania State College, State College, Penn., 1937), p. 223.

[53]W. R. Leker, "The Articulation of General Science with the Special Sciences," *General Science Quarterly*, 9:158-173, March, 1925, March, 1925, p. 170.

> expanded treatment of the concept if it is repeated. The series of texts analyzed in this study contain much of the material offered in the traditional high school science courses. If the concepts are repeated in class as often as they are used in the texts at the junior high school level the pupils should be well prepared to understand more advanced content in senior high school courses.[54]

In a study referred to previously in this report, Miss Woods found:

> The interests expressed by the pupils at the beginning of their study of the units in General Science correspond somewhat with their achievement in those units. Both negative and positive correspondence was found to occur. It is likely that the pupils' interests influenced to some extent their achievement in the units. . . . The interests expressed by the pupils at the end of their study of the units in General Science correspond both negatively and positively with achievement, but there is more positive than negative correspondence.[55]

Beauchamp conducted a study in which he attempted:

> . . . (1)to determine the extent and nature of the individual differences which arise in attaining specific learning products in elementary science; (2)to reveal the factors which influence the progress of pupils in the attainment of specific learning products; and (3)to make recommendations for the improvement of teaching technique on the basis of facts disclosed.[56]

He secured his data from Freshman and sub-Freshman science classes of the University of Chicago High School.

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[54]Richard James Foster, "Degree of Repetition or Expansion of Concepts in Series of General Science Texts for Grades Seven, Eight, and Nine," Part 1, (unpublished Master's thesis, University of Iowa, Iowa City, Iowa, 1940), pp. 167-168

[55]Woods, _op_. _cit_., pp. 47-50.

[56]Wilbur Lee Beauchamp, "An Analytical Study of Attainment of Specific Learning Products in Elementary Science," (unpublished Doctor's dissertation, University of Chicago, Chicago, Illinois, 1930), p. 51.

Teaching of science in those classes consisted of presentation of units by the Morrison procedure. Data were collected by tests, observations, and analysis of exercises prepared by the students. Those of his conclusions which are most pertinent to this study are:

> (1)The data reveal individual differences and variations in intelligence, rate of reading and ability to understand what is read, experiential background, percentage of application, span of application, attitude toward work, methods of study, the time required to solve the exercises presented for solution, the types of error made, and the ability to perform the different activities required in the study of science.
>
> (2)The study shows that while progress in the study of science is definitely related to such factors as intelligence, ability to read, experiential background, and sustained application, there are so many exceptions to this general relationship that the results are of little value in interpreting individual progress unless accompanied by observations and analysis of the individual's method of study. . . .
>
> . . . .
>
> (4)The investigation shows that individual variations in progress were, in general, caused by factors which were corrective in nature.
>
> . . . .
>
> (7)The comparison of the individual differences and variations in the progress of pupils when different methods of teaching are employed indicates that the individual differences and variations in the pupils are more closely related to progress than is the method of instruction employed.[57]

Hecht[58] focused a study primarily on the determination

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[57]*Ibid.*, pp. 52-53.

[58]Hecht, *op. cit.*, pp. 114-117.

of what aptitudes possessed by ninth grade students bear significant relationships to the achievement of these students through the course and, thus, could be used for prognosis purposes. After composing appropriate tests and giving them to 107 pupils in a New York high school he was able to identify the following correlations with overall achievement in science.

Test 1. Handkerchief Experiment (Scientific Method)	.46
Test 2-3. Visual Experience (Seeing, Comprehending, and Remembering).	.25
Test 4-5. Reading Comprehension and Memory	.50 to .58
Test 6. Comprehension and Memory (Class Activities).	.59
Test 8. Memory (Yesterday's Demonstration)	.59
Test 12. Visual Apprehension (Motion Picture Film)	.36
Test 13. Oral Comprehension (Verbal Statements)	.70
Criteria 18-19. Marks for Work (Elementary Grades)	.54

Summary and limitations of previous studies. Studies concerning the effect of prior instruction on the achievement of students in subsequent general science courses yield a rather clear-cut pattern of conclusions. The measuring instruments tend to record significant changes in the total scores of students concurrent with additional instruction. Quantitatively, however, these changes are small. Where tests have been used to measure gains concurrent with instruction, greater gains tend to be reported in those cases where the tests had been designed by the classroom teacher or with the close cooperation of the teachers of the students who were participating in the study. Students entering the ninth grade general science course tend to be familiar with a worthwhile portion of the information traditionally included in the course. They are more familiar with some blocks of the subject matter than with others. Many of the prior studies have reported significant relationships between various factors and the science information acquired by ninth grade students without parcelling out the contributing factors that may have been acting simultaneously. Most of the studies dealing with this problem have been done ten or more years ago. This raises the question of whether the increased emphasis on the teaching of science in the elementary school and the increased science training of the elementary school teachers has been accompanied by effects that will cause this study to reveal conflicting data.

Previous studies using a variety of achievement tests and a variety of intelligence tests reveal degrees of correlation ranging between .35 and .65. Most results tend to fall between .50 and .60. Although some studies report the correlation between intelligence and initial and final test scores there is inadequate evidence concerning the correlation between intelligence and individual gains in science achievement. Again, there is need for additional data regarding the intercorrelations of intelligence with other factors suspected of affecting the acquisition of science information.

The differences associated with sex differences are the most consistent data reported by related studies. Boys invariably do better on science achievement examinations. They tend to maintain but not increase the degree of this advantage during additional instruction. This study tends to accept these data and considers the sex factor only as a check on the over-all consistency of the study.

Previous studies tend to report favorable differences accompanying Scout experiences. These differences are, however, small and can well be inspected to determine whether or not it is the Scout experience that is peculiarly associated with the differences. Such factors as Scout work and 4-H Club experience tend to blend with the whole social-economic background factor. In this respect the pattern revealed by previous research tends to give the student from a "good" home a statistically significant advantage. Quantitatively measured, the advantage is small. Instruction tends to diminish the spread between the scores of students from good and poor homes.

Several extensive and scholarly investigations have been focused on the whole problem of the relationship between home and community activities and achievement in science. The findings consistently point to low correlation in regard to a great number of home and social factors which might have been suspected of exerting a much more pronounced effect. It is the intent in this study to accept, in general, the results of previous investigations regarding the relationship between social-economic home conditions and achievement in science. The factor will be explored in this study sufficiently only to insure that the student population of the study does not represent a marked discrepant.

Overall, this study is expected to make its own peculiar contributions to the science of education by (1)its recency and (2)by attempting to parcel out the independent effect of various factors that have been previously reported as affecting the achievement of science information but in conjunction with other factors acting simultaneously.

CHAPTER III

COLLECTION OF DATA

I. MATERIALS USED

<u>The Read General Science Test</u>. This test plays the major role in the collection of data for this study. All interpretations of the results from the study and the conclusions to be drawn by the consideration of these results will have to be made in light of the achievement in learning science that is represented by successful responses to the items on the Read Test. Copies of both Form A and Form B appear in the Appendix.

Basically the Read Test is one of a student's knowledge of science. The correct response to many of the items hinges on the ability to recall information customarily developed in general science textbooks and discussed in school science classes. Many of the items require the student to apply information to the solution of thought problems wherein the explanation of an observation involving some naturally occurring phenomenon requires the application of facts or principles.

One possible interpretation of the Read Test is that it measures a representative sample of the total activities included in the general science course. Another interpretation might be that this test extracts from the total course only a sample of a segment of the experiences of the course.

and then measures this sample. As suggested by Goodenough[1], it must be kept in mind that any test measures but a sample of some total experience. To say that the ninth grade students included in this study gained only eight or nine new ideas during a year's instruction would be very misleading. Estimates of the total gain from the year's instruction can be made only if one knows what per cent of the total year's experience the seventy-five items on the Read Test represent.

Inasmuch as the Read Test was not ready for general distribution by the publishers at the time this study was being organized, the standardization editions were used. The author was notified, however, that "The final form of the test booklet will be identical with the standardization editions except for the kind of paper on which they are printed."[2]

According to the publisher, the test ". . . can be given by the regular classroom teachers, without any extensive previous training."[3]

Seventy-five items comprise both Forms A and B of this

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[1]Goodenough, *op. cit.*, pp. 92-93.

[2]Personal Correspondence of the Author, letter from Roger T. Lennon, Director, Division of Test Research and Service, (New York: World Book Co., July 25, 1950.)

[3]John G. Read, *Directions for Forms A and B of the General Science Test*, (New York: World Book Company, 1950), p. 1.

test. All of the items are of the multiple-choice type with five alternate responses provided for each item. The test is scored as the number of correct responses. The test is designed to use machine-scored answer sheets. In this study, however, to avoid having to provide special pencils and the precise conditions of marking required by the machine scoring process, a mimeographed answer sheet was designed. This permitted the use of a hand scoring stencil. All answer sheets were scored by the author both for the total and subject matter area part scores.

In order to aid in the interpretation of the data gained through this study, the publishers of the Read Test provided certain information obtained from the standardization procedures, The average item difficulty for Form A was 52.61 and for Form B, 52.55. The average validity for the items in Form A was 42.13. The end-of-year mean score of 3,592 students in 56 communities in twenty-one states was 40.79. The semi-interquartile range equalled 7.5. The average item difficulty for the eighteen life science items was 53.4 per cent, for the nineteen earth science items, 54.4 per cent, and for the thirty-eight physical science items the average difficulty equalled 51.2 per cent. Difficulty in this case equals the per cent of the students in the standardizing group who answered the item correctly.

As previously inferred, in the opinion of the author of this study the items on the Read Test can be classified as originating from three areas of the natural sciences. Twenty-four per cent of the items stem from the life sciences, twenty-five per cent from the earth sciences, and the remaining fifty-one per cent from the physical sciences. The degree to which conclusions drawn from scores on the whole test may apply to these separate natural science areas can be estimated from the part with whole correlations. A sample of papers drawn as approximately every tenth paper from a final score rank sequence arrangement of the total 1,973 papers from the students who were able to provide initial and final scores yielded the following Pearson Product-Moment coefficients of correlation:

Total Score with Physical Science Items. . .91 SE = .03

Total Score with Earth Science Items . . . .82 SE = .03

Total Score with Life Science Items. . . . .87 SE = .03

The total score in this case refers to the initial score, that is, the beginning-of-the-year score.

Approximately equal numbers of Forms A and B were used in this study both as initial and final evaluation instruments. The testing was arranged so that if students in a school took Form A as the initial test they were given Form B as the final.

The actual administration of the test was left up to the individual classroom teachers. Each teacher was given directions for administering the test and provided with the necessary answer sheets. It is assumed that these teachers employed uniform practices in the administration of the test.

The completed answer sheets were returned to the author for scoring. This was done by means of a hand stencil with the total number of right answers indicated as total score. These answer sheets were further scored with separate stencils to determine the part scores for the life, earth, and physical science items.

Immediately upon obtaining the scores for the students in each school the teachers were given a report of the score made by each student enrolled in that school. Interest on the part of the teachers cooperating in this project prompted a preliminary report of the over-all results. This report was prepared and distributed. A copy appears in the Appendix, page 189.

Each of the cooperating schools was again visited early in the spring of the 1950-51 school year. During this visit plans were made and materials distributed to enable the teachers to give the second form of the Read Test. Again the answer sheets were returned to the author and scored in the same way as were those for the first form. Before the final statistical analysis of these scores was made the answer sheets for all students for whom either a first or second form answer sheet had not been obtained were eliminated.

With the completion of the major phases of the statistical analysis of the test scores during the summer of 1951, another report to the cooperating teachers was distributed. A copy of this report follows page 190 of the Appendix.

Personal information form. The design of the form used to collect and resord information concerning the students from whom the test data were collected was dictated by the nature of the investigation. A tentative form based on the preliminary plans for the investigation was reviewed by the advisor for this thesis. A copy of the final form appears in the Appendix. (See page 191.) The students completed this personal information form under the supervision of the classroom teachers. In those schools in which the length of the class period permitted, the form was completed during the period of the day the Read Test was given. The form was completed the preceding or following day in the remaining cases.

The initial and final total and part scores were recorded on these personal information forms thus enabling the preparation of frequency and correlation distribution tables. The statistical manipulation of the data from these tables was facilitated by means of mechanical calculators.

The group of ninth grade students who were taught general science through the year. The Read Test was given to 2,318 students entering the ninth grade general science course in the fall of 1950. This group is the source of the major portion of the data in this study. These students were enrolled in 27 high schools located in large and small cities and villages ranging in total population from that of the small cities to nothing more than a slight concentration of farm dwellings around a shopping center. With agriculture so definitely the predominant productive enterprise in Central Illinois, it would be difficult to prove that any student in the area would have been totally free from rural experiences through his home and family background.

The total ninth grade enrollment in some of the cooperating high schools was as low as 20 students. In other cases the total ninth grade enrollment was over 200. In all, 41 teachers devoted either full or part time to the general science instruction within these schools.

Table VI summarizes the characteristics of the group composed of those students who were able to furnish initial and final Read Test scores. Three hundred forty-five students were either absent the day the final form of the test was given or were enrolled in the one school which was unable to give the final form of the test at the prescribed time. Thirteen per cent of the students did not answer the question on the personal information form which dealt with reading

TABLE VI

CHARACTERISTICS OF THE GROUP OF 1,973 STUDENTS FROM WHOM THE MAJOR PORTION OF THE DATA FOR THIS STUDY WAS COLLECTED

Characteristic	Per cent possessing the characteristic
Rural home background	18
Village home background	12
City home background	55
Mixed home background	15
With Scout experiences	37
With 4-H Club experiences	21
With little interest in reading science books	25
With average interest in reading science books	49
With much interest in reading science books	13
From the "best" home background	16
From the "poor" home background	9
The total number of science classes per week through the sixth, seventh, and eighth grades was:	
Less than 2	14
2 - 3	7
4 - 5	9
6 - 7	9
8 - 9	8
10 - 11	13
12 - 13	9
14 - 15	22

interests. Twenty-five per cent of the students were enrolled in schools which could not furnish an estimate of the social-economic conditions of their students' homes. Nine per cent of the students did not provide usuable answers to the question concerning the number of science classes they had during the sixth, seventh, and eighth grades.

The data in Table VI show that within the total group it was possible to identify subgroups differing in respect to the variables included in the design of this study. The size of the total group was large enough so that the size of the subgroups would insure, in those cases where the basic standard error formula was applied, that a reasonable difference in the raw scores of subgroups should permit a reliable estimate of the probability that such a difference could be consistently identified in the total population of ninth grade students.

It was assumed in the design of this study that there would be a fairly normal distribution of intelligence within the group of cooperating students. In terms of the chi square test of goodness of fit, this assumption was found to be unjustified. Table VII shows the data pertaining to this test. According to the chi square test, there would be less that fifteen chances in one hundred that the discrepancies between the distribution of intelligence in the sample of students included in this study can be explained

TABLE VII

COMPARISON OF THE DISTRIBUTION OF THE INTELLIGENCE QUOTIENTS OF 1,520 STUDENTS WITH THAT EXPECTED IN A NORMAL DISTRIBUTION

Midpoint of C. I.	Intelligence quotients	
	Observed f	Expected f
138	8	7
133	12	17
128	42	37
123	67	63
118	122	109
113	150	159
108	207	200
103	212	221
98	206	212
93	194	179
88	117	135
83	74	88
78	50	52
73	35	26
68	16	10
63	8	5
Totals	1,520	1,520

as chance fluctuation. This abnormality of distribution of intelligence in the group may be related to several factors. Any ninth grade group of students represents at least a degree of selection from the total population. This particular group was selected not on a random basis but in a manner that permitted the comparison of certain variables. Some of these variables may well be closely related to intelligence. This abnormality of distribution of intelligence may also be related to the method whereby the intelligence quotients of the students were obtained. This factor will be given additional consideration later in this study.

The distribution of scores, both initial and final, on the Read Test can scarcely be considered a normal distribution according to the chi square test. (See Table VIII.) There are less than ten to fifteen chances in one hundred that the fluctuation in the distribution can be attributed to chance sampling errors. This abnormality of distribution reflects either the selection processes involved in setting up the experimental group or the inference that the distribution of ability to respond successfully to the items on the Read Test is not normally distributed throughout the total population of ninth grade students. The 1,973 students of this study produce a distribution of scores that meets the chi square test as satisfactorily as the group of 3,592 students who were used by the publishers of the Read Test

TABLE VIII

COMPARISON OF THE OBSERVED DISTRIBUTION OF THE SCORES OF 1,973 STUDENTS WITH THE FREQUENCIES EXPECTED IN A NORMAL DISTRIBUTION

Midpoint of C. I.	Initial Observed f	Initial Expected f	Final Observed f	Final Expected f
73	1		5	6
68	2	1	13	19
63	4	4	47	52
58	23	16	136	116
53	57	51	231	210
48	113	126	302	303
43	231	244	331	363
38	342	358	319	345
33	385	403	284	264
28	374	355	163	166
23	266	227	94	84
18	131	122	34	34
13	36	48	14	11
8	5	15		
3	3	3		
Totals	1,973	1,973	1,973	1,973

during the standardization procedures. (See Table IX.) A graphic portrayal of the distribution of these scores appears in Figure 1.

The mean initial scores established by the separate schools included in this study ranged between 26.45 and 37.15. This indicates a rather widespread variation in the e xpression of factors related to successful responses to the Read Test. There is no way to determine how much of the difference in the mean scores established by the separate schools is due to differences in the effectiveness of science instruction prior to the ninth grade. It is assumed in this study that differences due to effectiveness of instruction will be averaged out among the separate groups identified for comparison.

Inasmuch as the range of initial mean scores established by the separate schools was between 35 and 50 per cent of the total possible score, this shows that the difficulty of the test was such as to permit the more adequately trained students to register some gain through the year without totally frustrating the inadequately trained students.

<u>The group of ninth grade students who were taught no general science through the year</u>. This group was composed of 225 students, 193 of whom were able to provide both initial and final test scores. The four schools in which these students were enrolled through 1950-51 did not offer

TABLE IX

COMPARISON OF THE OBSERVED DISTRIBUTION OF THE SCORES OF 3,592 STUDENTS WITH THE FREQUENCIES EXPECTED IN A NORMAL DISTRIBUTION

Midpoint of C. I.	Final scores	
	Observed f	Expected f
72	4	18
67	39	30
62	123	37
57	212	210
52	396	339
47	532	548
42	619	677
37	626	636
32	500	515
27	349	286
22	138	138
17	39	53
12	14	4
7	0	0
2	1	0
Totals	3,592	3,592

general science as a required ninth grade course. The author knew of no reason why these students should differ in any significant respect from those in the major group with the exception of having had a little more science instruction prior to the ninth grade.

The tenth grade biology group who had been taught no general science through the ninth grade. This group was originally composed of 338 students. Through the elimination of those who, upon further investigation, were found to not share the criteria of the group and absentees on the day the final form of the test was given, initial and final test scores were obtained for 226 students. These students were taught by five teachers in four schools. The author knew of no reason why these students should differ markedly from those in the other two groups in respect to factors not considered in this study.

CHAPTER IV

THE DATA AND THEIR INTERPRETATIONS

I. COMPARISON OF THE INITIAL, FINAL, AND GAIN SCORES OF THE THREE GROUPS

According to the design of this investigation, the major portion of the data was to be drawn from a group of ninth grade students as they entered and completed the general science course. Two additional groups were included to provide information which would aid in the interpreting of these data. How much gain or loss in science information may occur through the ninth year of school independent of enrollment in a general science class was one question of concern. A second question involved the degree to which the tenth grade biology course could be expected to provide the general science experiences that had been omitted from the program of students who had not been given the ninth grade general science course.

The data describing the results of administering the Read General Science Test to these three groups are summarized in Tables X and XI. Some of the more pertinent facts from these data are:

1. The differences between the means of the initial scores of the three groups cannot be explained as due to chance sampling factors.

TABLE X

COMPARISON OF THE INITIAL AND FINAL SCORES OF THREE GROUPS OF STUDENTS WHO TOOK THE READ TEST

Group	Raw Score M	Raw Score SD	z Score	Group	Raw Score M	Raw Score SD	z Sc.
			Initial Scores				
Group II.*	35.12	9.10	.14	Group III.**	38.25	9.44	.46
Group I.***	33.12	9.75	-.06	Group I.	33.12	9.75	-.06
Diff.	2.00	-.65	.20		5.13	-.31	.52
SE_{diff}	.69	.49	.07		.67	.47	.07
t-ratio	2.39	1.34	2.86		7.65	.66	7.43
			Final Scores				
Group II.	37.50	9.60	-.36	Group III.	42.91	9.90	.10
Group I.	41.60	10.86	.02	Group I.	41.60	10.86	.02
Diff.	-4.10	-1.26	-.38		1.31	-.96	.08
SE_{diff}	.71	.46	.07		.71	.50	.07
t-ratio	7.65	.66	7.43		1.34	1.92	1.14

*198 ninth grade students who were taught no general science.

**226 tenth grade biology students who had been taught no ninth grade general science.

***1,973 ninth grade students who were taught general science.

TABLE XI

COMPARISON OF THE GAIN SCORES OF THREE GROUPS* OF STUDENTS WHO TOOK THE REAL TEST

Differences between Final and Initial Mean z Scores

Group I.	.08	Group I.	.08	Group II.	-.50
Group II.	-.50	Group III.	-.36	Group III.	-.36
Diff.	.58	Diff.	.44	Diff.	-.14
SE_{diff}	.07	SE_{diff}	.07	SE_{diff}	.10
t-ratio	8.28	t-ratio	6.28	t-ratio	1.40

Pearson Product-Moment Coefficients of Correlation Between Initial and Final Scores

	r	SE**
Group I.	.72	.01
Group II.	.76	.03
Group III.	.77	.03

*See Table X, page 69, for identification of the groups referred to in this table.

**The standard errors of correlation coefficients which are reported in this study were calculated by the simple equation; $SE = \frac{1 - r^2}{\sqrt{N}}$. The author is aware of the more recent discussion based on the abnormality of distribution of the sampling errors of r. The numbers of scores used in calculating the r's reported in this study, however, render the "three times the standard error" a test of reliability that is comparable to the z or t tests described by Goodenough.[1]

[1]Goodenough, op. cit., pp. 267-269.

2. The differences between the standard deviations of the distributions of initial scores may be ascribed to chance sampling errors.

3. There were significant differences between the final and initial mean scores of each of the three groups.

4. In terms of raw score points, the greatest gain was made by those students who were enrolled in general science classes.

5. Differences between the final and initial standard deviations of the three groups were small but sufficiently large to affect the calculation of gains as the differences between final and initial test scores. This infers that gains may be more reliably estimated as deviations from a common mean.

6. Entering ninth grade students are, as a whole, familiar with a worthwhile portion of the science information ordinarily presented in the ninth grade general science course. This portion may be much greater than the additional amount they acquire while enrolled in the course. This tends to justify an attempt to explore the origin of the possession of this information.

7. If gross gain accompanying ninth grade instruction is defined as final raw mean score minus initial raw mean score for the main group of 1,973 students this quantity becomes 8.48 score points. If gain due to maturity is

defined as the final raw mean score of the 198 students who were not taught general science through the ninth grade minus their initial raw mean score, this quantity becomes 2.38 score points. If net gain accompanying ninth grade instruction is defined as gross gain minus gain due to maturity, this quantity becomes 6.10 score points. The validity of these quantities is increased by identifying that the mean intelligence quotients of these groups did not differ by more than 0.5 of an IQ point. Additional evidence is established by comparing the end-of-year mean score of the ninth grade group which received no instruction with the beginning-of-the year mean score of the biology group. These quantities differ by 0.75 of a point. The mean intelligence quotient of the biology group was found to be 1.41 points higher. Applying the regression equation technique for matching groups[2] this would mean that their mean score on the Read Test would have been predicted to be 0.67 of a point higher.

8. To the degree that the Read Test is a measure of the attainment of science information, the interpretation is in order that the students in this study who had not had ninth grade general science instruction removed this deficienc

[2]Charles C. Peters and Walter R. Van Voorhis, Statistical Procedures and their Mathematical Bases, (New York: McGraw-Hill Book Company, 1940), p. 463.

while enrolled in the tenth grade biology course. This follows from the observation that their end-of-year mean score is 1.31 points higher than the end-of-year mean score of the students completing the ninth grade general science course. When this difference is adjusted for the advantage in intelligence enjoyed by the biology group, the reliability of the above interpretation becomes about 75 chances in 100 of being applicable to all samples of similar populations. Whether or not this interpretation may be applied equally to the life, physical, and earth science phases of the total general science course is a question that requires further investigation.

