SCIENTIFIC KNOWLEDGE CONTRIBUTED BY GENERAL
SCIENCE, BIOLOGY, CHEMISTRY, AND PHYSICS
IN RELATION TO TEACHERS' GRADES

OKLAHOMA
AGRICULTURAL & MECHANICAL COLLEGE
LIBRARY

SCIENTIFIC KNOWLEDGE CONTRIBUTED BY GENERAL NOV 11 1938

SCIENCE, BIOLOGY, CHEMISTRY, AND PHYSICS

IN RELATION TO TEACHERS' GRADES

By

GEORGE TEMPEL MCKINNEY

Bachelor of Science

University of Oklahoma

Norman, Oklahoma

1927

LIBRARY
AGRICULTURAL & MECHANICAL COLLEGE
OKLAHOMA

Submitted to the School of Education

Oklahoma Agricultural and Mechanical College

In Partial Fulfillment of the Requirements

For the Degree of

MASTER OF SCIENCE

1938

OKLAHOMA
AGRICULTURAL & MECHANICAL COLLEGE
LIBRARY
NOV 11 1938

APPROVED BY:

In Charge of Thesis

Dean of School of Education

Dean of Graduate School

ACKNOWLEDGMENTS

The writer is indebted to Miss Bessie M. Huff, Dean of Muskogee Junior College, for her part in making possible the completion of this study.

The writer is especially grateful to Dr. M. R. Chauncey, Professor of Education, for his suggestions, criticisms, and guiding influence.

G. M.

TABLE OF CONTENTS

CHAPTER	PAGE
I INTRODUCTION	1
II METHOD OF INVESTIGATION	5
III CORRELATIONS	14
IV GENERAL SCIENCE	24
V BIOLOGY	29
VI CHEMISTRY	34
VII PHYSICS	39
VIII SUMMARY AND CONCLUSIONS	44
APPENDIX	47
BIBLIOGRAPHY	68

Chapter I

INTRODUCTION

With the general use of late inventions and the broad knowledge of chemicals needed in the world today general scientific knowledge is receiving great emphasis in the high school curriculum. Science instruction in the high school is a preparation for rational, scientific living and thinking, which is one of the greatest needs of today when propaganda, frauds, cults, isms, and other evidences of unscientific thinking and living are rampant, despite the fact that the outstanding feature of modern intellectual leadership is the development of science and scientific method.¹ According to the survey made between the years 1908-1923 by George W. Hunter, courses in science on the whole were becoming standardized and there was a big advance in the number of hours devoted to science throughout the country. The reason for this increase was probably due to increased college entrance requirements and the common everyday interest in the subject.² The National Survey of Secondary Education found in 1930-31 that more than 78% of the schools studied offered general science as a regular part of their high school curriculum.³ The modern interest in science must be identified with the scientific awakening of the seventeenth and eighteenth centuries. It can be stated that science began with Galileo and Newton, but we find that science

1 Research Bulletin of the National Education Association, Vol. 7, No. 4, Sept. 1929, p. 218

2 School and Society, Dec. 13, 1924, Vol. 20, pp. 762-766

3 National Survey of Secondary Education, U. S. Bulletin, 1932, No. 17, Monograph, No. 19

found its way into the American school as a subject after Froebel (1782-1852) tried to establish an education that was based on a first-hand acquaintance with natural objects.⁴ Though the first public school science instruction constituted merely experimental lectures in natural philosophy, science instruction, from the very beginning, became a part of the curricula of the American high school. Instruction in the physical sciences, mainly in physics, held the dominant place until in the last few years the introduction of general science and biology has found its way into most high school curricula.⁵ These divisions in science instruction probably arose after the publication in 1918 of the report of the Commission on the Reorganization of Secondary Education, which placed an emphasis on curricular revision and pointed the way to more adequate objectives.⁶ According to the report of the sub-committee in general science made by Francis D. Curtis, "the subject matter of general science contributes substantially to all of the ultimate objectives and to most of the immediate objectives of the North Central Association, which are (1) health, (2) leisure time, (3) social objectives, and (4) vocational objectives."⁷ After an educational survey of the school systems of the State of Oklahoma under the direction of the Bureau of Education at Washington, D. C., in 1922, general science found its way as a required

4 E. R. Downing, *Teaching Science in the School*, p. 2

5 *Reconstruction of Secondary School Science Teaching*, Master's Thesis, Lawrence College, Appleton Wis., June 1936, p. 13

6 *Cardinal Principles of Secondary Education*, Washington, D. C. (U. S. Bureau of Education Bulletin No. 35, 1918) p. 3

7 *North Central Association Quarterly*, Dec. 1930, Vol. 5, No. 3, pp. 410-411

subject in all Oklahoma High Schools.⁸ In the Annual High School Bulletin of 1936 published by the Department of Education of the state of Oklahoma, regarding regulations for accrediting schools of the state of Oklahoma is the statement, "One year of general science is required for each pupil in the high schools of the state. This year may be spread over a period of two years with three periods of classwork weekly, or five days weekly in either the seventh or eighth grades. If short periods are used, seven seventy-five minute periods will be considered the minimum in the ninth grade science course. The science course must include material in agriculture and physiology."⁹

The studies made so far in the field of general science education are comparatively few in number. In 1929 Harrison Pfeiffer in