9. Investigations involving the administration of tests to school youngsters under conditions other than the usual school routine often bring up the question of the attitude of the students toward the test exercise. In general, it is necessary to rely on the subjective reports of the teachers regarding this factor. The correlation coefficients between the initial and final test scores of the three groups may be used to estimate the seriousness with which the students approached the test. It would appear that the students did not approach the test in a haphazard manner.

The degree to which total test scores may be interpreted as representing each of the areas of natural science may be estimated from the data in Table XII. The part-with-total score correlations imply a substantial degree of internal consistency within the total test. With the size of groups involved, the standard errors for the correlations shown in Table XII approximate .03 for the uncorrelated groups. If comparisons are to be made between the initial and final correlations of the same group, the standard error would be conservatively estimated at .03. The only consistent pattern in these correlation data appears to be the general tendency for the scores of the physical science items to show increased correlation on the final administration of the test.

Additional data regarding the separate phases of natural science are reported in Table XIII. Group I in this table is composed of a random sample of 200 scores drawn from the total 1,973 ninth grade students who took the initial and final forms of the Read Test and who were taught general science through the ninth grade. Group II is 198 ninth grade students who were taught no general science through the year. Group III is composed of 226 tenth grade biology students who had been taught no general science through the ninth grade.

An inspection of the data in Table XIII shows that the physical science items invariably ran more difficult. Inasmuch as a raw score difference greater than approximately

TABLE XII

CORRELATIONS BETWEEN PART SCORES AND TOTAL SCORES OF THE THREE GROUPS OF STUDENTS WHO TOOK THE READ TEST

Pearson Product-Moment Coefficient of Correlation	Group I.		Group II.		Group III.	
	Init.	Final	Init.	Final	Init.	Final
r between 19 earth science items and total score	.82	.86	.81	.79	.79	.71
r between 18 life science items and total score	.87	.80	.77	.78	.7[illegible]	.80
r between 38 physical science items and total score	.91	.94	.83	.86	.85	.88

NOTE: <u>Group I.</u> in this table refers to a sample of 200 ninth grade students drawn from a group of 1,973 who were taught general science. <u>Group II.</u> refers to 198 ninth grade students who were taught no general science. <u>Group III.</u> refers to 226 tenth grade biology students who were taught no general science through the ninth grade.

TABLE XIII

COMPARISONS BETWEEN THE INITIAL AND FINAL PART SCORES OF THREE GROUPS OF STUDENTS WHO TOOK THE READ TEST

Group	Earth Science Items			Life Science Items			Physical Science Items		
	M	SD	% of Total	M	SD	% of Total	M	SD	% of Total
				Initial Raw Scores					
Group I	9.10	3.31	48	8.75	2.96	49	14.32	4.86	38
Group II	9.33	3.38	49	10.20	2.92	57	15.97	4.70	42
Diff.	-.23	-.07	-1	-1.45	.04	-8	-1.65	.16	-4
Group I	9.10	3.31	48	8.75	2.96	49	14.32	4.86	38
Group III	10.54	3.18	55	10.62	2.92	59	16.87	5.02	44
Diff.	-1.44	.13	-7	-1.87	.04	-10	-2.55	-.16	-6
				Final Raw Scores					
Group I	11.01	3.50	58	11.06	3.04	61	19.48	5.79	51
Group II	10.34	3.06	54	10.40	3.20	58	16.88	5.31	44
Diff.	.67	.44	4	.66	-.16	3	2.60	.48	7
Group I	11.01	3.50	58	11.06	3.04	61	19.48	5.79	51
Group III	10.62	3.58	56	13.26	2.80	54	19.27	5.16	51
Diff.	.39	-.08	2	-2.20	.24	7	.21	.63	0

1.3 points or a percentage difference of approximately 7 per cent is required to reach a t-ratio of three, many of the observations drawn from these groups can be expected to apply to many similar samples drawn from the total population.

A typical observation that may be extracted from Table XIII would read as follows: between the times of the initial and final administrations of the Read General Science Test, the 226 biology students retained the same amount of their science information in the area of earth science whereas these students gained about twice as much in the area of life science as they did in the group of items dealing with the physical sciences.

In connection with the group of 1,973 ninth grade general science students from which the major portion of the data for this study has been drawn, the question may arise regarding the effect of absences at the time of the second administration of the Read Test. In this regard it may be noted that the initial mean score of the total group of 2,318 students was 32.98 with a standard deviation of 9.85. By eliminating the initial scores of the 345 students who were unable to provide end-of-year scores this raised the mean for the remaining 1,937 to 33.12 and changed the standard deviation to 9.75. Neither of these changes is a significant difference.

It may also be of interest to note that the end-of-year scores of 3,592 students, over three thousand of whom were ninth graders, and from whom data were gathered in connection with the standardization of the Read Test, produced a mean score of 40.83 with a standard deviation of 10.69. This is lower but not quite statistically significantly lower than the end-of-year mean score for the 1,973 students included in this study.

II. RELATIONSHIP BETWEEN INTELLIGENCE AND SCORES ON THE READ GENERAL SCIENCE TEST

Although intelligence in itself cannot very well be considered an experience of students prior to instruction it could be inferred that intelligence bears an important relationship to the acquisition of science information and would thus affect a student's performance on the Read Test. Knowledge of this relationship should aid in the interpretation of the effect of other factors which may act simultaneously with intelligence.

The intelligence quotients for 1,520 of the students in the group of 1,973 which supplied the major portion of the data for this study were obtained from the office files of the cooperating schools. These intelligence quotients had been derived in connection with the usual school guidance programs, hence the schools did not all use the same intelligence test. The tests used were the California Test of Mental Maturity,[3] the Otis Self-Administering Tests of Mental Ability,[4] Pintner General Ability Tests,[5] and the Terman-McNemar Test of Mental Ability.[6] The author was advised through correspondence with the publishers of these tests that each of the tests produced distributions of intelligence quotients with means of 100. The Otis test produced a distribution of intelligence quotients with a standard deviation of 12 whereas the other tests yielded standard deviations of 16. With this information, the intelligence quotients derived by means of the Otis test were converted to a common equivalence with those derived by the other tests according to the formula suggested by Guilford.[7]

The Pearson Product-Moment correlation coefficients

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[3]Elizabeth T. Sullivan, Willis W. Clark, and Ernest W. Tiegs, California Short-Form Tests of Mental Maturity, (Los Angeles 28: California Test Bureau, 1939).

[4]Arthur S. Otis, The Otis Self-Administering Tests of Mental Ability, (New York: World Book Co., 1922).

[5]Rudolph Pintner, Pintner General Ability Tests, (New York: World Book Co., 1939).

[6]L. M. Terman and Quinn McNemar, The Terman-McNemar Test of Mental Ability, (New York: World Book Co., 1941).

[7]J. P. Guilford, Fundamental Statistics in Psychology and Education, (New York: McGraw-Hill Co., 1942), p. 121.

between intelligence quotients and Read Test scores were calculated for each of the three groups of students in this study. These values are reported in Table XIV. The coefficients in this table are not corrected for attenuation. Since the intelligence quotients used in these correlations were derived by means of a variety of intelligence tests, the attenuation factor is difficult to estimate. The alternate form reliability of the Read Test was reported tentatively as .85.[8] Using this figure and estimating the reliability of the intelligence tests as .90, the author would estimate the correction for attenuation to be about 15 per cent. The standard errors indicated for these coefficients were calculated by the simple equation: $SE_r = \frac{1 - r^2}{\sqrt{N}}$. The relatively high correlation between intelligence and achievement on the Read Test means that all comparisons between group performances will have to take the intelligence of the groups into consideration. Intelligence is second only to initial test scores as a predictive factor for end-of-year scores. In so far as this study has been able to reveal, it is the most reliable single predictive factor in respect to initial or pre-instruction student performance on the Read Test.

This relationship of intelligence may be more meaningful

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[8] Lennon, loc. cit.

TABLE XIV

CORRELATIONS BETWEEN THE SCORES OF THE THREE GROUPS OF STUDENTS ON THE REAL GENERAL SCIENCE TEST WITH INTELLIGENCE

Group	Init. r	SE	Final r	SE
Group I, 1,520 ninth grade students who were taught general science through the ninth grade. . . .	.56	.02	.58	.02
Group II, 173 ninth grade students who were taught no general science	.68	.04	.62	.05
Group III, 208 students in tenth grade biology classes but who had been taught no general science through the ninth grade	.76	.03	.61	.04

Group	Differences between individual T-Scores with intelligence r	SE
Group I	-.01	.02
Group II	-.17	.07
Group III.	-.02	.07

if expressed in terms of the coefficient of determination.[9] Thirty-one per cent of the variance in the scores of entering ninth grade students may be attributed to the variations in the intelligence of the students. This quantity becomes thirty-four per cent for students who are completing a ninth grade general science course. However, if gains are expressed as differences between individual T-scores, intelligence is of very little value in predicting gains. Although there was a slight degree of negative correlation found in the cases of the samples of students in this study, quantitatively it is so low as to permit explanation as mere chance sampling errors.

III. DIFFERENCES IN ACHIEVEMENT ASSOCIATED WITH DIFFERENCES IN SEX

Data regarding this factor are reported in Table XV. These data show that there is a difference in the scores in favor of the boys both prior to and after the ninth grade general science experience. There is practically no chance that this difference may be attributable to chance sampling errors.

When the performance of boys and girls on the Read Test is expressed in any of several gain measures, no differences may be found which are great enough to permit any generalizati

[9] Guilford, *op. cit.*, p. 411.

TABLE XV

COMPARISONS OF THE SCORES OF 1,004 GIRLS AND 969 BOYS

	Initial			Final		
	Raw Score		z Score	Raw Score		z Score
	M	SD	M	M	SD	M
Boys	34.73	10.05	.165	43.28	11.32	.154
Girls	31.56	9.20	-.160	40.00	10.36	-.147
Diff	3.17	.85	.325	3.28	.96	.301
SE_{diff}	.29	.27	.04	.49	.34	.04
t-ratio	11.03	3.15	8.12	6.73	2.89	7.52

	Raw Score Gain	Gain as % of Possible Gain	z Score Gain	Gain as Mean Differences between T-scores
Boys	8.55	21	-.011	-.03
Girls	8.44	19	.013	.03
Diff	.11	2	-.024	-.06
SE_{diff}	.34	1.2	.03	.05
t-ratio	.32	1.4	.08	1.20

Point Biserial Coefficients of Correlation

	r	SE
Boys and Girls against Initial Test Scores. .	.16	.03
Boys and Girls against Final Test Scores. . .	.15	.03

about the total ninth grade population. In connection with the sample of the population which is involved in this study there was a tendency for the boys to gain more raw score points but the decrease in variability was in favor of the girls.

In the analysis of these data it was found that the girls in the main group of 1,973 ninth grade students enjoyed a difference advantage in mean intelligence quotient points over the boys of 1.65 IQ points. By using the regression equation technique for matching groups, this would give the girls a predicted advantage on the Read Test of .82. This does not change the direction of the interpretation of differences associated with sex but it does increase the quantitative relationship somewhat.

In order to gain an estimate of the functional value of the differences associated with sex differentiation, the point biserial coefficient of correlation[10] was calculated. With this value found to be less than .20 it follows that about three per cent of the total variance in the amount of science information possessed by students may be attributable to sex differences. Expressed in the terms of coefficient of alienation,[11] to know the sex of a student

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[10] Ibid., pp. 403-409.

[11] Ibid., p. 328.

would increase the chances of successfully predicting his or her score on the Read Test, and hence his or her store of science information, less than three or four per cent.

There can be little doubt that boys possess a significantly greater amount of science information both prior to and after ninth grade general science instruction. There is no consistent evidence, however, that the instructional experiences of the course favor either the boys or the girls.

Both qualitatively and quantitatively these findings are generally consistent with those from other studies.

An interpretation of these data regarding differences associated with differences in sex may follow one of several trends. A possible interpretation might hinge on the hypothesis of the existence of a mental trait more predominant in boys than in girls, a mental trait giving the boys an advantage on the marking of a general science test. The evidence provided by intelligence tests showing no similar advantage associated with the performance of boys would require that this hypothesized mental trait would have to be separate from those involved in a student's performance on intelligence tests.

A more consistent interpretation might be that the exercises on the Read Test involve experiences with which the boys have had more prior contacts. The validity of this interpretation, in turn, hinges on whether or not there is a significant relationship between successful response on the items on the Read Test and the experiences of boys and girls. If there is such a relationship then it would follow that a difference in the experiences of boys and girls would be reflected in their mean scores on the test.

Classroom experiences in connection with the ninth grade general science course tend to be shared equally by boys and girls. Evidence indicating that both sexes achieve equally during these experiences tends to add validity to this second interpretation.

IV. DIFFERENCES IN ACHIEVEMENT ASSOCIATED WITH MEMBERSHIP IN 4-H CLUBS AND SCOUTS

Differences associated with Scout experiences. The differences between the scores of Boy and Girl Scouts and students without Scout experiences were found to be greater than that which could be explained as within the limits of chance sampling errors. These differences were, however, reduced during the course of the year's instruction in general science. On the basis of final scores, the assurance that there was a real difference between the mean scores of such groups dropped to about 85 chances in 100. It follows from this that any expression comparing the gains of the two groups would show the gain to be greater for the non-Scout groups. This was convincingly so in the case of boys and showed a probability of about 75 to 100 of being generally true for girls. Data for this factor appear in Table XVI.

It may be noted that gains measured as differences between raw mean scores expressed directly as such or in deviation units may be interpreted as representing the mass effect or total variations of the individuals within the groups. The differences between the groups when expressed as the mean difference between individual T-scores gives a clearer estimate of the relative movement, that is gains or losses in relative rank position, within the groups.

The differences between the Scout groups and non-Scout groups on the final scores and on the gain estimates are less than those found in connection with initial scores.

The existence of real differences between Scouts, both boy and girl, and non-Scouts prior to instruction in the ninth grade is clearly established. Attention is next directed toward the question of whether this difference may be attributable to the peculiar effect of the Scout experience or may be better explained as associated with the unequal distribution of some other variable between the groups.

Preparatory to approaching an answer to this question, Boy and Girl Scouts were combined to form the more general

TABLE XVI

COMPARISONS OF THE SCORES OF 366 BOY SCOUTS WITH THE SCORES OF 603 BOY NON-SCOUTS AND OF 399 GIRL SCOUTS WITH THE SCORES OF 605 GIRL NON-SCOUTS

	Initial			Final		
	Raw Score		z Score	Raw Score		z Score
	M	SD	M	M	SD	M
Boy Scouts	36.49	10.48	.17	44.04	11.45	.07
Boy non-Scouts	33.66	10.12	-.10	42.82	11.25	-.04
Difference	2.83	.36	.27	1.22	.20	.11
SE_{diff}	.68	.49	.06	.75	.28	.06
t-ratio	4.16	.73	4.50	1.63	.71	1.83

	Raw Score Gain	Gain as % of Possible Gain	z Score Gain	Gain as Mean Difference between T-Scores
Boy Scouts	7.55	20	-.10	-1.04
Boy non-Scouts	9.16	22	.06	.63
Difference	-1.61	-2	-.16	-1.67
SE_{diff}	.52	2	.04	.16
t-ratio	3.10	1.0	4.00	10.43

	Initial			Final		
	Raw Score		z Score	Raw Score		z Score
	M	SD	M	M	SD	M
Girl Scouts	32.97	10.57	.16	40.98	10.57	.11
Girl non-Scouts	30.73	10.79	-.09	39.32	9.80	-.08
Difference	2.24	-.22	.25	1.66	.77	.19
SE_{diff}	.58	.42	.06	.66	.46	.06
t-ratio	3.86	.56	4.17	2.51	1.67	3.17

TABLE XVI (continued)

COMPARISONS OF THE SCORES OF 366 BOY SCOUTS WITH THE SCORES OF 603 BOY NON-SCOUTS AND OF 399 GIRL SCOUTS WITH THE SCORES OF 605 GIRL NON-SCOUTS

	Raw Score Gain	Gain as % of possible	z Score Gain	Gain as Mean Difference between T-Scores
Girl Scouts	8.01	19	-.05	-.11
Girl non-Scouts	8.59	19	.01	.07
Difference	-.58	0	-.06	-.18
SE_{diff}	.36	2	.05	.15
t-ratio	1.60	0	1.20	1.20

category of Scouts to be compared with non-Scouts. The validity of this procedure rests on the approximately equal numbers of boys and girls and the similarity in direction and quantitative relationship between the scores of Girl Scouts and girl non-Scouts and between the scores of Boy Scouts and boy non-Scouts. Data related to these combined groups appear in Table XVII. A comparison of the general characteristics of the two groups may be gained from Table XVIII.

These data show that the Scouts have several factors in their favor, to a degree, at least, that may be suspected of affecting the acquisition and possession of science information. The results from previous phases of this study prompt the inference that intelligence differences hold the greatest promise of providing an explanation of the superior performance of the Scouts. The coefficient of correlation between intelligence quotients and initial scores on the Read Test was found to be .557. By using the regression equation derived from this correlation as an estimating equation, a mean score on the Read Test of 34.84 would have been predicted for the Scouts and a mean score of 31.19 would have been predicted for the non-Scouts. This would give the Scouts a predicted superiority of 3.65 points in keeping with their superior intelligence. The observed difference between the groups was 2.46 with a standard error

TABLE XVII

COMPARISON OF THE SCORES OF 765 SCOUTS WITH THE SCORES OF 1,208 NON-SCOUTS

	Initial			Final		
	Raw Score		z Score	Raw Score		z Score
	M	SD	M	M	SD	M
Scouts	34.65	9.97	.16	42.44	11.39	.03
Non-Scouts	32.19	9.10	-.09	41.07	11.81	-.05
Difference	2.46	.37	.25	1.37	-.42	.13
SE_{diff}	.44	.31	.05	.47	.37	.05
t-ratio	5.59	2.81	5.00	2.91	1.14	2.60

	Raw Score Gain	Gain as % of Possible Gain	z Score Gain	Gain as Mean Diff. between T-Scores
Scouts	7.79	19	-.03	-.35
Non-Scouts	8.88	21	.04	.35
Difference	-1.09	-2	-.12	-.70
SE_{Diff}	.34	2	.07	.33
t-ratio	3.20	1.0	1.70	2.12

TABLE XVIII

COMPARISON OF THE CHARACTERISTICS OF THE SCOUT AND NON-SCOUT GROUPS

Characteristic	Scouts	Non-Scouts
Number.	765	1,208
Mean intelligence quotient.	104.05	99.54
Percentage with high interest in reading science books.	18	10
Percentage with low interest in reading science books.	22	28
Percentage from "best" home category. . .	16	6
Percentage from "poor" home category. . .	9	7
Mean number of science classes per week through the 6th, 7th, and 8th grades .	8.7	7.9

of 0.44. The standard error of estimate for the regression equation was about .30. The difference between predicted superiority of the Scouts and their observed superiority is great enough to raise the question whether Scout experience as an independent variable is actually accompanied by a negative relationship with the acquisition and possession of science information. An answer to this question was sought through the multiple correlation technique and the partial regression coefficients provided by this technique. Table XIX reports the correlation coefficients among the factors suspected of affecting the acquisition of science information which were included in this study.

Several comments regarding the derivation of the correlation coefficients reported in Table XIX are in order. The reader may understand the nature of the problem at hand at this phase of this investigation. Briefly stated, the problem consisted of estimating the quantitative correlation of several rather different variables on a common ability. There are adequate tests of the pencil-paper type for use in testing science information and intelligence. The literature of statistical analysis provides competent techniques for determining the correlation between such variables so measured. Factors such as Scout experience, 4-H Club experience, reading interests, and the social and economic home conditions of the students, although it may be assumed that such factors

TABLE XIX

COEFFICIENTS OF CORRELATION BETWEEN THE FACTORS SUSPECTED OF AFFECTING THE ACQUISITION OF SCIENCE INFORMATION*

	0	1	2	3	4	5
0. Science Information.	---	.157	.557	.265	.252	.134
1. Scout Experience . .	---	---	.138	.145	.167	.085
2. Intelligence	---	---	---	.257	.043	-.016
3. Social-Economic Home Conditions. . .	---	---	---	---	.000	**
4. Interest in Reading Science Books. . . .	---	---	---	---	---	.237
5. Periods of Science Instruction in 6th, 7th, and 8th grades.	---	---	---	---	---	---

*This table should be read according to the following example: The coefficient of correlation between Scout Experience (1) and Social-Economic Home Conditions (3) was found to be .145.

**No significant difference was found between the means of these groups hence no attempt was made to estimate the degree of correlation.

are normally distributed through the population, do not lend themselves to pencil-paper techniques of measurement. It was necessary in this study to resort to the use of categories in which professed degrees of these factors were represented. In the case of two of these factors, reading interests and social and economic home conditions, the author believed a more valid estimate of these factors could be obtained if the extreme cases were given preferred consideration in the statistical treatment.

There was a further limitation imposed on the collection of these correlation data. In anticipation of the need to be able to parcel out the effect of individual factors acting simultaneously with others it became necessary to use estimates of zero and second order correlations that are numerically equivalent. These problems turned the author's attention to such methods of estimating correlation as the biserial,[12] the tetrachoric,[13] the phi coefficient,[14] and the biserial and tetrachoric using widespread cases.[15]

Of the correlation coefficients reported in Table XIV, page 94, the coefficient reported for Scout experience and

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[12] Peters and Van Voorhis, op. cit., p. 362.

[13] Ibid., p. 366.

[14] Allen L. Edwards, Statistical Analysis for Students in Psychology and Education, (New York: Rinehart and Co., 1946), p. 118.

[15] Peters and Van Voorhis, op. cit., pp. 375 and 384.

science information is rather representative of those calculated by the biserial technique. In order to use this convenient means of estimating correlations it must be assumed that there would be a normal distribution of Scout experience within the total population and that this distribution may be divided into two categories. It would be difficult to prove that any student would have been totally isolated from the Scout experience. By dividing the total population into two categories, those with no or less than one year of Scout experience and those with one or more years of Scout experience, it is possible to work within the restrictions of the biserial technique. The biserial coefficients, r_{12} and r_{15}, also follow an argument similar to that upon which the procedure was applied to the calculation of r_{01}.

The coefficients of correlation between Scout experience and the students' social and economic home conditions, r_{13}, and science book reading interest, r_{14}, are tetrachoric r's calculated from widespread classes. According to Peters and Van Voorhis,[16] this technique can be used to estimate the correlation between two variables if they are normally distributed and there is a clear separation of the two extreme segments of the population. The origins of the

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[16]Peters and Van Voorhis, <u>op</u>. <u>cit</u>., p. 336.

data upon which these correlations are based aid in meeting the limitations on the use of this technique. The teachers in the cooperating schools were asked to identify the students who came from the best ten per cent of the homes and those who came from the poorest ten per cent. This assumed a normal distribution of home condition from the poorest to the best. The decision to use this approach stemmed from the belief that teachers, in general, are more apt to be acquainted with the extreme cases of their students' home backgrounds.

The use of this technique in arriving at an estimate of the students' interests in reading science books follows a similar argument. The author believed that the students' memories would give more accurate estimates of interest at the extremes than overall. A technique for calculating the degree of correlation that used these extreme responses more markedly would thus be assumed to yield a more reliable estimate of the actual relationship. Similarly, r_{23} and r_{24} were derived and they follow a similar argument.

To aid in the interpretation of the validity of the application of the above technique and the coefficients obtained thereby, the author calculated the straight tetrachoric r's, the phi coefficients, and the tetrachoric r's from widespread classes for Scout experience and reading interest in science books and with the social and economic home conditions. In the case of the first of these factors, interest in reading science books, the straight tetrachoric r was found to be .318, the phi coefficient .198, and the tetrachoric r from widespread classes equalled .167. In the case of Scout work and home condition, the straight tetrachoric r was .268, the phi coefficient .173, and the tetrachoric r from widespread classes was .145.

The values of the straight tetrachoric r's in the preceding paragraph would have been a valid estimate of the relationship between the two variables if the discrepancy between the two extreme categories would have been equal to the discrepancy between the two categories composed of the whole population. The phi coefficient would have given a valid estimate if the discrepancy between the two extreme categories would have equalled the difference between the high and low half. With the categories composed of the extreme cases the value of the degree of relationship is reduced still more by the widespread class adjustment to the tetrachoric technique.

With the exception of those involving achievement and intelligence the r's in Table XIX, page 94, run low. The coefficient between Scout experience and prior instruction is so low that no further analysis of this relationship will be made. The other factors were subjected to the multiple correlation technique in order to obtain an estimate of the partial regression coefficients. These were found to be:

Scout Experience	.042
Intelligence	.541
Social and Economic Home Condition	.023
Reading Interests.	.222

The partial regression coefficients for Scout experience and home conditions are substantially equal to zero. This leads to the interpretation that the one year or more of Scout experience of the 765 Scouts who were included in this study was not exclusively associated with the ability to respond to the items on the Read General Science Test. Their apparent raw score advantage must be associated with other factors two of which can well be assumed to be superior intelligence and a greater contact with books about science.

It should be noted that these partial regression coefficients do not lend themselves to use for prediction purposes or to estimate the net percentage of association for each of the factors acting exclusively of the others. The variety of techniques used in deriving the zero and second order r's did not permit measures of equal variability. Prediction was not the primary motive of this study. These partial regression coefficients may be used as an estimate of the relative weights of the suspected contributing factors which were included in this study.

Differences associated with 4-H Club experiences. The data concerning this factor appear in Table XX. It can be seen that the differences in initial, final, and gain scores are all in favor of the 4-H Club group. These differences are so large in comparison with their standard errors as to lead to the interpretation that there is a real difference between such groups in the total population.

As was the case when Scout experience was the factor being considered, attention is next directed to the question of whether other factors correlated with ability to answer the items on the Reed Test were equally distributed among the 4-H and non 4-H Club groups. There were found to be 126 boys and 249 girls in the 4-H Club group. It was further observed that the initial mean score of the 4-H boys was 34.07 which is practically equal to the initial mean score of the non 4-H boys. The initial mean score for the 4-H girls was 33.52 and this is significantly higher than the initial mean score for the non 4-H girls. This leads to the tentative interpretation that girl and boy 4-H Club experiences bear different relationships to the possession and acquisition of science information.

The comparative intelligence of the 4-H and non 4-H groups must be considered. It was found that the 4-H Club group as a whole enjoyed an intelligence quotient superiority of 2.31 intelligence quotient points. By using the previously

TABLE XX

COMPARISON OF THE SCORES OF 375 STUDENTS WITH 4-H CLUB EXPERIENCE WITH THE SCORES OF 1,598 STUDENTS WITHOUT 4-H CLUB EXPERIENCE

	Initial			Final		
	Raw Score M	Raw Score SD	z Score M	Raw Score M	Raw Score SD	z Score M
4-H Club	34.70	9.60	.16	43.72	10.45	.20
Non-4H Club	32.75	9.51	-.04	41.10	10.90	-.05
Difference	1.95	.09	.20	2.62	-.45	.25
SE_{diff}	.55	.40	.05	.59	.44	.05
t-ratio	3.54	.22	4.00	4.44	1.02	4.82

	Raw Score Gain	Gain as % of Possible Gain	z Score Gain	Gain as Mean Diff. between T-Scores
4-H Club	9.02	22	.03	.25
Non-4-H Club	8.35	20	-.01	-.06
Difference	.67	2	.04	.31
SE_{diff}	.71	1	.04	.41
t-ratio	.94	2.00	1.00	.76

interpreted regression technique for matching groups and assuming all other factors to be equally distributed, it would have been predicted that the 4-H Club group would have made a mean score on the Read Test of 34.47. The initial mean score observed for the group was 34.70.

The analysis of differences associated with Scout experience showed that the social and economic home conditions and Scout experience show exceedingly low independent correlation with scores on the Read Test; thus it was deemed unnecessary to check on the equality of distribution of these factors. Reading interests and the number of periods of prior science instruction show low correlation and there was no known reason to suspect that these factors would be markedly disproportionately distributed between the 4-H and non 4-H Club groups.

Although the gap between the two groups composing the sample of students in this study widened during the year's instruction, the gain differences were not great enough to permit very reliable generalizations beyond this group. This factor plus the relatively high correlation between the overall initial and final scores (.728), prompts the inference that the same interpretation may be made of the acquisition of science information through the ninth grade as was made of the information possessed prior to the year's instruction.

V. DIFFERENCES IN ACHIEVEMENT ASSOCIATED WITH DIFFERENCES IN HOME BACKGROUND

Differences associated with rural, village, and city home backgrounds. Data regarding this factor are reported in Tables XXI and XXII. A student was classified as belonging in one of these groups if he reported on the personal information form that he had spent the preceding five years in one of these home background categories. If parts of the preceding five years had been spent in two or more of these categories he was identified as coming from a mixed home background.

These data will have to be interpreted in light of the prevailing atmosphere of the rural influence in the area of Central Illinois. In few respects can the students who may be classified in the city category be expected to have the same background experiences in this area as city students would have in an area surrounded by purely industrial enterprises. In Central Illinois and especially so in the case of the students composing the sample for this study, students designated as coming from rural homes might well differ in the nature of their home experiences from those classified as city students but the village category should be considered a transition group between rural and city.

If the arbitrary t-ratio of 3.0 is to be maintained

TABLE XXI

COMPARISON OF THE INITIAL AND FINAL SCORES OF STUDENTS WITH RURAL, VILLAGE, CITY, OR MIXED HOME BACKGROUNDS

	Raw Scores							
	Rural		Village		City		Mixed	
	M	SD	M	SD	M	SD	M	SD
Final	43.10	10.39	42.42	10.10	40.87	11.15	42.06	10.80
Initial	32.22	9.65	33.64	9.95	33.18	9.80	33.48	8.40
Diff	10.88	.74	8.78	.15	7.69	1.35	8.58	2.40
SEdiff	.40	.37	.51	.46	.26	.65	.45	.39
t-ratio	27.2	2.00	17.2	.33	29.6	2.08	19.1	6.15

	z Scores			
	Rural	Village	City	Mixed
	M	M	M	M
Final	.14	.08	-.07	.04
Initial	-.09	.05	.01	.04
Diff	.23	.03	-.08	0.0
SEdiff	.04	.05	.01	.04
t-ratio	5.17	.60	8.00	0.0

TABLE XXII

COMPARISON OF THE GAIN SCORES OF STUDENTS WITH RURAL, VILLAGE, CITY, OR MIXED HOME BACKGROUNDS

Differences Between Mean Final and Initial z Scores

Rural	.23	Rural	.23	Rural	.23
Village	.03	Mixed	0.0	City	-.07
Diff.	.20		.23		.30
SE_{diff}	.06		.06		.05
t-ratio	3.33		3.33		6.00
Village	.03	Village	.03	City	-.07
City	-.07	Mixed	0.0	Mixed	0.0
Diff.	.10	Diff.	.03	Diff.	-.07
SE_{diff}	.05		.06		.05
t-ratio	2.00		.50		1.40

Mean Differences Between Individual T-Scores

Rural	1.94	Rural	1.94	Rural	1.94
Village	.72	Mixed	-.15	City	-.71
Diff.	1.22		2.09		2.65
SE_{diff}	.61		.54		.42
t-ratio	2.00		3.87		6.30
Village	.72	Vill.	.72	City	-.71
City	-.71	Mixed	-.15	Mixed	-.15
Diff.	1.43		.87		-.56
SE_{diff}	.54		.63		.46
t-ratio	2.65		1.38		1.22

Gain as Per Cent of Gain Possible

Rural	25	Rural	25	Rural	25	V'age	21	V'age	21	City	18
V'age	21	City	18	Mixed	21	City	18	Mixed	21	Mixed	21
Diff.	4		7		4		3		0		-3
SE_{diff}	4		3		4		3		4		3
t-ratio	1		2.3		1		1		0		1

s the test of statistical significance, the differences in he amount of science information possessed by entering inth grade students from rural, village, city, and mixed ome backgrounds are no greater than those which can be xplained as apt to accompany chance sampling variations. similar interpretation must be made in connection with the mount of science information possessed at the end of the inth grade except in the comparison of city with rural students. There can be little doubt that the rural students end to gain more than the city students and those with ixed home backgrounds. The gains of the rural students are sufficiently greater than those of the village students o give a probability of approximately ninety chances in one hundred of being generally applicable to ninth grade populations.

The standard errors for the differences between z score, initial and final, have been corrected for the correlation in the groups. The standard errors for the mean differences between individual T-scores have been calculated by the simple formula $SE = \sqrt{\frac{SD_1}{N_1} + \frac{SD_2}{N_2}}$ where the SD's indicate the standard deviations of the distributions of the individual differences between T-scores. These standard errors thus calculated will have to be considered as conservatively estimated.

With the exception of intelligence, other factors corelated with the ability to respond to the Read Test are assumed to be equally distributed among the home background categories. The mean intelligence quotients for 1,520 of these students were found to be:

234 rural students	100.45	SE = .94
136 village students	102.65	SE = 1.20
979 city students	101.75	SE = .45
173 students with mixed backgrounds	101.42	SE = 1.04

The differences between the mean intelligence quotients of the four groups are practically within the range of the sums of the standard errors. The greatest difference is found to be between the rural and village groups. By application of the regression equation technique for matching groups, this difference should give the village group a predicted advantage of approximately one point for a mean on the Read Test. With this adjustment applied not only to the comparison of village and rural students but also to all groups, no changes would occur in the directions of interpretations made from the data in Table XXI, page 104, and Table XXII, page 105. None of the t-ratios would be increased beyond or decreased below the accepted value of 3.0.

Differences associated with "best" and "poorest" homes. During the years the author of this thesis has been associated with public school teachers he had often heard students being referred to as coming from good or poor homes with the connotation expressed or implied that this bore a significant relationship to the students' school achievement. An attempt was made in this phase of this investigation to use this type of evaluation of the home background of students.

The teachers in the schools enrolling 1,616 of the 1,973 students in the major group used in this study were able to provide estimates of their students' home conditions. Originally 233 were identified as coming from the "best" homes and 167 from the "poorest." Apparently the teachers were more hesitant to identify students in the latter category. Initial and final scores were obtained for 228 of the "best" home group and 140 from the "poorest."

Data regarding the scores from these groups appear in Table XXIII. The reader should keep in mind the character of the groups and realize that the differences would be diluted if the total distribution had been included.

There can be no doubt that real differences exist between the "best" and "poorest" categories both on the initial and final test scores. The difference in the gains is not statistically significant. The biserial r calculated from these widespread classes provides an estimate of the functional value of the factor of home conditions if the total group had been considered. This value was found to be .26 for the initial scores and .27 for the final. These are significant.

TABLE XXIII

COMPARISON OF THE INITIAL, FINAL, AND GAIN SCORES OF STUDENTS FROM THE "BEST" AND "POOREST" HOMES

	Initial			Final		
	Raw Score M	Raw Score SD	z Score M	Raw Score M	Raw Score SD	z Score M
"Best" homes	38.85	9.50	.58	43.35	10.35	.61
"Poorest" homes	29.95	8.50	-.33	33.17	10.05	-.32
Difference	8.90	1.00	.91	10.18	.25	.93
SE_{diff}	.95	.67	.11	1.08	.77	.11
t-ratio	9.37	1.49	8.27	9.42	.32	8.45

	Raw Score Gain	Gain as % of Gain Possible	z Score Gain	Gain as Mean Diff. between T-Scores
"Best" homes	9.50	26	.03	.89
"Poorest" homes	3.22	18	.01	.92
Difference	1.28	8	.02	-.03
SE_{diff}	.83	9	.08	.79
t-ratio	1.54	.89	.25	.04

The standard errors for these r's when calculated by the simple formula $SE = \frac{1 - r^2}{\sqrt{N}}$ equalled .03. Peters and Van Voorhis[17] infer that this equation gives a conservative estimate of the standard errors of r's so calculated.

Continuing the pattern of this investigation, attention is next directed to the question of the possibility of unequal distribution of other factors correlated with success on the Read Test between "best" and "poorest" categories. In this connection the "best" group was found to have a mean intelligence quotient of 107.52 and the "poorest" group a mean of 97.30 with the standard deviations of the two distributions being 12.30 and 13.15 respectively. By relying on the estimated correlation between intelligence and scores on the Read Test as reported earlier in this thesis and the estimating equation derived from it, the predicted means for the two groups can be calculated. A mean initial score of 37.64 would have been predicted for the 153 "best" home students whose mean intelligence quotient was 107.52. The standard error of estimate for this prediction would be .63. A mean initial score of 29.73 with a standard error of estimate of .30 would have been predicted for the 99 students in the "poorest" home category. The observed values were 38.85 and 29.95 with standard errors of .63 and

[17] *Ibid.*, p. 391.

.71 respectively. The interpretation follows that the apparent superiority on the Read Test reported to be shown by the "best" home group is considerably overlapped by the superiority in intelligence simultaneously enjoyed by the group.

Eighteen per cent of the students in the "best" home category reported "high" interest in reading science books whereas 20 per cent reported "low" interest. This implies no difference between the two categories. This implication was supported by the value of the tetrachoric r between the two factors. This technique estimated the correlation between the factors to be .001 with a standard error of approximately .009. This implies that a degree of correlation no greater than plus or minus .03 exists between the social-economic home conditions of the students as estimated by their classroom teachers and their interest in reading science books.

Two hundred eleven of the students in the "best" category and 131 in the "poorest" category provided usable answers to the question concerning the number of periods of science instruction through the sixth, seventh, and eighth grades. The mean numbers reported were 8.67 and 9.60 with the difference of .89 in the favor of the "poorest" category. The low correlation between this factor and achievement on the Read Test together with the smallness of the difference between the means of the two groups precludes the necessity of determining the predicted effect the difference in the amount of prior instruction would have on the Read Test scores of the "best" and "poorest" groups. Although there is a difference in the amount of prior instruction experienced by the two groups included in this study the chances are low (15 in 100) that a similar difference would be found in other samples drawn from the ninth grade population.

The discussion on pages 96 through 99 of this thesis provides further aid in the interpretation of differences associated with the differences in home background conditions.

VI. DIFFERENCES ASSOCIATED WITH DIFFERENT DEGREES OF INTEREST IN READING SCIENCE BOOKS

The classification of students in the categories of "high" and "low" interest in reading science books and books about science was based on the students' replies to Question number seven on the personal information form. This question reads--"About how many, if any, science books or books about science have you read during the past two or three years?" The wording of this question proved to be faulty. The intent was to have the students exclude any science textbooks used in their pre-ninth grade science classes. Individual teachers and their students differed in their interpretation of the question but the general pattern appears to have been to include science textbooks in the estimate.

Those students who reported having read one or no science books or books about science were placed in the category of "low" interest. Those who reported more than four were placed in the "high" interest category.

An inspection of the data in Table XXIV shows significant differences in favor of the "high" interest group on the initial and final scores. In terms of raw score gain and maintenance of rank position the difference was in favor of the "low" interest group with the difference almost great enough to be statistically significant.

Earlier in this thesis on pages 96 through 99 it was shown that interest in reading science books as reported by the students in this study retained a fair degree of positive correlation with scores on the Read Test even when the overlapping of several other factors was eliminated. Along this same line, the mean intelligence quotient for the "high" interest category was 104.05 and for the "low" 102.30. Predicted mean initial scores for groups of this size and with these mean intelligence quotients would be 34.33 and 33.42 with standard errors of estimate of .50 and .35 respectively. This adjustment, if applied, would resolve only about 1.5 points of the raw score difference of 7.93 points originally observed.

TABLE XXIV

COMPARISON OF THE INITIAL, FINAL, AND GAIN SCORES OF STUDENTS WITH "HIGH" AND "LOW" INTEREST IN READING SCIENCE BOOKS

	Initial			Final		
	Raw Score		z Score	Raw Score		z Score
	M	SD	M	M	SD	M
"High" interest	38.12	10.70	.51	46.10	11.20	.41
"Low" interest	31.35	3.89	-.13	40.03	10.46	-.14
Difference	6.77	1.81	.69	6.02	.74	.55
SE_{diff}	.78	.55	.07	.84	.60	.07
t-ratio	8.67	3.29	9.36	7.16	1.23	7.36

	Raw Score Gain	Gain as % of Gain Possible	z Score Gain	Gain as Mean Diff. between T-Scores
"High" interest	7.98	22	-.10	-.99
"Low" interest	8.73	20	.04	.53
Difference	-.75	2	-.14	-1.57
SE_{diff}	.60	1.3	.05	.54
t-ratio	1.25	1.55	2.80	2.91

The two groups were observed to differ significantly in respect to the mean total number of science classes reported through the sixth, seventh, and eighth grades. The "high" interest group reported a mean number of 9.79 classes whereas the "low" group reported 4.76. The difference is in favor of the "high" interest group and amounts to 5.03 classes with a standard error of .37. The biserial r calculated by using widespread classes between reading interest and number of prior science classes is .35. The correlation between the number of periods of prior instruction and scores on the Read Test is, however, so low, .13 with a standard error of .02, that there is little overlapping on the correlation between reading interests and scores on the Read Test. This r with no elimination for overlapping is .24 and the partial r with the number of periods of prior instruction held constant is .21.

Thus the interpretation is implied that a significant degree of exclusive correlation exists between the performance of ninth grade students on the Read Test and their reported interest in reading science books and books about science. Due to a defect in the design of the personal information form, there is no way to interpret whether this correlation refers to science textbooks or science fiction.

VII. DIFFERENCES ASSOCIATED WITH DIFFERENT AMOUNTS OF SCIENCE INSTRUCTION THROUGH THE SIXTH, SEVENTH, AND EIGHTH GRADES

The data reported concerning this factor originated in the students' initial and final scores on the Read Test together with their replies to the question on the personal information form--"About how many science classes did you have each week while you were in the sixth grade? ___ Seventh grade? ___ Eighth grade? ___." The data thus acquired will have to be interpreted within all of the limitations imposed by having relied not only on the students' memories but also on their representation of what constituted a science class.

Of the 1,973 students from whom initial and final scores on the Read Test were obtained, 1,893 provided usable answers to the question pertaining to the number of prior science classes. The predominant reason for discarding papers was that the students had placed question marks or indicated in some other way that they were unable to answer the questions. The remainder of those discarded papers represented cases of discrepancies between the student's answer to the above question and to the question--"In which of these grades did you have a regular science textbook?" A discrepancy was declared if the student reported no science class in a particular grade and then indicated having used a science textbook through that grade.

As previously inferred, the replies of the students will have to be accepted for statistical purposes at their face value. The interpretation of this analysis, however, may be enlightened by relating some of the observations made pursuant to the collection of the original data.

The first of these concerns the difficulties encountered in gaining or attempting to gain a reliable estimate of the number of science classes experienced by students prior to the ninth grade. During conferences with district and city school superintendents it was often implied that the annual reports received by these officials too often reflected a degree of reporting desirable rather than actual amounts of science instruction through the sixth, seventh and eighth grades. Principals often implied that their statements of the number of classes in science taught their current ninth grade students during the sixth, seventh, and eighth grades might be in error due to adjustments in daily programs made by individual teachers, adjustments reflecting the individual teacher's confidence and interest in teaching science.

Observations reported by some of the classroom teachers may be indicative of the conditions which accompanied the students' recording of their replies to the personal information form questions. Students reportedly tended to compare replies to the question concerning prior science classes.

Discrepencies among the replies of students in the same class were often explained as due to individual students changing schools or missing science classes for one reason or another.

The data reported in Table XXV were drawn from 1,393 students with from zero to a total of fifteen science classes per week through the sixth, seventh, and eighth grades. With the standard errors of these means reported in Table XXV ranging around .65, a difference between means of approximately 2.75 points is sufficient to reach statistical significance.

The non-regular increase in means with increasing numbers of prior science classes prompted the calculation of the correlation ratio and the use of the epsilon-square technique to test the linearity of the relationship and the significance of the correlation. Peters and Van Voorhis[18] provided tabled values of epsilon-square at the five and one per cent levels of confidence. These values can be used to compare a correlation ratio with the degree of correlation that could be expected on the basis of chance fluctuation when the true correlation is zero. Eight columns were used in the calculation of the correlation ratio and the scores of 1,393 students were used. The tabled value of epsilon-square with k-1 equal to 7 and N-1 equal to 1,000 is .011 at the one per cent level of confidence. The

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[18] *Ibid.*, pp. 494-97.

TABLE XXV

COMPARISON OF THE INITIAL SCORES OF STUDENTS WITH VARIOUS AMOUNTS OF SCIENCE CLASSES THROUGH THE SIXTH, SEVENTH, AND EIGHTH GRADES

Total Number of Classes Reported	N	M	SD	SE_M	Mean Intelligence Quotient N	Mean Intelligence Quotient IQ
0 - 1	311	30.75	8.75	.50	243	101.4
2 - 3	147	31.03	9.90	.82	84	100.1
4 - 5	203	33.54	9.55	.67	174	102.2
6 - 7	188	34.83	9.65	.70	159	102.6
8 - 9	189	34.93	9.15	.67	146	102.3
10 -11	219	34.43	9.50	.64	[illegible]	101.8
12 -13	178	34.12	9.27	.69	142	102.4
14 -15	457	33.50	9.55	.45	308	102.4

Pearson Product-Moment r between Read Test Scores and Number of Science Classes 134
SE = .02

Correlation Ratio, corrected for sample size and number of classes, between Read Test Scores and Number of Science Classes 17
SE = .02

epsilon-square value was observed to be .025 which indicates a degree of real relationship between the scores on the Read Test and the number of prior science classes.

The product-moment r between these factors equalled .134 with a standard error of .02. The epsilon-square test of linearity revealed a value of .009. This value is significant at the five per cent level of confidence if only 1,000 scores had been used. The interpretation follows that there are less than five chances in one hundred that the relationship between Read Test scores and the reported total number of science classes through the sixth, seventh, and eighth grades is linear.

In the calculation of the above correlation ratio and product-moment r, no consideration was made of the relative recency of the prior instruction. For example, in the tabulations on the correlation chart three classes per week through the sixth grade were treated identically with three classes per week that may have been reported through the eighth grade. Table XXVI reports some of the data gathered in an attempt to estimate the effect of recency. Instruction that occurred through the eighth grade tends to be accompanied by higher Read Test scores but the differences are not great enough to justify generalizations beyond the sample of students included in this study. These differences were great enough, however, to prompt an investigation of the

TABLE XXVI

COMPARISONS OF THE INITIAL SCORES OF GROUPS OF STUDENTS DIFFERING IN RESPECT TO THE GRADE IN WHICH PRIOR SCIENCE INSTRUCTION HAD OCCURRED

Group	N	M	SD	SE_M
Science Classes in Sixth Grade only	80	30.25	10.43	1.14
Science Classes in Seventh Grade only	68	32.19	9.75	1.18
Science Classes in Eighth Grade only	128	33.55	9.65	.85
Science Classes in 6th and 7th Grades	68	31.90	9.61	1.20
Science Classes in 7th and 8th Grades	350	33.77	9.85	.27
Science Classes in 6th and 8th Grades	18	31.90	9.35	4.88
Science Classes in all Three Grades	1423	33.59	9.70	.26
Science Classes in none of the Three Grades	318	29.30	9.40	.53

(These data were calculated from the total group of entering ninth grade students. This included those who were taught science through the ninth grade as well as those who were not.)

effect of weighting the reported number of science classes. A random sample of 200 scores drawn in connection with a phase of this study reported earlier (page 74) was used to test the effect of multiplying the number of classes reported through the sixth grade by one, the number through the seventh by two, and the number reported through the eighth by three. Thus treated, a student reporting five classes per week through each of the three grades would be handled as having a total of thirty classes in science prior to the ninth grade whereas a student who reported three classes per week through the sixth, none through the seventh, and three per week through the eighth would be identified with a total of twelve classes. One hundred eighty-nine of the students in the 200 paper sample provided usable answers to the question at hand. The product-moment r from this sample equalled .126; SE = .07. The results from this sample infer that no significant differences can be associated with the recency of the prior science classes.

Differences between the Read Test final or end-of-year scores of groups of students with varying amounts of prior instruction show relationships which are similar to those found for initial test scores. These data appear in Table XXVII. With the standard errors of the means as reported, a difference of approximately 3.0 is sufficient to show a significant difference between these means.

TABLE XXVII

COMPARISONS OF THE FINAL SCORES OF STUDENTS WITH VARIOUS NUMBERS OF SCIENCE CLASSES THROUGH THE SIXTH, SEVENTH, AND EIGHTH GRADES

Total Number of Classes Reported	N	M	SD	SE_M
0 - 1	311	39.27	10.50	.60
2 - 3	147	40.00	11.70	.97
4 - 5	203	41.60	10.70	.75
6 - 7	189	43.15	10.95	.80
8 - 9	189	42.30	10.70	.73
10 -11	219	42.70	10.25	.69
12 -13	178	43.90	10.20	.77
14 -15	457	42.10	10.65	.50

Product-Moment r between Read Test Scores and Number of Science Classes. . . . . .09 SE = .02

Correlation Ratio, corrected for sample size and number of classes, between Read Test Scores and Number of Science Classes. .12 SE = .02

The decrease in the value of the product-moment r between the initial and final administrations of the Read Test is significant if the standard errors take the correlation between the initial and final test scores into consideration. Thus calculated, the standard error of the difference between these two r's equalled .015. A similar interpretation follows for the difference between the initial and final correlation ratios.

The epsilon-square test reveals the correlation ratio value of .120 to be significant at the one per cent level and further that the chances are less than one in one hundred that the relationship between these Read Test scores and the reported number of prior science classes is a linear relationship.

Estimates of the gains made by groups of students with various numbers of science classes through the sixth, seventh, and eighth grades may be made from the data reported in Table XXVIII. An inspection of these data shows that each group made significant gains through the year. The standard errors of the mean raw gains have been corrected for the correlation between initial and final Read Test scores. The standard errors of the gains expressed as per cent of gain possible are difficult to estimate due to the action of correlation between the initial and final test scores. If the initial and final raw scores are expressed as the per cent of the total

TABLE XXVIII

COMPARISON OF THE MEAN DIFFERENCES BETWEEN INDIVIDUAL FINAL AND INITIAL T-SCORES OF STUDENTS WITH VARIOUS NUMBERS OF SCIENCE CLASSES THROUGH THE SIXTH, SEVENTH, AND EIGHTH GRADES

Total Number of Classes Reported	N	M	SD	SE_M*
0 - 1	311	.63	7.30	
2 - 3	147	.48	7.59	
4 - 5	203	-.03	7.29	
6 - 7	139	.18	7.83	
8 - 9	139	-.36	7.26	
10 -11	219	.12	6.72	
12 -13	178	.15	7.11	
14 -15	457	-.63	6.63	

Product-Moment r between Read Test Scores and Mean Differences between Individual Final and Initial T-Scores . . . . -.052

Correlation Ratio, corrected for sample size and number of classes, between Read Test Scores and Number of Science Classes. . -.035

*See page 126.

score, the standard error of these percentage scores is approximately three per cent. On this basis the standard errors of the differences between final and initial percentage scores would have a standard error of approximately two per cent by applying the correction for the correlation between initial and final scores. Under these conditions the interpretation would follow that there are no significant differences, in general, between the gains of any two of the groups of students with various numbers of science classes through the sixth, seventh, and eighth grades. The same interpretation would be made of the differences between gains when expressed in raw score points.

Gains expressed as mean differences between individual T-scores should be interpreted as changes in relative rank position. The process of converting raw scores to T-scores reduces all scores to a common distribution and it would follow that if there were no changes in relative rank position within two distributions there would be no differences between mean scores of the two distributions. It is difficult to estimate the standard errors between such mean differences as reported in Table XXIX but the significance of the whole relationship between mean individual T-score differences may be estimated from the product-moment r and the correlation ratio. The product-moment r is just short of the arbitrary three times its standard error requirement for statistical

TABLE XXIX

COMPARISON OF THE READ TEST GAIN SCORES OF GROUPS OF STUDENTS WITH VARIOUS NUMBERS OF SCIENCE CLASSES IN THE SIXTH, SEVENTH, AND EIGHTH GRADES

Total Number of Classes Reported	N	Raw Score Gain	SE_{gain}	Gain as % of Gain Possible	Gain as Mean Diff. between individual T-Scores
0 - 1	311	8.52	.42	19.2	.63
2 - 3	147	8.97	.66	20.4	.48
4 - 5	203	8.06	.53	19.4	-.03
6 - 7	139	8.27	.56	20.6	.18
8 - 9	139	7.37	.55	18.4	-.36
10 -11	219	8.22	.49	20.3	.12
12 -13	178	9.73	.55	23.9	.13
14 -15	457	8.60	.35	20.7	-.63

Product-Moment r between gains expressed as mean differences between individual T-scores and the number of science classes in the sixth, seventh, and eighth grades . . -.052

Correlation ratio between these two factors. -.035

Eta with epsilon square correction 004

significance. The value of the correlation ratio was found to be -.035. This would be significant by applying the standard error derived by the simple formula: $SE = \frac{1 - eta^2}{\sqrt{N}}$ but the epsilon-square test gives a value of .004, a value that comes short of the .007 required for significance in cases where 1,000 scores were used in the calculation. The negative sign of the correlation is based on inspection of the pattern of scores on the correlation chart and the value of the product-moment r.

The epsilon-square test of the linearity of the relationship between Read Test score gains measured as mean differences between individual T-scores and the reported number of science classes through the sixth, seventh, and eighth grades provided a value of .001 when .003 would be required for significance at the five per cent level of confidence. This means that there is no reason to believe that the relationship is non-linear.

The reader may recall that the product-moment correlation between mean differences between individual T-scores and intelligence, reported on page 32 of this thesis, was also low and negative. This might lead to the interpretation that the technique as applied here penalizes the students who made high scores on the initial test through having their scores too close to the functional ceiling of the test. If this interpretation is not valid then it would follow that the instructional experiences through the ninth grade general science course do not provide the students who are initially superior in rank position an opportunity to maintain this relative superiority.

CHAPTER V

THE DATA SUMMARIZED AND GENERALIZATIONS PROMPTED BY THE DATA

This study was initiated to determine the relationship between the science information possessed by ninth grade students and such school and out-of-school factors as intelligence, sex, membership in Scouts and 4-H Clubs, interest in reading science books, social and economic home conditions, and prior instruction in science through the sixth, seventh, and eighth grades.

Estimates of the science information possessed by entering and end-of-year ninth grade students were obtained by the use of the Read General Science Test. The classification of students in categories representative of the school and out-of-school factors included in the study was based on the students' replies to questions on a personal information form, on the intelligence quotients obtained from their school office files, and on information obtained from conferences and correspondence with their teachers.

The identity of relationship between a factor suspected of affecting the possession of science information was revealed by the comparison of the test scores of groups differing in respect to the possession or lack of the suspected factor. If a statistically significant difference was identified, the functional value of the relationship was estimated by calculating the degree of correlation between the factor and scores on the Read Test.

<u>Data concerning groups differing in respect to general science instruction through the ninth grade.</u> The results of this study show:

1. Students who were taught general science through the ninth grade, students who were not taught general science through the ninth grade, and students taught biology through the tenth grade but who were taught no general science through the ninth grade showed significant increases in their mean scores on the Read Test between the final and initial administrations.

2. The students who were taught general science made the greatest gain, and the students who were not taught general science made the least gain.

3. There was a high correlation between the initial and final test scores of all three groups.

4. There was high correlation between the part scores from the subject matter areas of the natural sciences; earth, life, and physical, and the total scores on the test. These correlations were obtained from a sample of 200 students who had had science through the ninth grade.

5. Both the initial and final mean scores of all three

roups show greater familiarity with the earth and life cience items than with the physical science items.

6. The greatest gain of the non-science ninth grade roup was in the area of the earth sciences.

7. The greatest gain of the biology group was in the rea of the life sciences and second greatest gain in the hysical sciences.

8. The initial mean score of the ninth grade students as approximately 45 per cent of the total possible score nd the final mean score of this group was approximately 5 per cent of the total possible score.

Generalizations accruing from the results of this hase of the study are:

1. The items on the Read Test are related to the nstructional activities in the ninth grade general science class and to the activities of ninth grade students who may not be enrolled in either a general science or biology class.

2. The items on the Read Test are more closely related to the subject matter of the ninth grade general science course than to the subject matter of the tenth grade biology course or to the everyday activities of boys and girls who are enrolled in neither of these courses.

3. The instructional experiences in the general science and biology courses tend to have about the same effect on

all students in regard to the gaining of additional science information.

4. Interpretations made on the basis of the total test scores are applicable to each of the subject matter areas.

5. Students upon entering the ninth grade general science course are already familiar with a worthwhile portion of the science information customarily included in the course.

<u>Data concerning the relationship between intelligence and scores on the Read Test.</u> The results from this phase of the study show:

1. There is a moderate degree of correlation between intelligence and the distributions of the initial scores on the Read Test.

2. There is about the same degree of correlation between intelligence and the final scores on the Read Test.

3. Of the factors included in this study, intelligence showed the greatest degree of correlation with the initial test scores.

4. In connection with the distribution of final scores, the degree of correlation between intelligence and final scores was exceeded only by the degree of correlation between initial and final scores.

5. The correlation between intelligence and gains in

scores on the Read Test, although negative, was too low to be statistically significant.

Generalizations accruing from this phase of the study are:

1. Whatever it is that gives a student an advantage on the intelligence tests which were used to estimate intelligence also gives the student an advantage in possessing science information prior to enrollment in the ninth grade general science class.

2. Intelligence is the most reliable single factor for predicting initial scores on the Read Test.

3. The instructional experiences included in the general science class are of such nature that the intellectually bright and dull student have equal opportunities to gain additional science information.

<u>Differences in achievement associated with differences in sex</u>. The results obtained from this phase of the study are:

1. The boys invariably showed higher mean scores on the Read Test than did the girls.

2. There was no significant difference between the gains of the boys and girls.

3. The mean intelligence quotient of the girls was significantly higher than that of the boys.

4. The difference between the mean score of the boys and girls was sufficient to show a point biserial coefficient of correlation of .16, SE = .03, on the initial distribution and .15 on the final.

Generalizations accruing from the results of this phase of the study are:

1. The difference found to be associated with sex differences, although on the surface a rather prosaic and academic statistic, does show by the principle of concomitance that the subject matter of the course is related to the everyday activities of boys and girls. This assumes there to be differences in the everyday out-of-school activities of boys and girls.

2. There is a closer relationship between the subject matter of the Read Test and the everyday activities of boys and girls than between these activities and the exercises in the intelligence tests whereby the intelligence quotients of the students were determined.

Data concerning differences associated with membership in Scout organizations and 4-H Clubs. The results obtained from this phase of the study are:

1. Boy and Girl Scouts consistently showed statistically significant superiority on the Read Test.

2. The superiority of the Scouts decreased between the

initial and final testing periods.

3. Members of the Scout organizations had a higher mean intelligence quotient, a greater concentration of their members with "high" interest in reading, a greater per cent of their members among the students in the "best" home category, and a greater amount of science instruction through the sixth, seventh, and eighth grades.

4. The biserial coefficient of correlation between Scout experience and Read Test scores equalled .157; between Scout experience and intelligence quotients, .138; the tetrachoric coefficient of correlation calculated from widespread cases between Scout experience and social-economic home conditions, .145; the tetrachoric r from widespread cases between Scout experience and science book reading interests, .167; and the biserial r between Scout experience and periods of science instruction through the sixth, seventh, and eighth grades equalled .085. Each of these coefficients is equal to more than three times its standard error.

5. The partial regression coefficient for the relationship between Scout experience and Read Test scores with each of the other factors in "4" above held constant equalled .042.

6. Students with 4-H Club experience showed statistically higher initial and final mean scores than did students without 4-H Club experience.

7. Students with 4-H Club experience gained more but not significantly more through the ninth grade general science course.

8. Girl 4-H Club members showed a significantly higher initial mean score than did the girl non 4-H Club members whereas there was no such difference in the case of boys.

9. The superiority of the 4-H Club members was overlapped by a comparable degree of superiority in intelligence.

Generalizations accruing from the results of this phase of the study are:

1. Membership in Scout organizations and in 4-H Clubs is accompanied by some factor that gives students an advantage on the Read Test and also on intelligence tests.

2. Eliminate from the relationship between membership in these organizations and Read Test scores the overlapping of other factors and there is no significant degree of correlation remaining.

3. The experiences of the general science course must duplicate some of the experiences shared by the members of these organizations prior to instruction but denied the non-members prior to enrollment in the course.

<u>Data regarding differences in achievement associated with differences in home backgrounds.</u> The results from this

phase of the study are:

1. There were no significant differences in the initial Read Test mean scores of students entering the ninth grade general science course from rural, village, city, or mixed home backgrounds.

2. The superior gain made by rural students gave them a significant advantage over the city and mixed home background students on the final distribution of scores. Their advantage over the village students was sufficient to show a high degree of probability of being generally applicable in the total ninth grade population.

3. There were no significant differences between the mean intelligence quotients of the four groups.

4. Students coming from the "best" homes showed significantly greater initial and final Read Test mean scores than did those coming from the "poorest" homes.

5. The advantage of the students in the "best" home category on the initial distribution was sufficient to give a biserial r calculated from widespread cases of .26, a significant degree of relationship.

6. Students from the "best" and "poorest" homes tend to gain the same amount of science information as measured by the Read Test through the ninth grade general science course.

7. The superiority in Read Test scores is virtually overlapped by a superiority in intelligence.

8. Students from the "best" and "poorest" homes do not differ in respect to their reported interest in reading science books.

9. The partial regression coefficient of social-economic home conditions and Read Test scores with Scout experiences, intelligence, and science book reading interest held constant was found to be .023. This was not a significant degree of relationship.

Generalizations accruing from this phase of the study are:

1. Rural, village, and city children are equally aware or unaware of the relatedness of science information to their everyday activities prior to instruction in the ninth grade general science class. Rural children, however, may be closer to the actual point of application of many of the principles of science and thus become more aware of the role of science in their everyday activities causing them to retain a greater amount of the information developed in the course.

2. The "best" home environment provides no more of a stimulus to a student to pick up science information in science classes or elsewhere than does the "poorest" home except in the same way that the "best" home tends to develop students with superior intelligence.

<u>Data concerning the differences associated with different degrees in interest in reading science books and books about science.</u> The results from this phase of the study are:

1. The students who reported a "high" degree of interest in reading science books were significantly superior on the initial and final distributions of Read Test scores.

2. Students in the "low" interest group showed the greater gains between the initial and final testing periods. The difference in gain was almost great enough to be statistically significant.

3. The biserial coefficient of correlation calculated from widespread cases between reported reading interest and initial Read Test scores was found to be .252, a significant degree of correlation. The partial regression coefficient for this relationship with intelligence, Scout experience, and social-economic home conditions held constant was found to be .222.

4. The students with "high" interest in reading science books had experienced a significantly greater number of science classes through the sixth, seventh, and eighth grades.

Generalizations according from this phase of the study are:

1. The degree of relatedness between the science

information possessed by ninth grade students and their reported interest in reading science books is greater than the relatedness between such information and any other factor encountered in this study, the intelligence of the students being considered constant.

2. The items on the Read Test reflect a close association with the science information ordinarily included in science textbooks and semi-popular juvenile science books.

3. Students with high and low intelligence show about the same degree of interest in reading science books.

4. There is no difference in the degree of stimulation toward reading science books offered by the "best" and "poorest" homes.

5. The more contact a student has had with formal science classes the more apt he is to have read science books.

Data concerning the differences in achievement associated with different amounts of science instruction through the sixth, seventh, and eighth grades. The results from this phase of the study are:

1. Although a significant degree of correlation was found between Read Test scores, initial and final, and the reported number of science classes through the sixth, seventh, and eighth grades, it was so low as to be almost negligible.

2. The relationship between Read Test scores, initial

and final, was found to be non-linear.

3. There was a significant decrease in the degree of correlation between Read Test scores and the number of science classes through the sixth, seventh, and eighth grades between the initial and final testing periods.

4. There was a degree of negative correlation between gains on the Read Test between the initial and final administrations and the reported number of prior science classes. The value of this correlation was almost negligible and scarcely statistically significant.

5. There was no reason to believe that the relationship between gains on the Read Test and the reported number of prior science classes is non-linear.

Generalizations accruing from this phase of the study are:

1. The subject matter learned by students in the ninth grade general science course is similar to but far from duplicated by the science information acquired by students in general science classes through the sixth, seventh, and eighth grades.

2. Somewhere between "none at all" and "five days a week" through the three grades prior to the ninth there is a number of science classes that would make the most efficient use of instructional time.

3. Instruction in the ninth grade general science course tends to close the gap between students who enter the course with a minimum and a maximum amount of prior instruction in science. It follows from this that a student who shows precocious ability in the acquisition of science information is not provided instructional experiences enabling him to maintain his relative superiority.

CHAPTER VI

RECOMMENDATIONS FOR FUTURE STUDIES

The results from this study show a rather definite pattern in so far as the objectives as measured by the Read Test are concerned. An examination of these results, however, brings to mind the question of whether other objectives of science instruction would, if measured and subjected to similar analysis, show similar results. Additional studies might focus attention more specifically on the ability of the students to apply scientific principles to the solution of thought problems involving natural phenomena. Other studies might consider one or more of the various factors associated with the methods whereby scientists identify and solve problems.

Identification of the relative degree to which entering ninth grade students are familiar with the subject matter customarily included in the general science course raises a question concerning research on the allocation of topics among the grades prior to the ninth. Further research might reveal additional subject matter areas suitable for inclusion in the course. These additional subject matter areas might provide the students a greater opportunity to advance their possession of science information beyond the level existent at the beginning of the course.

The lack of positive correlation between intelligence and the acquisition of science information through the ninth grade general science course is another cause for concern. Additional research could well be directed toward the determination of new subject matter areas that could be included in the course and would be capable of challenging the upper levels of intellectual ability. This recommendation assumes that there should be something of a normal distribution of the ability to acquire additional science information through the ninth grade.

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APPENDIX

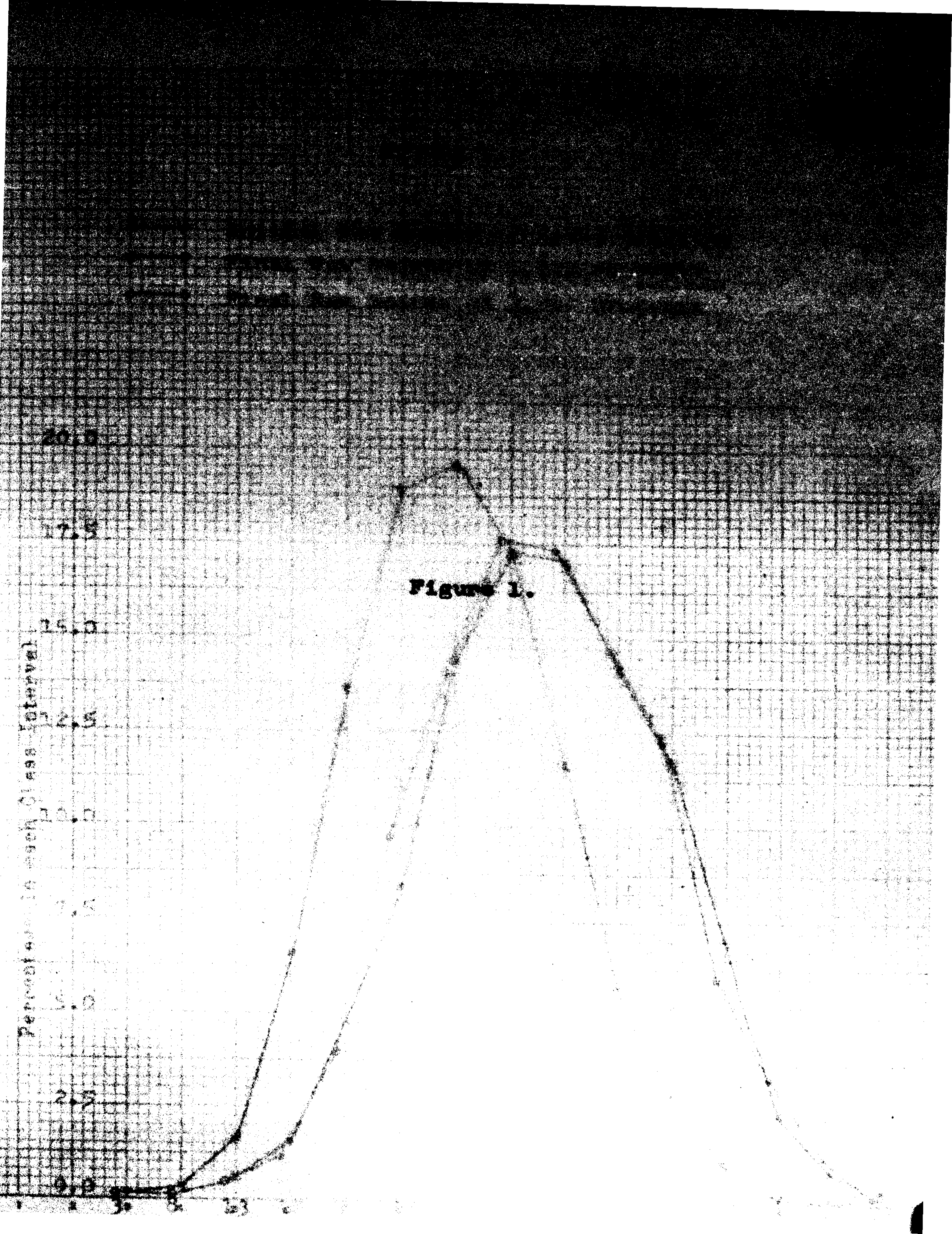

20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
Percentage in each Class Interval
3
8
13

Figure 1.

FIGURE 1.

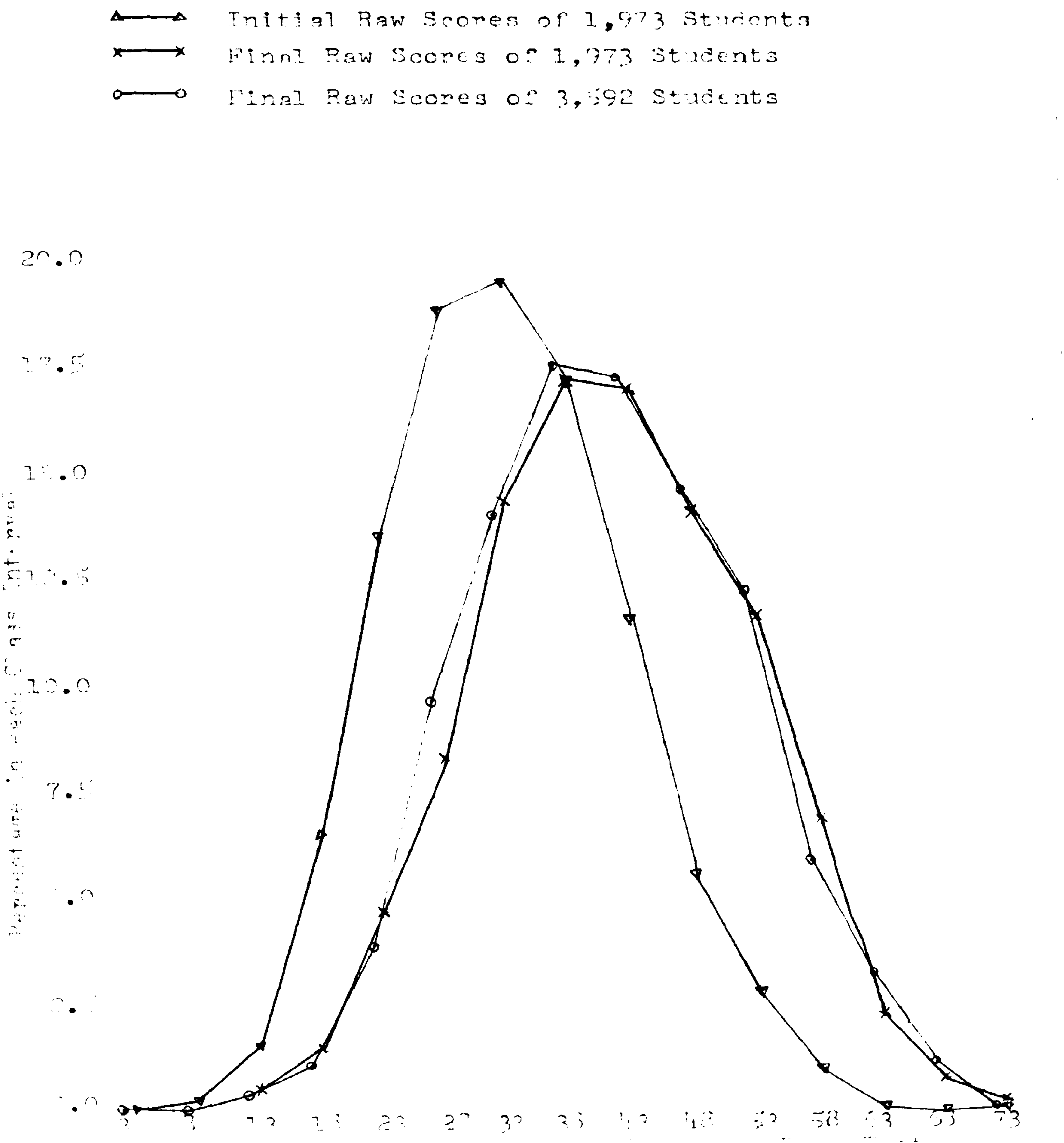
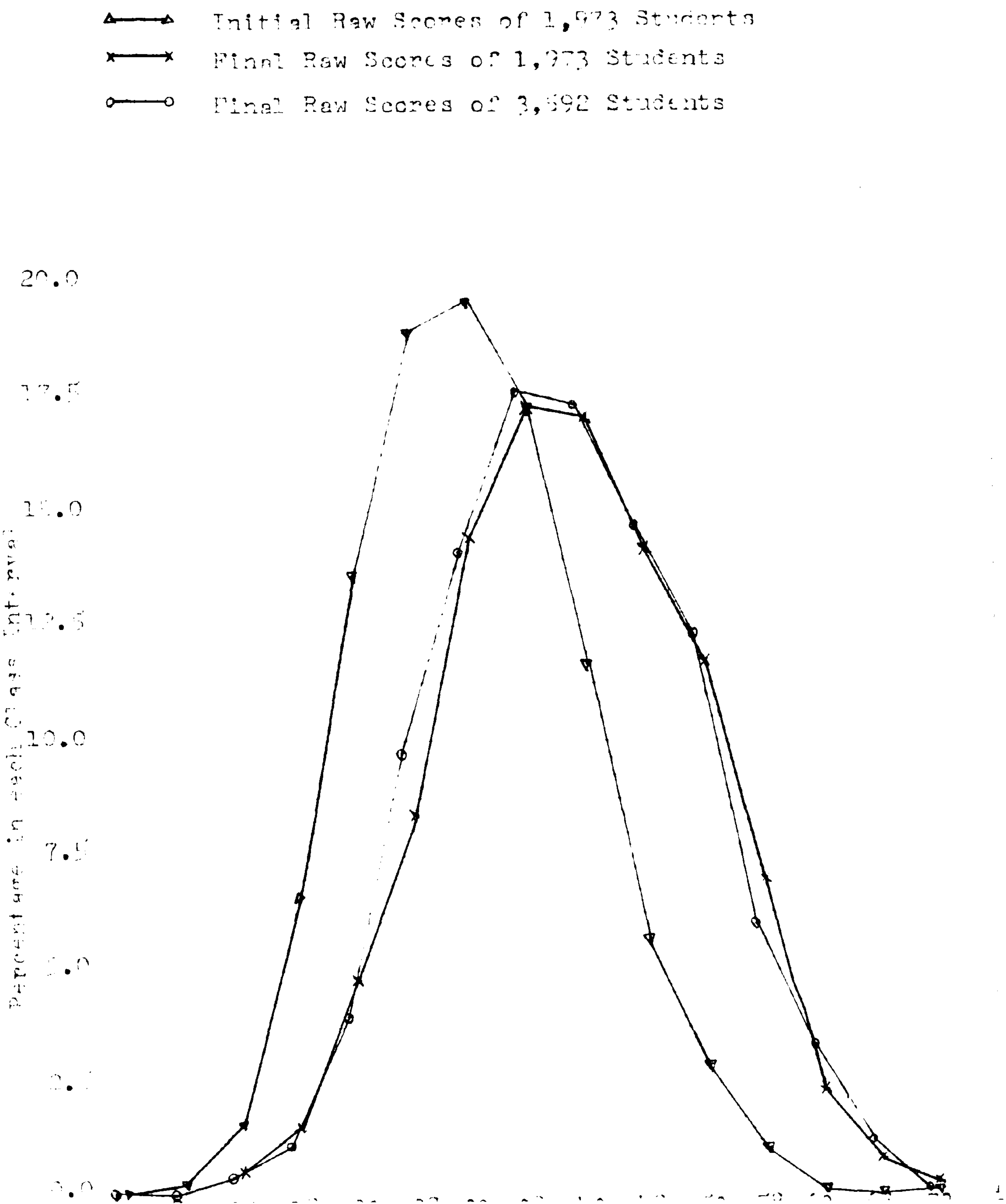

Initial Raw Scores of 1,973 Students
Final Raw Scores of 1,973 Students
Final Raw Scores of 3,592 Students
20.0
10.0
58
73

FIGURE 1.


Initial Raw Scores of 1,973 Students
Final Raw Scores of 1,973 Students
Final Raw Scores of 3,892 Students
20.0
10.0
7.5

(Supplementary Frequency Distributions and Correlation Tables)

Final Scores	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Total
73												4			[illegible]	[illegible]
68										[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
63		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4	8	17	15	9	[illegible]	[illegible]		[illegible]
58						2	12	26	40	30	19	5	1	1		[illegible]
53				1	11	15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					[illegible]
48				4	14	[illegible]	77	90	65	19	3	1				[illegible]
43			1	9	34	68	88	85	44	4		1				[illegible]
38			1	15	49	90	98	90	15	2	1					[illegible]
33		1	7	29	79	94	48	25	6	2						[illegible]
28		2	6	31	42	50	28	4		2						165
23	1		8	22	34	18	8	2			1					94
18	2	1	6	9	6	6	2	1	1							34
13		2	4	2	5	3	1									14
8																
Totals	5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	87	73	4	2	[illegible]	1,973

TABLE XXX

DISTRIBUTION OF THE CORRELATED INITIAL AND FINAL SCORES OF 1973 NINTH GRADE GENERAL SCIENCE STUDENTS

Final Scores: Midpoint of C. I.	Initial Scores: 3	8	13	18	23	28	33	38	43	48	53	58	63	68	73	Tot
73												4			1	5
68										2	3	5	2	1		13
63							1	4	6	17	15	3	1			47
58						[illegible]	12	28	40	30	19	5	1	1		136
53				1	1	13	41	60	59	37	15	4				231
48				4	14	31	77	90	65	19	3	1				302
43			1	[illegible]	34	[illegible]	[illegible]	[illegible]	44	4		1				331
38			1	11	49	90	95	50	13	2	1					319
33		1	7	29	79	94	46	20	5	1						2[illegible]4
28		2	5	31	4[illegible]	50	22	3		1						163
23	1		9	2[illegible]	32	18	2	3			1					94
18	2	1	[illegible]	[illegible]	6	[illegible]	1	1	1							34
13		1	4	2	3	3	1									14
8																
Totals	3	8	3[illegible]	131	2[illegible]	3[illegible]	3[illegible]	3[illegible]	251	113	57	23	4	2	1	1,973

TABLE XXXI

DISTRIBUTION OF THE CORRELATED INITIAL AND FINAL SCORES OF 198 NINTH GRADE STUDENTS WITH NO GENERAL SCIENCE THROUGH THE NINTH GRADE

Midpoint of C. I. (Final Scores)	Initial scores															
	3	8	13	18	23	28	33	38	43	48	53	58	63	68	73	Total
73																
68												1				1
63											1					1
58										1		2				3
53						1			2	8	1					12
48							1	3	5	9	2					25
43					3	1	8	9	3	2						31
38					1	2	13	17	4	2						39
33			1	1	6	10	12	11								41
28				1	7	6	7	1	1							23
23				4	6	4	1		1							16
18				3	1	1										5
13				1												1
8																
Totals			1	10	24	25	42	46	21	22	4	3				198

TABLE XXXII

DISTRIBUTION OF THE CORRELATED INITIAL AND FINAL SCORES OF 227 TENTH GRADE BIOLOGY STUDENTS WHO HAD HAD NO GENERAL SCIENCE THROUGH THE NINTH GRADE

Final Scores: Midpoint of C. I.	Initial Scores: 3	8	13	18	23	28	33	38	43	48	53	58	63	68	73	Total
73																
68																
63							1				3	4				8
58									3	7	7	3				20
53						2	4	5	4	9	5					29
48					1		2	9	9	8						29
43						7	7	14	12	1	1	1				43
38					3	7	13	16	7	2						48
33				2	4	7	8	6	1							28
28				1	3	3	1	1								14
23			1	2		2										5
18					2	1										3
13																
8																
Totals			1	5	13	34	36	51	36	27	16	8				227

TABLE XXXIII

DISTRIBUTION OF THE INITIAL SCORES OF A 200 PAPER SAMPLE ON THE EARTH SCIENCE ITEMS CORRELATED WITH TOTAL INITIAL SCORE

	Midpoint of C. I.	Score on Earth Science Items									
		1.5	3.5	5.5	7.5	9.5	11.5	13.5	15.5	17.5	Total
Total Scores	73										
	68										
	63								2		2
	58							1			1
	53								3	1	4
	48						3	5	3	1	12
	43				1	6	7	6	2		22
	38			2	4	11	15	5			37
	33			4	3	14	8	2			36
	28	1	1	6	19	10	4				41
	23		3	10	3	3					24
	18		9	6	1						16
	13		3	2							5
	8										
	Totals	1	16	30	41	44	37	19	10	2	200

TABLE XXXIV

DISTRIBUTION OF THE INITIAL SCORES OF A 200 PAPER SAMPLE ON THE LIFE SCIENCE ITEMS CORRELATED WITH TOTAL INITIAL SCORE

Midpoint of C. I. (Total Score)	Score on Life Science Items 1.5	3.5	5.5	7.5	9.5	11.5	13.5	15.5	17.5	Total
73										
68										
63								2		2
58								1		1
53						1	2	1		4
48					3	7	2			12
43					4	11	6	1		22
38				7	17	12	1			37
33			2	10	16	7	1			36
28		5	7	12	16	1				41
23		2	10	12						24
18	1	7	4	3	1					16
13	2	3								5
8										
Totals	3	17	23	44	57	39	12	5		200

TABLE XXV

DISTRIBUTION OF THE INITIAL SCORES OF A 200 PAPER SAMPLE ON THE PHYSICAL SCIENCE ITEMS CORRELATED WITH TOTAL INITIAL SCORE

Total Score: Midpoint of C. I.	Score on Physical Science Items: 1	4	7	10	13	16	19	22	25	28	31	34	37	Total
73														
68														
63											1	1		2
58									1					1
53								2	2					4
48							1	8	3					12
43					1	4	11	6						22
38					1	17	17	2						37
33				3	15	14	4							36
28			1	9	24	6	1							41
23			2	17	4	1								24
18		1	8	4	3									16
13		1	4											5
8														
Totals		2	15	33	48	42	34	18	6	0	1	1		200

TABLE XXXVI

DISTRIBUTION OF THE FINAL SCORES OF A 200 PAPER SAMPLE ON THE EARTH SCIENCE ITEMS CORRELATED WITH FINAL TOTAL SCORE

	Midpoint of C. I.	Score on Earth Science Items: 1.5	3.5	5.5	7.5	9.5	11.5	13.5	15.5	17.5	Total
Total Score	73										
	68									2	2
	63								1	3	4
	58						1	3	4	6	14
	53					1	3	10	10		24
	48					1	12	9	5		27
	43				2	7	11	12	1	1	34
	38				7	16	11	1	1		36
	33			2	8	12	6				28
	28		1	6	5	4					16
	23		4	4	1						9
	18		3		1						4
	13		1	1							2
	8										
Totals			9	13	24	41	44	35	22	12	200

TABLE XXXVII

DISTRIBUTION OF THE FINAL SCORES OF A 200 PAPER SAMPLE ON THE LIFE SCIENCE ITEMS CORRELATED WITH FINAL TOTAL SCORE

Total Score: Midpoint of C. I.	Score on Life Science Items: 1.5	3.5	5.5	7.5	9.5	11.5	13.5	15.5	17.5	Total
73										
68								2		2
63							1	2	1	4
58							7	6	1	14
53					2	5	12	5		24
48					2	7	12	6		27
43				3	8	13	9	1		34
38				4	13	15	3	1		36
33		1	2	6	13	5	1			28
28			4	4	6	2				16
23			3	4	1	1				9
18	1		3							4
13	1	1								2
8										
Totals	2	2	12	21	45	48	45	23	2	200

TABLE XXXVIII

DISTRIBUTION OF THE FINAL SCORES OF A 200 PAPER SAMPLE ON THE PHYSICAL SCIENCE ITEMS CORRELATED WITH FINAL TOTAL SCORE

Total Score: Midpoint of C. I.	Score on Physical Science Items: 1	4	7	10	13	16	19	22	25	28	31	34	Total
73													
68												2	2
63										2	1	1	4
58									2	10	2		14
53								3	14	6	1		24
48					1		4	14	7			1	27
43						5	18	10	1				34
38					1	16	16	3					36
33				1	11	14	2						28
28				1	11	3	1						16
23			1	2	4	2							9
18			3		1								4
13		1	1										2
8													
Totals		1	5	4	29	40	41	30	24	18	4	4	200

TABLE XXXIX

DISTRIBUTION OF THE INITIAL SCORES OF 1,520 STUDENTS CORRELATED WITH INTELLIGENCE QUOTIENTS

Initial Test Scores: Midpoints of C. I.	Intelligence Quotients															
	63	68	73	78	83	88	93	98	103	108	113	118	123	128	133	138
73									1							
68											1		1			
63									1	1	2	4				1
58							2			2	4	3		1		2
53							1		2	4	4	8	7	4	6	
48						1	1	6	6	10	17	19	14	8	1	2
43					2	1	12	21	24	37	29	22	16	11		2
38		1	2	2	3	5	22	39	44	46	38	31	20	12	2	1
33	1	1	6	4	11	23	47	39	42	52	29	26	8	2	2	
28		2	5	15	26	39	38	57	42	30	21	8		3	1	
23		4	6	17	18	26	46	32	29	17	5	2	1	1		
18	3	4	5	9	11	16	16	10	12	6						
13	4	3	6	1	3	3	5	2	5	2						
8		1	1	1		1			1							
3			1	1					1							
Totals	8	16	35	50	74	117	194	205	212	207	150	122	67	42	12	8

TABLE XL

DISTRIBUTION OF THE INITIAL SCORES OF 173 NINTH GRADE STUDENTS WITH NO GENERAL SCIENCE IN THE NINTH GRADE CORRELATED WITH INTELLIGENCE QUOTIENTS

Midpoints of C. I.	Intelligence Quotients															
	63	68	73	78	83	88	93	98	103	108	113	118	123	128	133	138
Initial Scores 73																
68																
63																
58								1				1				
53												2	1			1
48						1	1		1	3	5	9			1	1
43						1	1	3	3	3	2	3	2	1		
38					1	2	4	9	8	8	4	3		1		1
33						2	7	5	10	8						
28		1			2	6	9	5		1						
23			1	2	2	5	4	3	2					1		
18			1	1	1	3	3	1								
13			1													
8																
Totals		1	3	3	6	20	29	27	24	23	9	18	3	3	1	3

TABLE XLI

DISTRIBUTION OF THE INITIAL SCORES OF 208 TENTH GRADE BIOLOGY STUDENTS CORRELATED WITH INTELLIGENCE QUOTIENTS

Midpoints of C. I.	Intelligence Quotients															
	63	68	73	78	83	88	93	98	103	108	113	118	123	128	133	138
Initial Scores 73																
68																
63																
58							1		1	1	2				2	
53								1	3	4	2	2	2	2	1	1
48						2		4	4	3	6	2	1	2	2	
43					1	1	2	2	8	9	4	1	1		2	1
38					1	3	5	7	7	10	7	2		2		
33				1		4	8	5	7	5	3	4				
28		1	2	1	4	2	7	3	5	2						
23		2		3		2	2	2								
18						3	1		1							
13					1											
8																
Totals		3	2	5	7	17	26	24	36	34	24	11	4	6	7	2

TABLE XLII

DISTRIBUTION OF THE FINAL SCORES OF 1,520 NINTH GRADE STUDENTS CORRELATED WITH INTELLIGENCE QUOTIENTS

Midpoints of C. I.	Intelligence Quotients 63	68	73	78	83	88	93	98	103	108	113	118	123	128	133	138
Final Scores 73							1		1					1		1
68											2	1	1	1		1
63								1	2	2	10	10	3	5	4	1
58					1		2	6	14	24	15	18	15	8	3	1
53					1	5	7	13	23	32	34	34	12	9	2	
48				2	3	7	27	37	32	39	38	29	19	8	1	1
43		1	1	5	6	17	32	38	49	46	29	14	7	5	2	3
38	1	2	6	4	11	21	46	41	39	31	13	9	4	3		
33	1	2	6	7	24	32	40	39	32	20	7	7	6			
28	1	4	10	17	16	21	20	17	9	9	1			1		
23	1	3	6	10	7	8	17	6	7	4	1	2		1		
18	2	4	1	4	5	5		2	4							
13	2		5	1		1	2	1				1				
8																
Totals	6	16	35	50	74	117	194	206	212	207	150	122	67	42	12	3

TABLE XLIII

DISTRIBUTION OF THE FINAL SCORES OF 173 NINTH GRADE STUDENTS WITH NO GENERAL SCIENCE IN THE NINTH GRADE CORRELATED WITH INTELLIGENCE QUOTIENTS

Midpoints	Intelligence Quotients															
of C. I. (Final Scores)	63	68	73	78	83	88	93	98	103	108	113	118	123	128	133	138
73																
68								1								
63																1
58												2				
53							2	1	1		2	4	1			1
48						1		2	4	8	1	5	2		1	1
43						1	6	3	5	4	2	4		2		
38						4	4	4	6	10	3	2				
33			2		1	5	9	9	5	2		1		1		
28				2	3	3	3	6	2	1	1					
23		1		1	1	4	4	1	1							
18			1		1	1	1									
13						1										
8																
Totals		1	3	3	6	20	29	27	24	25	9	18	3	3	1	3

TABLE XLIX

DISTRIBUTION OF THE FINAL SCORES OF 208 TENTH GRADE BIOLOGY STUDENTS CORRELATED WITH INTELLIGENCE QUOTIENTS

Midpoints of C. I.	Intelligence Quotients 63	68	73	78	83	88	93	98	103	108	113	118	123	128	133	138
Final Scores 73																
68																
63							1		1		2	1			2	
58								2	3	5	4		2	1	2	1
53						2	2	3	3	5	2	5	1	2	1	1
48						1	1	1	6	6	6	4			1	
43				1	1	1	7	3	8	9	5	1		2		
38				2	1	3	7	9	10	7	3		1		1	
33					1	6	5	4	3	2	2			1		
28		2	1	1	2	2	2	2	2							
23			1		1	2	1									
18		1		1	1											
13																
8																
Totals		3	2	5	7	17	26	24	36	34	24	11	4	6	7	2

TABLE L

DISTRIBUTION OF THE DIFFERENCES BETWEEN INDIVIDUAL FINAL AND INITIAL T-SCORES OF 1,520 STUDENTS CORRELATED WITH INTELLIGENCE QUOTIENTS

Midpoints of C. I.	Intelligence Quotients															
Differences between Individual T-Scores	63	68	73	78	83	88	93	98	103	108	113	118	123	128	133	138
21						1			1							
18				1		1		1	6	1				1		
15		1	1	2	1	3	2	6	5	3	5	3	5	1	2	
12	1	1	1	2		3	10	12	16	17	3	7	1	1	1	
9			2	1	4	4	21	13	10	19	11	6	4	1		1
6			3	2	13	11	21	17	26	31	17	13	7	5	1	
3	3	1	6	[illegible]	[illegible]	18	37	35	32	26	19	15	9	5	1	2
0	1	4	7	6	16	32	30	34	30	34	24	19	11	9	3	
-3		5	4	12	17	21	28	28	32	33	29	22	9	6	1	
-6	2	2	4	4	10	10	22	22	27	11	19	22	8	6	2	1
-9			4	6	5	9	15	17	15	17	12	5	5	4	1	1
-12	1	2		2	1	4	3	7	5	7	4	5	4	2		2
-15			2	1	1		2	5		6	3	1				
-18			1	1			2	1		2		1	2			1
-21			1					1	1			1	2	1		
-24				1			1	1	1			2				
Totals	8	16	35	50	74	117	194	203	212	207	150	122	67	42	12	8

TABLE LI

DISTRIBUTION OF DIFFERENCES BETWEEN INDIVIDUAL FINAL AND INITIAL T-SCORES OF 173 STUDENTS CORRELATED WITH INTELLIGENCE QUOTIENTS

Differences between Individual T-Scores — Midpoints of C. I.	Intelligence Quotients 63	68	73	78	83	88	93	98	103	108	113	118	123	128	133	138
21							1							1		
18						1										
15			1						1							
12			1				1	1	1							
9							1	1	2	2		1				
6			1		4	4	3	3		5						1
3				2		4	7	5	8	3	1					1
0		1				4	9	4	2	2	1	4	2		1	1
-3				1		5	4	6	4	6	3	7	1	1		
-6					1	1	1	3	3	1	3	4		1		
-9							2	2	3	3	1	1				
-12					1			2				1				
-15										1						
-18																
-21																
-23						1										
Totals		1	3	3	6	20	29	27	24	23	9	18	3	3	1	3

TABLE XLVII

DISTRIBUTION OF THE DIFFERENCES BETWEEN INDIVIDUAL FINAL AND INITIAL T-SCORES OF 208 BIOLOGY STUDENTS CORRELATED WITH INTELLIGENCE QUOTIENTS

Midpoints of C. I.	Intelligence Quotients															
Differences between Individual T-Scores	63	68	73	78	83	88	93	98	103	108	113	118	123	128	133	138
21							1					1				
18								1								
15										1		2				
12				1		1	1	1		2						
9				1		2	4	2	5	1	1	2				1
6						1	3	2	3	2	1	1	1		2	
3		2			1	1	2	4	6	4	4	1	1		1	
0			1	1	2	3	6	2	9	10	1	1	1	3	1	
-3				1	2	6	6	5	5	7	6			1	1	
-6						1	2	2	7	5	3	3			2	1
-9			1	1	2	1		1	3	2	4		1	1		
-12		1				1	1	1	1	2						
-15								2						1		
Totals		3	2	5	7	17	26	23	39	36	20	11	4	6	7	2

TABLE XLVIII

DISTRIBUTION OF THE INITIAL SCORES OF 1,973 NINTH GRADE STUDENTS ARRANGED ACCORDING TO SEX

	Midpoint of C. I.	Boys	Girls	Total
	73	1		1
	68	1	1	2
	63	4	0	4
	58	17	6	23
	53	45	14	57
	48	66	47	113
	43	128	103	231
	38	186	156	342
	33	184	201	385
	28	169	205	374
	23	100	166	266
	18	50	81	131
	13	17	19	36
	8	3	2	5
	3		3	3
Totals		969	1,004	1,973

TABLE XLIX

DISTRIBUTION OF THE FINAL SCORES OF 1,973 NINTH GRADE STUDENTS ARRANGED ACCORDING TO SEX

	Midpoint of C. I.	Boys	Girls	Total
	73	5		5
	68	11	2	13
	63	34	13	47
	58	94	42	136
	53	126	105	231
	48	150	152	302
	43	163	168	331
	38	139	180	319
	33	126	153	284
	28	59	104	163
	23	36	58	94
	18	18	16	34
	13	3	6	14
	8			
Totals		969	1,004	1,973

TABLE L

DISTRIBUTION OF THE DIFFERENCES BETWEEN INDIVIDUAL FINAL AND INITIAL T-SCORES ARRANGED ACCORDING TO SEX

	Midpoint of C. I.	Boys	Girls
	21	3	1
	18	10	5
	15	22	23
	12	31	54
	9	71	64
	6	110	117
	3	138	157
	0	153	197
	-3	163	154
	-6	122	107
	-9	78	64
	-12	34	37
	-15	16	14
	-18	8	4
	-21	3	2
	-24	4	3
	-27	3	1
Totals		969	1,004

TABLE LI

DISTRIBUTION OF THE INITIAL SCORES OF 1,973 STUDENTS ARRANGED ACCORDING TO BOY AND GIRL SCOUT EXPERIENCE

Midpoint of C. I.	Boy Scout	Boy non-Scout	Girl Scout	Girl non-Scout	Scouts	Non-Scouts
73		1				1
68	1	0	1		2	0
63	2	2	0		2	2
58	13	4	4	2	17	6
53	21	22	7	7	28	29
48	31	35	23	24	54	59
43	55	73	41	62	96	135
38	83	103	76	80	159	193
33	54	130	83	118	137	248
28	49	120	73	132	122	252
23	32	68	63	103	95	171
18	17	33	20	61	37	94
13	6	11	7	12	13	23
8	2	1	0	2	2	3
3			1	2	1	2
Totals	366	603	399	605	765	1,208

TABLE LII

DISTRIBUTION OF THE SCORES (FINAL) OF 1,973 STUDENTS ARRANGED ACCORDING TO BOY AND GIRL SCOUT EXPERIENCE

Midpoint of C. I.	Boy Scout	Boy non-Scout	Girl Scout	Girl non-Scout	Scouts	Non-Scouts
73	2	3			2	3
68	7	4	2		9	4
63	17	17	11	2	28	19
58	40	54	21	21	61	75
53	36	90	36	69	72	159
48	65	85	73	79	138	164
43	61	102	66	102	163	204
38	53	86	66	114	119	200
33	45	81	53	105	98	186
28	19	40	43	61	62	101
23	13	23	20	38	33	61
18	4	14	6	10	10	24
13	4	4	2	4	6	8
8						
Totals	366	603	399	605	765	1,208

TABLE LIII

DISTRIBUTION OF THE INITIAL AND FINAL SCORES OF 1,973 STUDENTS ARRANGED ACCORDING TO 4H CLUB EXPERIENCE

Midpoint of C. I.	Initial		Final	
	4H Club	Non-4H Club	4H Club	Non-4H Club
73		1	1	4
68		2	4	9
63	2	2	10	37
58	5	18	29	107
53	11	46	56	175
48	20	93	67	235
43	43	183	74	257
38	69	273	65	254
33	77	308	23	261
28	71	303	26	137
23	43	223	14	80
18	21	120	3	31
13	7	29	3	11
8	1	4		
3		3		
Totals	375	1,598	375	1,598

TABLE LIV

DISTRIBUTION OF THE INITIAL SCORES OF 1,973 STUDENTS ARRANGED ACCORDING TO RURAL, VILLAGE, CITY, OR MIXED HOME BACKGROUNDS

Midpoint of C. I.	Rural	Village	City	Mixed
73			1	
68	1		1	
63	1		2	1
58	1	1	17	4
53	8	8	33	8
48	21	15	61	16
43	36	34	126	35
38	50	47	206	39
33	69	29	213	74
28	60	35	218	61
23	54	29	141	42
18	21	13	82	10
13	10	4	19	3
8	2	0	3	
3	1	1	1	
Totals	335	221	1,124	293

TABLE LV

DISTRIBUTION OF THE FINAL SCORES OF 1,973 STUDENTS ARRANGED ACCORDING TO RURAL, VILLAGE, CITY OR MIXED HOME BACKGROUNDS

Midpoint of C. I.	Rural	Village	City	Mixed
73	1		3	1
68	2		10	1
63	7	4	23	8
58	26	18	72	20
53	56	29	109	37
48	44	35	169	54
43	66	46	176	43
38	55	37	184	43
33	40	23	173	43
28	23	16	101	23
23	9	9	63	13
18	5	3	20	6
13	1	1	11	1
8				
Totals	335	221	1,124	293

TABLE LVI

DISTRIBUTION OF THE INITIAL AND FINAL SCORES OF 223 STUDENTS REPORTED AS COMING FROM THE "BEST" HOMES AND 140 STUDENTS REPORTED AS COMING FROM THE "POOREST" HOMES

Midpoint of C. I.	Initial "Best"	Initial "Poorest"	Final "Best"	Final "Poorest"
73			3	
68			[illegible]	
63	1		14	2
58	10		29	4
53	17	3	40	11
48	27	5	42	18
43	41	6	41	19
38	47	20	29	26
33	40	25	14	30
28	31	33	5	18
23	7	34	0	7
18	6	10	1	3
13	1	4	1	2
Totals	228	140	223	140

TABLE LVII

DISTRIBUTION OF THE INITIAL AND FINAL SCORE OF 254 STUDENTS WHO REPORTED "MUCH" INTEREST IN READING SCIENCE BOOKS AND 503 STUDENTS WHO REPORTED "LITTLE" INTEREST

	Midpoint of C. I.	Initial		Final	
		"Much" Interest	"Little" Interest	"Much" Interest	"Little" Interest
Read Test Scores	73	1		3	1
	68	1		8	3
	63	2	2	10	10
	58	13	1	30	18
	53	15	5	42	43
	48	32	19	44	36
	43	36	49	38	35
	38	45	84	34	31
	33	44	103	24	89
	28	35	104	11	43
	23	21	85	7	32
	18	8	39	2	8
	13	1	10	1	4
	8		1		
	3		1		
Totals		254	503	254	503

TABLE LVIII

DISTRIBUTION OF THE INITIAL SCORES OF 1,973 STUDENTS ARRANGED ACCORDING TO THE TOTAL NUMBER OF SCIENCE CLASSES REPORTED THROUGH THE SIXTH, SEVENTH, AND EIGHTH GRADES

Initial Score: Midpoint of C. I.	Number of Classes Reported: 0-1	2-3	4-5	6-7	8-9	10-11	12-13	14-15	No Reply
73									1
68							1	1	
63	1	1			1			1	
58	1	2		4	4	1	2	8	1
53	1	2	3	7	3	12	7	15	2
48	10	5	15	14	13	17	8	30	1
43	22	11	27	25	20	27	26	66	7
38	52	23	34	42	36	43	26	73	8
33	65	24	44	35	43	37	38	35	9
28	63	2[illegible]	32	27	31	46	42	91	14
23	58	26	23	21	1[illegible]	21	21	56	21
18	27	14	1[illegible]	10	13	12	5	23	7
13	9	[illegible]	5	3	1	3	2	1	7
8	1	1						2	1
3	1			1					1
Totals	311	147	203	139	1[illegible]	21[illegible]	17[illegible]	457	80

TABLE LVIX

DISTRIBUTION OF THE FINAL SCORES OF 1,973 STUDENTS ARRANGED ACCORDING TO THE TOTAL NUMBER OF SCIENCE CLASSES REPORTED THROUGH THE SIXTH, SEVENTH, AND EIGHTH GRADES

	Midpoint of C. I.	Number of Classes Reported 0-1	2-3	4-5	6-7	8-9	10-11	12-13	14-15	No Reply
Final Score	73		1				1		2	1
	68	1	1	1	3	3	0	3	1	0
	63	2	2	5	7	5	6	5	13	2
	58	16	11	16	17	10	14	15	32	5
	53	29	14	27	19	24	23	24	59	7
	48	41	19	23	32	32	44	33	66	7
	43	51	24	30	36	36	34	31	30	9
	38	53	22	27	30	31	41	29	19	7
	33	57	13	34	22	24	27	23	60	19
	28	36	19	24	13	9	12	9	36	5
	23	13	9	10	5	10	3	4	23	12
	18	7	6	1	4	5	2	1	4	4
	13	5	1		1		2	1	2	2
	Totals	311	147	203	189	189	219	178	457	80

TABLE LX

DISTRIBUTION OF THE INITIAL SCORES OF A 200 PAPER SAMPLE CORRELATED WITH THE "CORRECTED" NUMBER OF PRIOR SCIENCE CLASSES

Midpoint of C. I. (Initial Score)	Number of Classes Reported: 1	4	7	10	13	16	19	22	25	28	31	33
73												
68												
63	1							1				
58											1	
53				1	1	1		1				
48	1	1			2	2			3	3		
43	3	1		2	3	4	1		1	2	5	
38	8	3	1	2		6	2	3	2		8	
33	5	2	1		2	6	4	3	2	3	7	
28	7	3	1	2	1	3	2	3	4	4	7	
23	6	3	1	2		1		2	3	1	3	
18	3	2	2		3	2	1			1	1	
13	1				1	2						
Totals*	35	15	6	9	13	27	10	13	15	14	32	

(*Eleven students did not provide usable answers.)

TABLE LXI

DISTRIBUTION OF THE DIFFERENCES BETWEEN INDIVIDUAL FINAL AND INITIAL T-SCORES CORRELATED WITH THE REPORTED NUMBER OF PRIOR SCIENCE CLASSES

Midpoint of C. I. (Difference between Final and Initial T-Score)	Number of Prior Science Classes							
	0.5	2.5	4.5	6.5	8.5	10.5	12;5	14.5
21	2		1	1				
18	6	1	1	3		1		3
15	6	5	6	5	5	4	3	7
12	15	7	6	10	6	7	12	21
9	24	15	16	11	15	16	14	19
6	43	19	23	20	25	27	23	37
3	47	17	26	30	24	34	29	69
0	41	21	43	34	29	43	22	102
-3	54	28	23	26	34	31	25	75
-6	39	13	23	21	25	24	20	60
-9	16	11	15	14	14	15	18	37
-12	7	7	8	7	5	8	9	13
-15	4	1	4	4	3	1	3	10
-18	2	0	2	1	1	1		4
-21	1	1	1	0	1	1		
-24	2	0		1	2	1		
-27	2	1		1				
Totals	311	147	203	189	189	219	173	457

TABLE LXII

DISTRIBUTION OF THE INTELLIGENCE QUOTIENTS OF 1,520 STUDENTS CORRELATED WITH THE TOTAL NUMBER OF SCIENCE CLASSES REPORTED THROUGH THE SIXTH, SEVENTH, AND EIGHTH GRADES

	Midpoint of C. I.	Number of Prior Science Classes							
		0.5	2.5	4.5	6.5	8.5	10.5	12.5	14.5
Intelligence Quotient	138	3		1		1			3
	133	0	2	1	3	1	1		4
	128	6	0	7	7	3	6	4	8
	123	11	4	12	10	6	3	8	17
	118	22	11	13	12	9	18	7	22
	113	31	5	13	12	15	14	20	31
	108	32	10	26	18	28	29	21	37
	103	34	9	22	25	23	27	20	38
	98	26	13	30	23	16	24	19	46
	93	24	9	13	19	17	27	21	50
	88	26	7	12	11	12	14	11	22
	83	8	4	10	10	7	6	4	15
	78	11	3	6	4	6	5	4	9
	73	7	3	5	5	1	3	1	4
	68	5	3	1		1	1	1	1
	63	2	1	2			1	1	1
	Totals	243	84	174	159	146	179	142	308

[illegible]

DIRECTIONS: [illegible]

Do not open this booklet until you are told to do so.

[illegible] is a test of your knowledge of general science. For each question there are five possible answers. [illegible] decide which answer is the best one. [illegible] that your answer is correct, but you should avoid wild guessing. [illegible] question.

[illegible] the sample questions below and notice how the answers are marked on the separate answer sheet.

(The Read General Science Test)

Form A

Sample A. The correct name for fluffy summer clouds is —

1. cirrus.
2. stratus.
3. nimbus.
4. cumulus.
5. thunder.

[illegible] Sample A the correct answer, of course, is "cumulus," which is answer 4. [illegible] your answer [illegible] At the top of the page in the left-hand column is a box [illegible] In the five answer spaces [illegible] Sample A, a heavy mark has been made filling the space [illegible] marked 4.

Sample B. The man known as the "wizard of the plant kingdom" was —

6. Joseph Lister.
7. Louis Pasteur.
8. Luther Burbank.
9. Thomas Edison.
10. none of the above.

[illegible] correct answer for Sample B is "Luther Burbank," which is answer 8, so you would answer Sample B by [illegible] a heavy black mark that fills the space under the number 8 [illegible] If the correct answer had [illegible] given, you would have chosen answer 10, "none of the above."

[illegible] each question carefully and decide which [illegible] your choice [illegible] then, on the separate answer sheet, make a heavy black mark in the space [illegible] In marking [illegible] answers, always be sure that the question number [illegible] number [illegible] answer sheet. Erase completely any answer [illegible] marks [illegible] kind on your answer sheet or on your test booklet. [illegible] to the next page. [illegible] finish the entire test before the time is up [illegible] rapidly and as [illegible] as you can.

[illegible] you are told to do so, open your booklet [illegible]

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COÖRDINATOR FOR SCIENCE TESTS: VICTOR H. NOLL, MICHIGAN STATE COLLEGE

AD GENERAL SCIENCE TEST

HN G. READ
F EDUCATION, BOSTON UNIVERSITY

FORM **A**

TIONS:

Do not open this booklet until you are told to do so.

is a test of your knowledge of general science. For each question there are five possible answers. You ecide which answer is the best one. You may answer a question even when you are not perfectly .t your answer is correct, but you should avoid wild guessing. Do not spend too much time on any stion.

y the sample questions below, and notice how the answers are marked on the separate answer sheet.

Sample A. The correct name for fluffy summer clouds is —

1. cirrus.
2. stratus.
3. nimbus.
4. cumulus.
5. thunder.

Sample A the correct answer, of course, is "cumulus," which is answer **4**. Now look at your answer At the top of the page in the left-hand column is a box marked SAMPLES. In the five answer spaces mple A, a heavy mark has been made filling the space (the pair of dotted lines) marked **4**.

Sample B. The man known as the "wizard of the plant kingdom" was —

6. Joseph Lister.
7. Louis Pasteur.
8. Luther Burbank.
9. Thomas Edison.
10. none of the above.

correct answer for Sample B is "Luther Burbank," which is answer **8**; so you would answer Sample B by a heavy black mark that fills the space under the number **8**. Do this now. If the correct answer had n given, you would have chosen answer **10**, "none of the above."

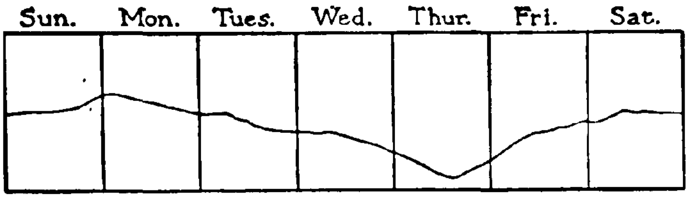
d each question carefully and decide which one of the answers is best. Notice what number your choice en, on the separate answer sheet, make a heavy black mark in the space under that number. In marking swers, always be sure that the question number in the test booklet is the same as the question number nswer sheet. Erase completely any answer you wish to change, and be careful not to make stray marks kind on your answer sheet or on your test booklet. When you finish a page, go on to the next page. inish the entire test before the time is up, go back and check your answers. Work as rapidly and as ely as you can.

en you are told to do so, open your booklet to page 2 and begin.

Published by World Book Company, Yonkers-on-Hudson, New York, and Chicago, Illinois

ich one of the following causes the wind to blow?

1. differences in air pressure
2. moving tree branches
3. attraction of the moon
4. the presence of water vapor in the air
5. dust in the air



what day, according to the above graph of barometric essure, did a very bad storm occur?

6. Monday
7. Tuesday
8. Wednesday
9. Thursday
10. Friday

three dishes of vanilla ice cream and one of chocolate ice eam are set on a table out-of-doors, the chocolate ice cream ll melt the fastest because —

1. it is always softer when it is in the package.
2. it reflects the heat better.
3. it absorbs heat because it is colder.
4. it radiates heat because it is thicker.
5. it absorbs more heat because it is dark in color.

ods are heated when canned to —

6. kill the bacteria.
7. keep the color of the food.
8. remove the moisture.
9. improve the quality.
10. increase the air pressure.

hich one of the following statements is FALSE?

1. It is better never to drink when driving.
2. It is practically certain that alcohol will slow down your reaction time.
3. Alcohol is considered to be a poor food.
4. Everyone can take one drink without having it affect him.
5. Alcohol is often habit-forming, and its users find it difficult to stop drinking.

asteur is known for his work with —

6. electricity.
7. bacteria.
8. molds.
9. radium.
10. X rays.

ne danger with most fuels is that when they are burned ey may produce —

1. carbon tetrachloride.
2. carbon monoxide.
3. nitrogen monoxide.
4. hydrogen.

8. Charges of electricity which move along a copper wire and which make up an electric current are called —
   6. protons.
   7. positrons.
   8. neutrons.
   9. electrons.
   10. deuterons.

9. Which word does NOT describe a form of energy?
   1. crystalline
   2. electrical
   3. atomic
   4. mechanical
   5. radiant

10. There is night and day because the —
    6. earth revolves around the sun.
    7. moon revolves around the sun.
    8. earth rotates on its axis.
    9. sun revolves around the earth.
    10. moon rotates on its axis.

11. Most erosion in the upper Mississippi Valley was caused by the —
    1. mining of iron.
    2. mining of coal.
    3. cutting of timber.
    4. building of dams.
    5. building of hydroelectric plants.

12. Which one of the following is NOT a color obtained when white light passes through a prism?
    6. red
    7. yellow
    8. brown
    9. green
    10. indigo

13. If an extremely long-needled variety of pine tree produced some cones whose seeds grew into short-needled trees, it indicated that —
    1. the parent pine tree was getting old.
    2. there was not enough rain that year.
    3. pollen from a hemlock tree reached the long-needled tree.
    4. pollen from a short-needled pine fertilized the long-needled tree.
    5. the seeds of the pine were damaged by squirrels.

14. Most of the northern part of the United States is covered with sand and gravel deposited by —
    6. tidal waves.
    7. sandstorms.
    8. hurricanes.
    9. meteor showers.
    10. glaciers.

15. In an automobile, oil is used in the —
    1. radiator.
    2. crankcase.
    3. vacuum tank.
    4. gasoline filter.

Which one of the following is most necessary for proper growth of the bones?

6. calcium
7. iron
8. fluorine
9. iodine
10. carbon

It is possible to contract tuberculosis ONLY if one —

1. loses weight.
2. comes in contact with the tuberculosis bacillus.
3. gets overtired.
4. does not get enough fresh air at night.
5. is bitten by a certain kind of mosquito.

. Sound vibrations from the human voice are changed to electrical energy in the —

6. telegraph.
7. teletype.
8. telautograph.
9. teleportation.
10. telephone.

. Which one of the following statements about air on a mountain top is true?

1. It has color.
2. It has odor.
3. It has weight.
4. It is visible.
5. It has taste.

). At present most gasoline comes from —

6. petroleum.
7. kerosene.
8. natural gas.
9. plant oils.
10. coal.

1. On a sunny spring morning, spider webs in the grass were covered with tiny drops of dew. Where had the dew come from?

1. the air
2. the grass
3. the spiders
4. the morning sunlight
5. melted frost

2. Which one of the following is replaceable as it is NOT a natural resource of the country?

6. nickel
7. plastics
8. tungsten
9. petroleum
10. copper

3. Two explorers measured the height of the same mountain in Alaska — one in 1898, the other in 1940. Their results were different by over 500 feet. Which one of the following best explains this discrepancy?

1. The 1898 figure was obtained in the summer.
2. The 1940 figure was obtained in the winter.
3. The 1898 figure was obtained by climbing the mountain.
4. The 1940 survey was by airplane, using photographic mapping.
5. None of the above gives a completely satisfactory

24. Which pair of terms is correctly matched?

6. Sun — satellite
7. Neptune — planet
8. Meteor — star
9. Moon — asteroid
10. Comet — sunspot

25. A green vegetable like lettuce is valuable in the diet because it supplies —

1. carbohydrates.
2. fats.
3. proteins.
4. vitamins.
5. all of the above.

26. Which one of the following causes the handle of an aluminum saucepan on a gas stove to become very hot, although the handle is not over the flame?

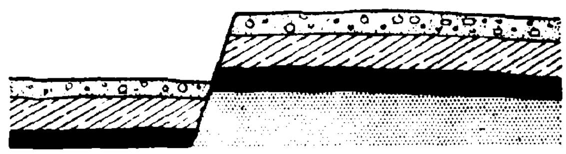
6. convection
7. evaporation
8. radiation
9. insulation
10. conduction

27. In poems and legends, ships which have sunk are said to

"Float forever and forever
Halfway between the ocean floor
And stormy waves above."

These ships are thought to reach a point where the water is so dense that they will not sink. Why is this FALSE?

1. Wooden ships would be broken up by the water.
2. Metal plates on ships would bend under the great pressure.
3. Water can be compressed very little. Therefore, its density cannot be increased very much.
4. Ships with cargoes which will float cannot be sunk.
5. Salt water is much more dense than fresh water.



28. The geological formation above constitutes evidence of —

6. volcanic action.
7. erosion.
8. folding.
9. sedimentation in a running stream.
10. movement in the earth's crust.

29. The distinctive shape of "Green Mountain" potatoes is due primarily to the —

1. amount of cultivation they receive.
2. amount of rainfall.
3. hereditary character of the seed potatoes.
4. amount of fertilizer applied.
5. ... during the growing season.

30. Which one of the following does NOT refract light?
6. eyeglasses
7. microscope
8. Galilean telescope
9. mirror
10. reading or magnifying glasses

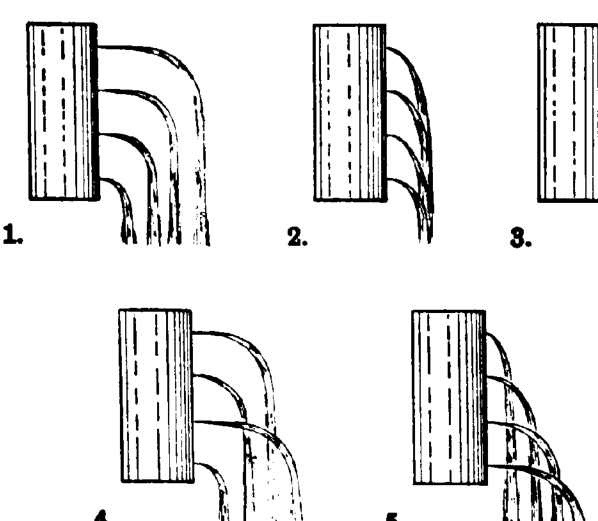
31. Which one of the following does NOT usually carry bacteria which are harmful to man?
1. ticks
2. flies
3. mosquitoes
4. fleas
5. bees

32. It had been a clear, cold November day with the temperature at 25° F. That night at the railroad yards a leaky steam pipe sent a white cloud of steam into the air all night. The temperature remained at 25° F. In the morning what would probably be on the ground near the leaky steam pipe?
6. dew
7. sleet
8. frost
9. hail
10. steam

33. Many low, rounded banks of sand, boulders, and pebbles were probably formed by —
1. glaciers.
2. meteor showers.
3. tidal waves.
4. sandstorms.
5. hurricanes.

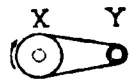
34. A comic-book science story showed a man building a big balloon out of very thin sheets of aluminum cemented together so as to be airtight. He pumped the air out of the balloon, and the balloon then floated. At present this would be impossible because —
6. aluminum cannot be made airtight.
7. it would take too much cement.
8. the outside air pressure would crush the balloon.
9. the balloon would not hold hydrogen.
10. aluminum is too heavy.

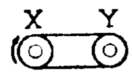
35. Which one of the following diagrams shows best what will happen if 4 holes of the same diameter are punched at the same time in a tall tin can full of water?

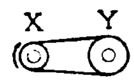


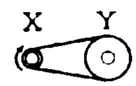
36. Which one of the following is an example of a chemical change?
6. melting wax
7. breaking glass
8. burning wood
9. crushing stone
10. freezing water

37. If pulley X is turning at 178 revolutions per minute, the arrangement of pulleys that will give pulley Y the lowest speed of rotation is —

1. 

2. 

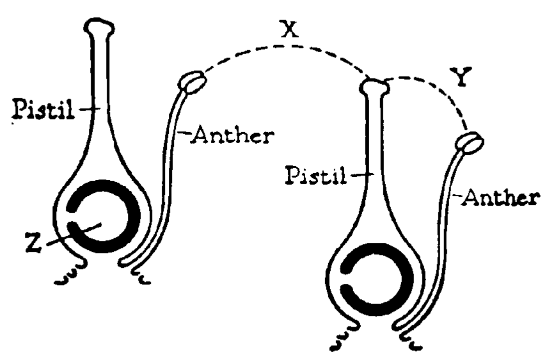
3. 

4. 

5. none of the above

38. About every seven years everyone should be vaccinated against —
6. typhoid fever.
7. diphtheria.
8. smallpox.
9. influenza.
10. colds.

39. After the explosion of the gasoline occurs in a cylinder of an automobile engine, the next action in that cylinder is —
1. intake.
2. exhaust.
3. compression.
4. carburetion.
5. suction.



40. The process shown above at Y is called —
6. self-pollination.
7. cross-fertilization.
8. mutation.
9. cell division.
10. budding.

41. A dynamo causes electricity to flow by —
1. chemical action.
2. moving a coil of wire across a magnetic field.
3. moving a coil of wire in a storage battery.
4. moving static electrical charges to an insulator.

Which pair of terms is correctly matched?

6. speed of light — 93,000,000
7. rotation of the earth — 186,000
8. revolution of the earth — 365¼
9. distance from earth to sun — 240,000
10. none of the above

Tracks of dinosaurs left on the muddy banks of streams are found now as fossils. About how many years ago were they made?

1. 1 thousand
2. 10 thousand
3. 50 thousand
4. 100 thousand
5. 1 million

Why does heat make iron easier to shape?

6. Heat often causes the iron to become red.
7. Heat increases the motion of molecules.
8. Heat causes the iron molecules to expand.
9. Heat decreases the elasticity of the iron.
10. Heat increases the density of the iron.

Musical sounds result ONLY from what kind of vibrations?

1. amplified
2. supersonic
3. regular
4. slow
5. fast

Astrologers use the position of the stars and the planets at the hour, day, and minute of a person's birth to predict his future. Which one of the following statements regarding this practice is true?

6. The modern astrologer can now predict one's future more accurately because there are better telescopes in use.
7. Some astrologers inherit the ability to understand the stars from their mothers or their fathers.
8. Study and long years of training in astrology make an astrologer's predictions of one's future more accurate.
9. Very good astrologers are worth the high fees which they charge.
10. Scientific evidence has not shown that astrologers can predict the future of an individual on the basis of what they know about the stars.

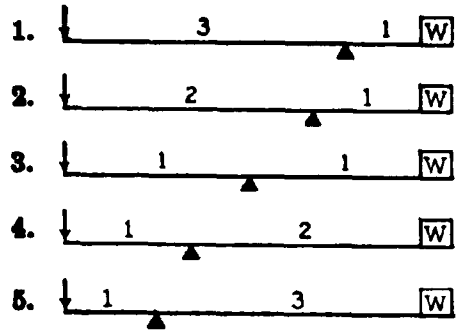
Which one is NOT a lever?

1. pencil sharpener
2. seesaw
3. derrick
4. fishing rod
5. scissors

Which one of the following statements is true and applies both to magnets and to static electricity?

6. Copper particles are attracted.
7. Like charges or poles repel.
8. Paper is attracted.

49. If a 500-pound weight is placed at the arrow, which lever will lift the 60-pound weight W the highest?



50. Which pair of terms is correctly matched?

6. Ursa Major — Big Dipper
7. Ursa Minor — Little Dog
8. Cassiopeia — Dipper
9. Polaris — The W
10. Orion — Milky Way

51. A warm cyclonic storm moves across the country from west to east in July. Winds blow strongly toward its center and rain falls near the edge of the whirling mass of air. In the diagram above the place where the temperature is most likely to be the lowest is at point —

1. 1
2. 2
3. 3
4. 4
5. 5

52. A pulley arrangement which gives NO mechanical advantage is the —

6. single movable.
7. single fixed.
8. double movable, single fixed.
9. double fixed, single movable.
10. double movable, double fixed.

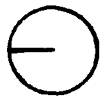
53. What part of the blood is effective in destroying invading bacteria?

1. plasma
2. red corpuscles
3. toxin
4. white corpuscles
5. lymph

54. The chemical name of the gas which is produced when coal is burned with plenty of oxygen is —

6. carbon tetrachloride.
7. nitrogen.
8. hydrogen.
9. carbon dioxide.

5. Penicillin is obtained from —
   1. molds.
   2. bacteria.
   3. vaccines.
   4. laboratory animals.
   5. serums.



6. The circle above represents the age of the earth, and the shaded part represents the time that civilization may have existed. About how many years are represented by the shaded portion?
   6. 50 thousand
   7. 750 thousand
   8. 30 million
   9. 100 million
   10. 1 billion

57. A large soap bubble will rise in the air if it is filled with —
   1. carbon dioxide.
   2. air.
   3. nitrogen.
   4. oxygen.
   5. hydrogen.

58. In an experiment, an iron ball at a temperature of 200° F. was placed in a pan and covered with water whose temperature was 72° F. The room temperature was 70° F. After 10 minutes the temperature of both ball and water was measured and found to be about —
   6. 72° F.
   7. 150° F.
   8. 200° F.
   9. 201° F.
   10. 272° F.

59. A vital factor in producing a new variety of tomatoes is —
   1. selection of the best seed.
   2. self-pollination.
   3. good soil.
   4. plenty of moisture.
   5. cross-pollination.

60. Which one of the following has probably had the LEAST over-all effect in the breaking down of rocks into soil?
   6. running water
   7. wind, carrying sand
   8. tides
   9. explosives used by man
   10. chemical changes

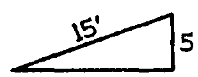
61. Which pair of terms is correctly matched?
   1. longer string — higher pitch
   2. heavier string — higher pitch
   3. slower vibration — lower pitch
   4. faster vibration — lower pitch

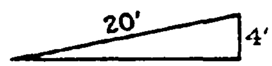
62. The oxygen in the air is necessary for all EXCEPT which one of the following?
   6. decay of wood
   7. burning
   8. respiration
   9. rusting
   10. photosynthesis

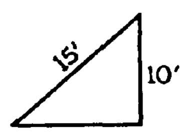
63. In January a warm cloud from which rain fell moved from the south northward. When it reached Vermont, the rain changed to snow. What probably caused the change?
   1. The lakes were frozen.
   2. Not enough moisture was left in the cloud for it to rain.
   3. The temperature of the air around the cloud was 36° F.
   4. The air temperature at the cloud level was 25° F.
   5. The direction of the wind changed.

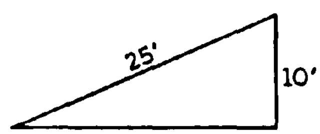
64. Radar depends for its operation on an electronic tube which sends out pulses of energy, and on a device called the —
   6. spectroscope.
   7. oscilloscope.
   8. telescope.
   9. camera.
   10. projector.

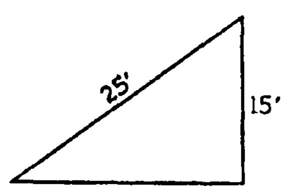
65. A 125-pound box on rollers is pushed up an inclined plane. Which inclined plane will require the greatest force to move the box?

1. 

2. 

3. 

4. 

5. 

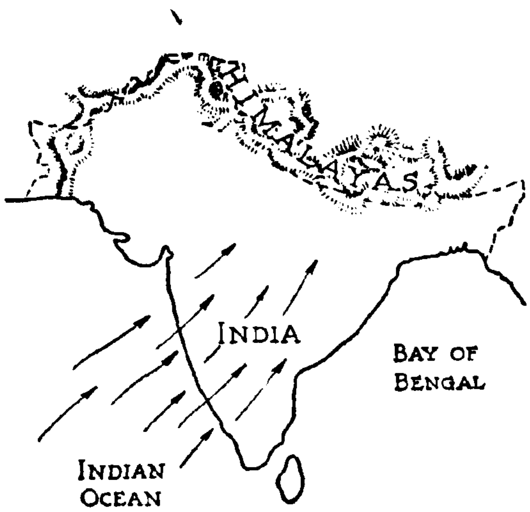
66. An acid used in the home is —
   6. soap powder.
   7. bicarbonate of soda.
   8. onion juice.
   9. vinegar.

each one of the following was expressed by a number, ich one would be the largest?

1. speed of light in miles per second
2. distance from the earth to the sun in miles
3. distance from the earth to the moon in miles
4. number of days necessary for one revolution of the earth
5. number of miles in a light-year

sailboat going from a point 100 miles up the Mississippi iver to the ocean without stopping would —

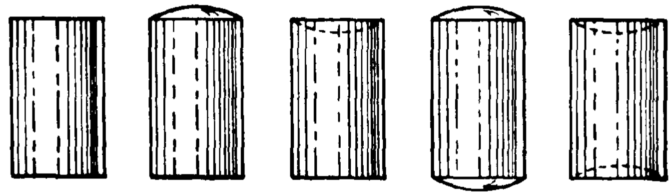
6. float higher in the ocean.
7. float lower in the ocean.
8. weigh less in the river.
9. weigh less in the ocean.
10. be buoyed up less by the ocean.



About May 20, a southwest wind called the "wet monsoon" begins to blow over most of India from the tropical Indian Ocean toward the Himalayas. Tremendous thunderstorms occur, and then the rainy season continues for two or three months. The best reason why it rains so long over most of India is that the —

1. cool air from the mountains is saturated with moisture.
2. warm air from the ocean is cooled over the land.
3. warm dry air bumps into cool mountain peaks.
4. cool air from the ocean carries more water.
5. cool air from the mountains has picked up snow from the peaks of the Himalayas.

70. If a large empty tomato-juice can is completely sealed and then placed in a glass container from which most of the air is pumped, the can then will most resemble diagram —



6. 7. 8. 9. 10.

71. Which one of the following is a compound?
    1. sugar
    2. iron
    3. hydrogen
    4. sulfur
    5. mercury

72. The resistance of conductors of electric current is measured in —
    6. volts.
    7. watts.
    8. amperes.
    9. ohms.
    10. coulombs.

73. Which one of the following is NOT a legume?
    1. string beans
    2. soybeans
    3. corn
    4. clover
    5. alfalfa

74. If a friend says, "Oh, nobody in my family ever had diphtheria, so I won't ever have it," you might properly make all EXCEPT which one of the following statements?
    6. "We can ask the school doctor about diphtheria."
    7. "Let's look it up in a health book."
    8. "I had the diphtheria toxoid and now I probably won't have diphtheria."
    9. "Maybe you are right."
    10. "I don't believe that immunity from diphtheria is hereditary."

75. If a completely new kind of melon appeared in a melon patch, and this new type of melon reproduced the same kind of melons from its seeds, the cause of this new type of melon probably was —
    1. injury to the melon blossom.
    2. mutation.
    3. an extra amount of fertilizer.
    4. self-pollination.
    5. cell division.

Go back and check your answers.

READ GENERAL SCIENCE TEST

By JOHN G. READ
SCHOOL OF EDUCATION, BOSTON UNIVERSITY

DIRECTIONS:

Do not open this booklet until you are told to do so.

This is a test of your knowledge of general science. For each question there are five possible answers. You are to decide which answer is the best one. You may answer a question even when you are not perfectly sure that your answer is correct, but you should avoid wild guessing. Do not spend too much time on any one question.

(The Read General Science Test)

Study the sample questions below, and notice how the answers are marked on the separate answer sheet.

Form B

Sample A. The correct name for [illegible] clouds is —

1. cirrus.
2. stratus.
3. nimbus.
4. cumulus.
5. thunder.

For Sample A the correct answer, of course, is "cumulus," which is answer 4. Now look at your answer sheet. At the top of the page in the left-hand column is a box marked SAMPLES. In the five answer spaces after Sample A, a heavy mark has been made filling the space (the pair of dotted lines) marked 4.

Sample B. The man known as the "wizard of the plant kingdom" was —

6. Joseph Lister.
7. Louis Pasteur.
8. Luther Burbank.
9. Thomas Edison.
10. none of the above.

The correct answer for Sample B is "Luther Burbank," which is answer 8; so you would answer Sample B by making a heavy black mark that fills the space under the number 8. Do this now. If the correct answer had not been given, you would have chosen answer 10, "none of the above."

Read each question carefully and decide which one of the answers is best. Notice what number your choice is. Then, on the separate answer sheet, make a heavy black mark in the space under that number. In marking your answers, always be sure that the question number in the test booklet is the same as the question number on the answer sheet. [illegible] answer you wish to change, and be careful not to make stray marks of any kind on your answer sheet or on your test booklet. When you finish a page, go on to the next page. If you finish the entire test before the time is up, go back and check your answers. Work as rapidly and as accurately as you can.

When you are told to do so, open this booklet to page 2 and begin.

[illegible]

EVALUATION AND ADJUSTMENT SERIES

GENERAL EDITOR: WALTER N. DUROST, SCHOOL OF EDUCATION, BOSTON UNIVERSITY
COÖRDINATOR FOR SCIENCE TESTS: VICTOR H. NOLL, MICHIGAN STATE COLLEGE

READ GENERAL SCIENCE TEST

BY JOHN G. READ
SCHOOL OF EDUCATION, BOSTON UNIVERSITY

FORM **B**

DIRECTIONS:

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Study the sample questions below, and notice how the answers are marked on the separate answer sheet.

Sample A. The correct name for fluffy summer clouds is —

1. cirrus.
2. stratus.
3. nimbus.
4. cumulus.
5. thunder.

For Sample A the correct answer, of course, is "cumulus," which is answer 4. Now look at your answer sheet. At the top of the page in the left-hand column is a box marked SAMPLES. In the five answer spaces after Sample A, a heavy mark has been made filling the space (the pair of dotted lines) marked 4.

Sample B. The man known as the "wizard of the plant kingdom" was —

6. Joseph Lister.
7. Louis Pasteur.
8. Luther Burbank.
9. Thomas Edison.
10. none of the above.

The correct answer for Sample B is "Luther Burbank," which is answer 8; so you would answer Sample B by making a heavy black mark that fills the space under the number 8. Do this now. If the correct answer had not been given, you would have chosen answer 10, "none of the above."

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1. A fire burns more slowly in a stove or fireplace when the dampers are closed because there is less —
   1. oxygen.
   2. nitrogen.
   3. smoke.
   4. fuel.
   5. heat.

2. The only source of heat given below which may NOT produce carbon monoxide is —
   6. gasoline.
   7. electricity.
   8. kerosene.
   9. coal.
   10. oil.

3. A person can be sure that he is free from active pulmonary (lung) tuberculosis ONLY by having —
   1. yearly skin tests.
   2. radium treatments.
   3. a blood test.
   4. a throat examination.
   5. yearly chest X rays.

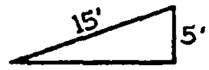
4. Millions of dollars were spent to build the 200-inch telescope on Mount Palomar in California. It will be used largely to take pictures of stars billions of miles out in space. Which one of the following statements is probably true?
   6. This 200-inch telescope is useful only to the men who enjoy looking at the stars.
   7. The discoveries made by looking through great telescopes have been of little use to ninth-grade pupils.
   8. The money used to build the 200-inch telescope should have been used to find the causes of some human diseases.
   9. No one can tell what discoveries, useful to man, may be made by the 200-inch telescope.
   10. It was a waste of money to build the 200-inch telescope, as smaller telescopes are just as good.

5. Which one of the following statements is probably true?
   1. Willingness to study hard for long hours is important if a person is to become a doctor.
   2. No one can be a successful doctor if his parents are wealthy.
   3. It is possible to become a doctor today with very little formal education.
   4. Only those who have saved money enough to go to medical school can become doctors.
   5. Poor home living conditions prevent success in the field of medicine.

6. Which one of the following does NOT belong with the other four?
   6. frost
   7. hail
   8. dew
   9. sleet
   10. snow

7. The most effective way to prevent future floods in hill country where lumbering is a major industry is to —
   1. reforest after cutting mature trees.
   2. make ditches.
   3. build dams.
   4. build restraining levees.
   5. build hydroelectric plants.

8. A 125-pound box on rollers is pushed up an inclined plan Which inclined plane will require the LEAST force move the box? (Neglect friction.)

6.


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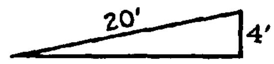

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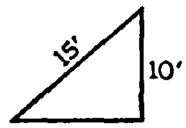

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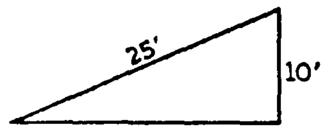

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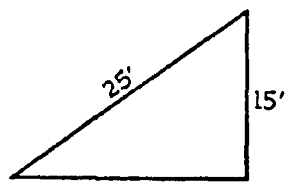
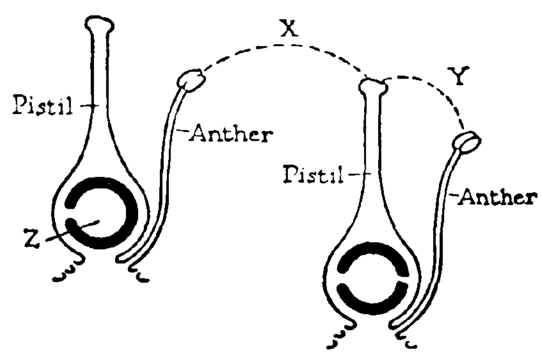


9. The most effective way eventually to wipe out small in the United States is through —
   1. quarantines during smallpox epidemics.
   2. regular health inspections in schools.
   3. inspection of foods.
   4. vaccination of all children.
   5. chlorination of drinking water.



10. The process shown above at X is called —
   6. self-pollination.
   7. self-fertilization.
   8. cell division.
   9. budding.
   10. cross-pollination.

11. White light can be broken into rainbow colors by means of a —
 1. photometer.
 2. telescope.
 3. prism.
 4. reflector.
 5. mirror.

12. Water used in an automobile battery should be —
 6. chlorinated.
 7. distilled.
 8. carbonated.
 9. filtered.
 10. sterilized.

13. The dust storms of the Great Plains and the deserts carry soil for miles. As the velocity of the wind dies down, which particles of material are deposited first?
 1. the heaviest
 2. the driest
 3. the lightest
 4. the smallest
 5. the smoothest

14. Very short electrical waves of extremely high energy given out in pulses are "bounced" off objects which are normally invisible because of darkness, fog, or distance. This form of communication is called —
 6. short-wave telephony.
 7. radiation.
 8. radar.
 9. telegraphy.
 10. radio.

15. A thermometer made of a plastic that stretches a little would NOT be accurate when tested in hot water because —
 1. the molecules of the mercury would stick to the plastic.
 2. the molecules of the mercury would have more space between them.
 3. the molecules of the plastic would be changed to mercury.
 4. the mercury could expand in more than one direction.
 5. the mercury molecules would escape through the plastic.

16. Which one of the following insects is most likely to be a carrier of malaria germs?
 6. fly
 7. ant
 8. mosquito
 9. flea
 10. bee

17. A famous laboratory discovered that alcohol even in small amounts will slow down a man's "reaction time" by as much as 20 per cent. An automobile driver who has had a drink has an accident. In the police court, the most scientific statement for him to make is —
 1. "Alcohol never bothers me."
 2. "I was driving carefully."
 3. "The weather was good and I could see the road way ahead."
 4. "I didn't have time to stop."
 5. "I shall depend on the doctor's report of my condition at the time of the accident."

18. Sound is possible ONLY if some material is —
 6. heated.
 7. vibrating.
 8. stretched.
 9. compressed.
 10. electrified.

19. All materials which are used to change electrical energy into heat energy must —
 1. be easily oxidized.
 2. be made of nichrome.
 3. be enclosed in vacuum tubes.
 4. have a low melting point.
 5. be conductors of electricity.

20. When starchy foods are eaten, they are usually first changed by a digestive process that begins in the —
 6. stomach.
 7. small intestine.
 8. mouth.
 9. liver.
 10. pancreas.

21. Petroleum is found in —
 1. sea water.
 2. plants.
 3. granite.
 4. limestone.
 5. porous rock layers.

22. Of the following, the most important source of calcium is —
 6. potato.
 7. meat.
 8. celery.
 9. chocolate.
 10. milk.

23. Which one of the following statements best describes the air in this room?
 1. It is nitrogen.
 2. It is oxygen.
 3. It will burn.
 4. It is a mixture of gases.
 5. It is visible.

24. Which one of the following shines by reflected light?
 6. star
 7. moon
 8. sun
 9. meteor
 10. sunspot

25. Stalagmites and stalactites found in underground caves consist principally of —
 1. mica.
 2. lava.
 3. slate.
 4. limestone.
 5. anthracite.

Go on to the next page.

26. If a bar magnet is broken into two parts, it will produce a total of —
   6. two S poles.
   7. three N poles.
   8. three S poles.
   9. four N poles.
   10. four S poles.

27. In the winter, a mile of railroad track was laid in a straight line over a flat sandy place. The ends of the rails were fitted carefully together, so that when a train went over the joining cracks there would be no bumps. Why, after a very hot day the next summer, did the originally straight track have curves and bends in it?
   1. The sand reflected the heat.
   2. Steel molecules do not vibrate.
   3. Heat increased the motion of molecules.
   4. The steel rails softened in the heat.
   5. Molecules of steel were changed to iron.

	THURSDAY 6 A.M.	THURSDAY 6 P.M.	FRIDAY 6 A.M.	FRIDAY 6 P.M.
Barometer	30.00	30.01	29.98	30.00
Temperature	44° F.	36° F.	30° F.	20° F.
Wind Direction	West	North-west	North	North
Clouds	Cumulus	Cumulus	None	Cumulus
Weather	Rain	Clearing	Clear	Clear

28. According to the chart above, what is the best weather prediction for Saturday?
   6. snow, clearing
   7. snow, colder
   8. rain, colder
   9. clear, colder
   10. cloudy, warmer

29. In developing a new blueberry, which one of the following methods is most apt to produce a sweeter, larger berry?
   1. plant cuttings of very sweet berries near cuttings of large berries
   2. cross-pollinate very sweet berries with very large berries
   3. self-pollinate very sweet berries
   4. self-pollinate very large berries
   5. mix the seeds of very sweet berries with those of very large berries, and plant them together

30. Scarce metals used in industry may in some situations be replaced by —
   6. plastics.
   7. copper.
   8. nickel.
   9. steel.
   10. tungsten.

31. The kidneys are necessary in —
   1. respiration.
   2. elimination of wastes.
   3. circulation of the blood.
   4. reproduction.
   5. digestion.

32. A tightly fitted steel plug rests on top of water in a ste pipe. Why will the pipe burst if the plug is struck with heavy hammer?
   6. The steel plug will not float on the water.
   7. The water makes the plug stick.
   8. The water is not pure.
   9. Steel is harder than iron.
   10. The water is not compressible.

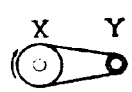
33. The terms of which pair belong together?
   1. Lister — yellow fever
   2. Reed — antisepsis
   3. Pasteur — bacteria
   4. Jenner — radium
   5. Curie — smallpox

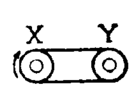
34. When a boy drinks milk through a straw, what makes t milk rise into his mouth?
   6. osmotic pressure
   7. differences in air pressure
   8. capillary action
   9. fat particles in the milk
   10. molecular motion in the milk

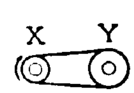
35. On New Year's Day, when it is early afternoon in C fornia, it is nearly dark in Boston. This difference in ti is due to —
   1. daylight-saving time.
   2. revolution of the earth.
   3. rotation of the sun.
   4. rotation of the earth.
   5. mean Greenwich time.

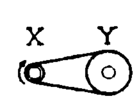
36. A motor converts —
   6. electrical energy into chemical energy.
   7. rotary motion into electrical energy.
   8. electrical energy into mechanical energy.
   9. power into rotary motion.
   10. chemical energy into rotary motion.

37. If pulley X is turning at 178 revolutions per minute, arrangement of pulleys that will give the greatest spee rotation to pulley Y is —

1. 

2. 

3. 

4. 

5. none of the above.

38. Man has learned about plants and animals that lived long ago on the earth through the study of fossils found in —

6. granite.
7. marble.
8. iron ore.
9. pumice.
10. shale.

39. On a very hot day in August a breeze may start to blow from the ocean toward the beach most probably because —

1. cool air over the ocean is saturated with water.
2. warm air can hold more water than cool air.
3. cool air forces warm air upward.
4. the water in the ocean has warmed up.
5. the tide has changed.

40. While digging into a sand and gravel pit, workmen noticed a layer of very fine sand between two layers of large rounded pebbles. How was this fine sand most probably deposited?

6. by the wind
7. during a severe rainstorm
8. by slowly moving water currents
9. during a volcanic eruption
10. during an earthquake

41. Which one of the following does NOT involve a chemical change?

1. baking potatoes
2. making vinegar
3. baking pies
4. cooking meat
5. melting ice

42. Over a period of many years, Luther Burbank produced new fruits and vegetables by crossbreeding after careful —

6. mutation.
7. pruning.
8. X-raying.
9. selection.
10. self-pollination.

43. A sailboat going from the ocean, without stopping, to a point 100 miles up the Mississippi River, would —

1. float higher in the river.
2. float lower in the river.
3. weigh less in the river.
4. weigh less in the ocean.
5. be buoyed up less by the ocean.

44. Of the following home-insulation materials, the one that operates on a principle different from the other four is —

6. rock wool.
7. aluminum foil.
8. cork.
9. fiberglas.
10. cotton.

45. All EXCEPT which one of the following can be used to refract light?

1. spectroscope
2. convex lens
3. concave lens
4. mirror
5. prism

46. A newspaper reporter recently wrote a story about a huge fossil palm tree uncovered in New England during the excavating of a cellar. What is probably the best explanation of the finding of this fossil palm tree in New England?

6. The climate of New England was once semitropical.
7. The tree floated there about a hundred years ago.
8. The tree was buried by Indians.
9. The tree was carved from stone by someone.
10. The reporter made a mistake.

47. Harmful wastes in the blood are excreted largely by the —

1. heart.
2. veins.
3. thyroid.
4. arteries.
5. kidneys.

48. In a simple zinc-copper-acid cell the electrical energy comes from —

6. the acid alone.
7. the copper alone.
8. a chemical change.
9. heat.
10. none of the above.

49. Which one of the following bacteria-killing agents comes from a mold?

1. sulfadiazine
2. penicillin
3. iodine
4. hydrogen peroxide
5. ammonia

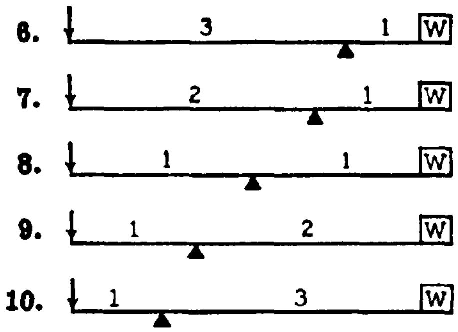
50. There are water faucets on every one of the seven floors o an office building. On the upper floors the water alway runs out slowly from the faucets, while on the first an second floors it flows much faster. The best explanatio of this is that —

6. water pressure depends on air pressure.
7. water will rise as high as the top of the offic building.
8. there are new pipes on the lower floors.
9. the outlet of the city water reservoir is not muc higher than the top of the office building.
10. the city water reservoir needs a good cleaning.

51. When some hailstones half as big as baseballs were cu open, they were seen to be made of layers of ice. Some c the layers were clear, and some were white. What wa necessary for the formation of such big hailstones?

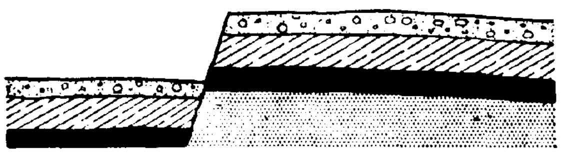
1. strong vertical air currents
2. cirrus clouds
3. snow
4. sleet
5. lightning

52. Which one of the following levers will lift the 60-pound weight W if a 20-pound weight is placed at the arrow? (Neglect weight of the lever.)



53. Two scientists in a balloon filled with helium gas ascend to a height of 2000 feet. They have with them the following equipment: 2 tanks of compressed helium; an air pump; 10 heavy canvas bags each filled with sand and fastened to a strong 100-foot rope. To take some measurements at 1000 feet, the scientists must —

1. pump air into the balloon.
2. release some of the helium from the balloon.
3. pour the sand over the side of the basket.
4. lower one or more of the bags of sand to the full length of the rope.
5. let some of the compressed gas from the tanks flow into the balloon.



54. If the geological change shown above should occur in the United States today, it would be accompanied by —

6. erosion.
7. an earthquake.
8. a volcano.
9. sedimentation.
10. folding.

55. Which one of the following is NOT a base or an acid?

1. salt
2. vinegar
3. lye
4. milk of magnesia
5. grapefruit juice

56. The distinctive bright red color of ripe "John Baer" tomatoes depends primarily on the —

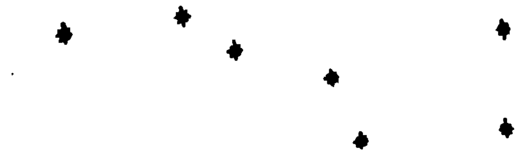
6. amount of rainfall.
7. amount of sunshine.
8. temperature.
9. hereditary character of the seed.
10. amount of fertilizer used.

57. Which tool does NOT belong with the other four?

1. saw
2. chisel
3. knife
4. wedge

58. Wind and running water are most effective in breakin down rocks into soil when they —

6. are cool.
7. are warm.
8. move slowly.
9. carry sand.
10. are changing direction.



59. The diagram above is an illustration of —

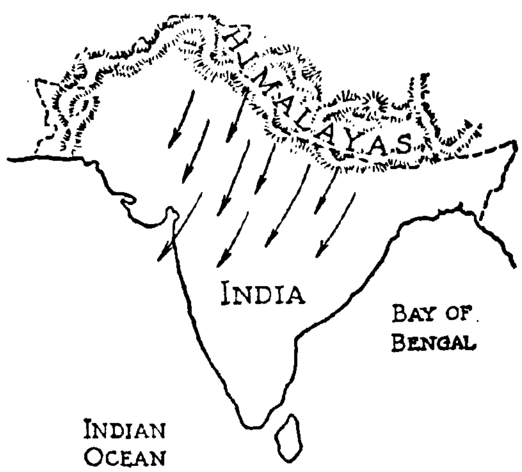
1. Ursa Major.
2. Big Dog.
3. Canis Major.
4. Cassiopeia.
5. Draco.

60. Heat travels from a hot-air register near the floor to t farthest corner near the ceiling of a room by —

6. humidification.
7. evaporation.
8. convection.
9. conduction.
10. radiation.

61. Which arrangement of pulleys gives the greatest mech ical advantage?

1. double movable, single fixed
2. double movable, double fixed
3. single movable
4. single fixed
5. double fixed, single movable



62. In India, after three months of rain, the northeast " monsoon" begins to blow in October and cold air from Himalayas covers almost all the country. Why is t little or no rain at this time?

6. The cold air is too heavy to form clouds.
7. The cold air has snow, not rain, in it.
8. Cold air can hold little moisture.
9. The ocean water does not evaporate in the fall
10. Cool air becomes colder as it flows down from

. Charges of negative electricity which move freely are called —

1. protons.
2. neutrons.
3. atoms.
4. molecules.
5. electrons.

. If a neighbor says she is not going to have her child given the Schick test to see if he is immune to diphtheria, as no one gets diphtheria nowadays, you should be willing to do all EXCEPT which of the following?

6. Agree with her decision.
7. Explain that the test is harmless.
8. Tell her about the four cases in the local hospital.
9. Ask her to request free information from the school doctor.
10. Help her to arrange for a Schick test.

. Which one of the following is the largest?

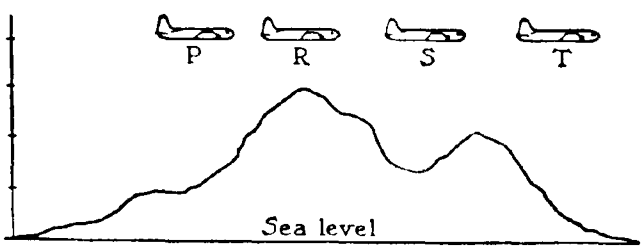
1. meteor
2. star
3. comet
4. moon
5. earth

. A bright blue coat contains a dye which absorbs all the following colors EXCEPT —

6. red.
7. orange.
8. green.
9. blue.
10. yellow.

. Conversations over telephone wires really travel as —

1. sound waves.
2. light waves.
3. mechanical energy.
4. heat and energy.
5. electrical energy.



8. A pilot flying an airplane over a mountain range whose highest peak is 3000 feet checked his altitude with his altimeter (air-pressure height-meter) at points P, R, S, and T, as shown above. The altimeter readings the pilot made at these points were most like those below in column —

6	7	8	9	10
P-4000 R-4000 S-4000 T-4000	P-2000 R-1000 S-2000 T-4000	P-2500 R-4000 S-2000 T-1000	P-1000 R-2000 S 3000 T-4000	P-4000 R-2000 S-4000 T-1000

69. On a very calm December day, the air temperature up to 1600 feet was below 30° F. Above 1600 feet the temperature ranged from 38° F. to 43° F. If rain falls from clouds at 3400 feet, what strikes the earth?

1. frost
2. dew
3. rain
4. sleet
5. hail

70. Which one of the following is an element?

6. water
7. limestone
8. sulfur
9. wood
10. carbon dioxide

71. Gas used for cooking in homes is often made from —

1. lime.
2. nitrogen.
3. kerosene.
4. wood.
5. coal.

72. Legumes can take nitrogen from the air with the aid of certain —

6. bacteria.
7. chemicals in the soil.
8. cultivation methods.
9. temperature changes.
10. molds.

73. Which one of the following statements about the air is true?

1. It is mostly oxygen.
2. It is about one-half carbon dioxide.
3. It is about one-fifth hydrogen gas.
4. It is about four-fifths nitrogen gas.
5. It is about one-third krypton, neon, and argon.

74. Geraniums can be started by cutting a "slip" from a plant and rooting it in sand. If a red geranium is "slipped" and grown in sand between a white geranium and a salmon-colored one, the slip will produce a bloom which is —

6. salmon-red.
7. pink.
8. salmon-red and pink.
9. white.
10. red.

75. In a gasoline engine, when the energy of the gasoline is changed into heat, it is called —

1. intake.
2. compression.
3. explosion.
4. exhaust.
5. carburetion.

Go back and check your answers.

(First Preliminary Report to the

Cooperating Teachers)

ILLINOIS STATE NORMAL UNIVERSITY
NORMAL, ILLINOIS

(addresses to the
individual cooperating
schools)

I am offering this preliminary report of my project in which you are helping by giving the <u>Read General Science Test</u> to your students. I have spent some time studyint the scores of the 2,800 or so students. The results are thought provoking. Sufficiently so, in fact, that I am now asking you to help me examine the whole project to see if there are factors that I may have overlooked which may, if brought under control, help with an analysis of the data.

Too, I have wondered about the extent to which the intelligence of the students may affect their performance on this test. In anticipation of this I asked the administrators of the cooperating schools if intelligence scores of some sort would be available for their students. By now I believe that intelligence may be a significant variable and had better be examined. Will you please ask your principal or superintendent to give me the intelligence scores for your students? It may be convenient to write them on the enclosed yellow sheet which lists their scores on the Read test. Please be sure to have someone indicate which intelligence test was used and what the scores mean, i. e., raw scores, percentile ranks, or intelligence quotients.

Another hunch I have is that the social and economic conditions of the home backgrounds of the students may be a significant variable. Do you know your students well enough to be able to place an "R" in front of the names of about ten per cent who come from definitely good homes and a "P" in front of an equal number who come from definitely "poor" social and economic home backgrounds?

Please feel free to offer any guesses you can that may help account for the data on the attached report. These guesses may involve the questions on the personal information form, the <u>Read Test</u> itself, or my whole approach to the problem of the relationship of the pre-ninth grade school science experiences to the achievement in the ninth grade general science course.

'Tis true that my main focus is on achievement. This can't be examined until the scores are in from the second form of the test to be given in the spring. However, I prefer to probe as many of the data as I can while the project is fresh in our minds. Thanks for your cooperation and I hope that someday I can help you investigate a problem that has originated in your mind.

Sincerely yours,

John H. Woodburn
Assist. Prof. of Science

(Page 2)

The following report consists mainly of presenting the mid or median score and arithmetical average score of groups of the students who took the <u>Read General Science Test</u> this fall. For example, the first portion may be read: "2256 students who entered the ninth grade in 27 Central Illinois schools this fall had a median score of 32.46 and an average score of 32.62."

Number	Description	Median	Mean
2256	Students entering the ninth grade general science course in 23 Central Illinois schools..................................	32.46	32.62
3592	Students completing the ninth grade general science course last spring in 56 schools throughout U. S. (National end-of-year norms provided by the World Book Company.).....	40.84	40.83
	Students entering the ninth grade in.....	______	______
516	Students entering the ninth grade general science course who indicated that they have a total of between 0 and 3 weekly classes in science during the 6th 7th, and 8th grades.		29.02
446	Same as above except that they indicated a total of between 4 and 7 weekly classes in		

science during the 6th, 7th, and 8th grades. 33.75

542 Students indicating between 8 and 11 classes. 34.11

752 Students indicating between 12 and 15 classes in science during the three grades prior to the ninth.......................... 34.48

Note: The students from indicate that they have had on the average a total of weekly classes in science during the 6th, 7th, and 8th grades.

A random sample of about one-fifth of the total papers provides the following data:

240	Boys	34.2	34.9
216	Girls	31.2	31.1

Note: Another sample similarly drawn yielded these results- Boys: 35.5 and 35.2. Girls 31.8 and 32.1.

87	Students with farm background.............	32.1	32.3
74	Students with village background..........	33.6	33.9
294	Students with city background.............	32.35	32.8

Note: The distinction between city and village when left up to the students was somewhat loose. Another check based on the size of the city in which the school was located showed that 527 students in 5 schools in cities with a population above 30,000 had a median score of 28.70 and an average score of 29.13.

76	Students with 4H Club experience.........	32.7	33.7
168	Students with more than ½ year of Scout work..................................	33.4	33.8
207	Students who reported that they have read more than 2 books about science during the past two or three years....................	32.1	32.1
222	Students who reported reading less than two books about science during the past two or three years....................	32.1	32.1

A random sample of 400 papers shows the following data:

51.1% of the earth science items were answered correctly.

51.4% of the life science items were answered correctly.

33.2% of the physical science items were answered correctly.

The national norms for these part scores are 54.5%, 53.4%, and 51.2%.

The following correlations have been calculated by using the Pearson Product-Moment system.

2256	Total score against the total number of science classes reported by the students in the 6th, 7th, and 8th grades..	.17
400	Total score against score on earth science items.	.35
400	Total score against score on life science items..	.82
400	Total score against score on physical science items	.83

(The original copy of this report was in the form of a mimeographed letter so arranged as to permit filling in the data, where appropriate, for each school.)

(Second Preliminary Report to the Cooperating Teachers)

[illegible] general science [illegible] recall that the Read General Science Test was given to [illegible] general science students.

In approaching this brief report I hope you share with me [illegible] the same attitude toward the use of tests which have [illegible] by the classroom teacher to observe the performance of [illegible] learning exercises. I look upon such tests as the one used in this project as a means whereby a sample of the class experiences [illegible] included in the ninth grade general science course may be [illegible] the total. A metaphor may help you see my attitude. I have come to look upon the total complex of experiences which we provide our students as something like a flowing stream. A test then becomes a means to divert a portion of the total experiences through a small canal so that a closer study may be made. It then becomes a matter of judgment as to how representative of the whole stream of experiences included in the course is that small stream that was diverted to permit observation.

Some teachers tend to look upon a test as extending clear across the total stream of course activities and sampling each of the experiences arranged by the teacher to bring about the growth of his or her students. The validity of this point of view again rests on the teacher's judgment of how representative of the total course activities are the exercises in the test. I can see how either of these interpretations might be applied to aid in understanding the results of your students in my research project. The only interpretation toward which I take a very dim view is that a test, commercially prepared or teacher designed, provides a measure of the whole complex of experiences represented by a teacher's contacts with a group of students.

The fact that the end-of-year scores of the students who were included in this study did show significant gains through the year is pretty good evidence that the Read General Science Test involves learnings closely associated with what goes on in the ninth grade course.

This project was organized [illegible] estimate of the relationship between the science [illegible] by ninth grade students and [illegible] their [illegible] out-of-school [illegible]. In my opinion [illegible] would better [illegible] examination. In many [illegible] found to be [illegible] of the [illegible] school. [illegible] that [illegible] administration [illegible] prior to graduation. [illegible] many students [illegible]

[illegible] I finished [illegible] subject with which [illegible] General Science [illegible] general science students.

[illegible]

[illegible] divert a [illegible] a class [illegible] how [illegible] course [illegible]

(Second Preliminary Report to the Cooperating Teachers)

Some [illegible] total stress of [illegible] arranged by the [illegible] his or her students. The validity of this [illegible] teacher's judgment of how representative [illegible] the exercises in the text. I can [illegible] might be applied to aid in [illegible] to my research project. [illegible] a very dim view is that a text, [illegible] provides a measure of the whole [illegible] teacher's contacts with a group of students.

The fact that the [illegible] were included in this study did [illegible] is pretty good evidence that the [illegible] closely associated with what [illegible]

This project [illegible] the relationship between [illegible] sixth [illegible] In [illegible] combination. In [illegible] science experience [illegible] the only formal contact of [illegible]

ILLINOIS STATE NORMAL UNIVERSITY
Normal, Illinois
September 10, 1951

This summer I finished studying the results obtained from the general science project with which you helped me last winter. You may recall that the Read General Science Test was given to your ninth grade general science students.

In approaching this brief report I hope you share with me somewhat the same attitude toward the use of tests which have not been composed by the classroom teacher to observe the performance of students on learning exercises. I look upon such tests as the one used in this project as a means whereby a sample of the class experiences ordinarily included in the ninth grade general science course may be separated from the total. A metaphor may help you see my attitude. I have come to look upon the total complex of experiences which we provide our students as something like a flowing stream. A test then becomes a means to divert a portion of the total experiences through a small canal so that a closer study may be made. It then becomes a matter of judgment as to how representative of the whole stream of experiences included in the course is that small stream that was diverted to permit observation.

Some teachers tend to look upon a test as extending clear across the total stream of course activities and sampling each of the experiences arranged by the teacher to bring about the growth of his or her students. The validity of this point of view again rests on the teacher's judgment of how representative of the total course activities are the exercises in the test. I can see how either of these interpretations might be applied to aid in understanding the results of your students in my research project. The only interpretation toward which I take a very dim view is that a test, commercially prepared or teacher designed, provides a measure of the whole complex of experiences represented by a teacher's contacts with a group of students.

The fact that the end-of-year scores of the students who were included in this study did show significant gains through the year is pretty good evidence that the Read General Science Test involves learnings closely associated with what goes on in the ninth grade course.

This project was organized initially to gain an estimate of the relationship between the science information possessed and acquired by ninth grade students and some of their school and out-of-school experiences. In my opinion no single course in the total science program of many schools would better justify the investment of time and effort in a review and reexamination. In many schools this course is the only common science experience to be shared by all of the students who may enroll in the school. In some cases this course is the only contact with science instruction that the administrative officials of the school insure each student will experience prior to graduation. It is increasingly becoming the only formal contact of many students with the earth and physical sciences.

The ninth grade general science course coming at the time it does in the total school program of boys and girls occupies a strategic position. The extreme interpretation of this position would be that a student's whole life interest in and attitude toward the total science enterprise may be subject to influence by this course.

An estimate of the amount of repetition of prior experiences within the course as now taught should be worthwhile. Some teachers may be interested in estimates of the degree to which the course consists of experiences which are related to prior experiences both within and beyond the students' school environments. This factor becomes of increased concern as new studies reveal how much a sense of need and utility conditions a student's learning and retention rate.

I believe that each school and each teacher rightfully retains the responsibility of interpreting what experiences shall be most meaningful to each youngster under guidance. In organizing this study it was my intention merely to provide evidence of a sort which may aid school administrative officials and classroom teachers in forming these interpretative decisions.

Living as we do in a world in which the impact of science on even our most insignificant experience is becoming strikingly evident, I think it unnecessary to do more than cite the increasing responsibility of all schools to aid their students to understand the realm of science and the functioning of the whole science enterprise.

The following facts may help you interpret how your students made out in this study.

	Average Initial Score	Average Final Score
Your students.	______	______
1,973 ninth grade general science students . .	33.12	41.60
3,592 students in 56 communities in 21 states used by publisher to establish norms. . . .		40.79
198 ninth grade students who were taught no general science through the year.	35.12	37.50
226 tenth grade biology students who had been taught no gen. sci. in the 9th grade. . . .	38.25	42.91
The boys in the 1973 ninth grade group	34.73	43.28
The girls in the 1973 ninth grade group. . . .	31.56	40.00
366 Boy Scouts	36.49	44.04
603 Boy non-Scouts	33.66	42.82

399 Girl Scouts.	32.97	40.98
605 Girl non-Scouts.	30.73	39.32
375 Students with 4-H Club experience.	34.70	43.72
1598 Students without 4-H Club experience.	32.75	41.10
335 rural students	32.22	43.10
221 village students	33.64	42.43
1124 city students	33.18	40.87
2?8 students from the "best" homes	38.85	48.35
140 students from the "poorest" homes.	29.95	38.17
254 students reporting "high" interest in reading science books	38.12	46.10
503 students reporting "low" interest in reading science books	31.35	40.03
311 students with practically no science instruction through the 6th, 7th, and 8th grades.	30.75	39.27
596 students with about the average* amount of science instruction through the 6th, 7th, and 8th grades	34.76	42.72
457 students with at least 4 or 5 science classes per week through each of the 6th, 7th, and 8th grades.	33.50	42.10

The following correlation coefficients were found to be rather significant and may help with your understanding the results of the whole project.

Between initial and final test scores	.72
Between total initial score and score on the physical science items.	.91
Between total initial score and the score on the earth science items.	.82
Between total initial score and the score on the life science items.	.87
Between initial score and intelligence quotients. .	.56
Between final score and intelligence quotients. . .	.53
Between individual gains and intelligence quotients	.00

*The average was a total of 8 classes per week through the 6th, 7th, and 8th grades combined.

Usually when people cooperate on studies of this kind one of the most interesting aspects is the exchange of opinions regarding the general conclusions and recommendations growing out of the study. I hope for a chance to talk with you about the results and have you give your opinions of the significance and validity of the whole project. My personal generalizations would include such comments as:

1. Students upon entering the ninth grade general science course are already familiar with a worthwhile portion of the science information customarily suggested by textbooks designed for the course. They gain a significant additional amount of this information through the year independently of enrollment in the general science course.

2. All students regardless of their abilities or background experiences have about the same chance to pick up additional science information while enrolled in the general science course.

3. Whatever it is in the abilities of boys and girls that give some of them an advantage on intelligence tests gives them about the same degree of advantage on general science tests.

4. Such factors as Scout experience, 4-H Club experience, "good" home background, and so forth tend to be accompanied by superior performance on the Read test. A similar amount of superiority on intelligence tests was also indicated.

5. The greater amount of science information possessed by the students who indicated "high" interest in reading science books was <u>not</u> accompanied by comparable superiority in intelligence.

6. The subject matter learned by students in the ninth grade general science course is similar to but far from duplicated by the science information acquired by students in general science classes through the sixth, seventh, and eighth grades.

7. Somewhere between "none at all" and "classes five days a week" through the three grades prior to the ninth there is a number of science classes that would make the most efficient use of instructional time.

8. Instruction in the ninth grade general science course tends to close the gap between students who enter with minimum and maximum amounts of accumulated science information. It follows that a student who shows precocious ability in the acquisition of science information is not provided instructional experiences enabling him to maintain his relative superiority.

9. Although there was evidence that the science information that is suggested by textbooks is related to the everyday activities of boys and girls this degree of relationship is very low. The question remains whether the relationship is sufficient to create in the minds of the students a sense of the need and utility of science information. There is some evidence that youngsters do not recognize the relationship between science and many of their everyday activities unless they are led to explore and identify this relationship through formal instruction.

10. The students who were included in this study tend to be more familiar with the earth and life sciences than with the physical sciences. According to the results obtained from the 3,592 students in the standardizing group, the difficulty of the items from the three natural science areas was practically the same.

I hope you recognize how grateful I am for all of the large and small instances of cooperation that are involved in the conception and maturity of this research project. Especially should I mention my appreciation of the interest which the administrative officers of Illinois State Normal University have shown. Not only have they made it possible for me to use much of my free time on the project but they have also shown their tendency to encourage such research by making many campus services available to me. I presume that this cooperation is representative of what may be expected from the University Field Services recently reorganized under the leadership of Dr. L. W. Miller.

I realize that this report is quite sketchy. If there are any questions which you would care to raise or additional information that I can provide, especially in regard to your own group of students, please feel free to call on me. Perhaps we can take advantage of circumstantial visits either on our campus or in your school to discuss the project to our mutual satisfaction.

Incidentally, I have no further use for the Read General Science Test booklets and had planned to leave them with the schools. If you would like enough for a section or two of students I will be glad to send them along.

May the coming school year be interesting and filled with a great many satisfactions.

Sincerely yours,

John H. Woodburn
Assist. Prof. of Science

[illegible]

Name ______________________ Age ____ Grade [illegible]

[illegible] you live in a city, village, or on a farm [illegible]

[illegible] How many of the past five years have you lived on a farm [illegible]

[illegible] Underscore any of these hobbies that you may have. [illegible] Collecting insects. Collecting rocks. [illegible] model airplanes, boats, cars, etc. Raising [illegible] Home science lab. Science scrapbook. Building radios. [illegible]

[illegible] How many years have you belonged to a science club? ____ [illegible]

[illegible] About how many, if any, science books or books about science [illegible] during the past two or three years?

(Personal Information Form)

7. About how many science classes did you have each week [illegible] sixth grade? ____ Seventh grade? ____ Eighth grade? ____ [illegible]

8. In which of these grades did you have a regular science [illegible]

9. ____

(The original copies of this personal information form were mimeographed. The replies received for question number four and for the first part of number five did not provide data permitting further study of these factors.)

PERSONAL INFORMATION

1. Name ______________________ Age ____ School ______________________

2. Do you live in a city, village, or on a farm? (Underscore one). Boy or Girl.

3. How many of the past five years have you lived on a farm? ___ City? ___ Village? _

4. Underscore any of these hobbies that you may have. Gardening. Fishing. Hunting. Collecting insects. Collecting rocks. Developing and printing photos. Building model airplanes, boats, cars, etc. Raising rabbits, mice, chickens, etc. Home science lab. Science scrapbook. Building radios. _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

5. How many years have you belonged to a science club? ___ 4H Club? ___ Scouts? ___

6. About how many, if any, science books or books about science have you read during the past two or three years? ___

7. About how many science classes did you have each week while you were in the sixth grade? ___ Seventh grade? ___ Eighth grade? ___ Ninth grade? ___

8. In which of these grades did you have a regular science textbook? ___________

9. _

(The original copies of this personal information form were mimeographed. The replies received for question number four and for the first part of number five did not provide data permitting further study of these factors.)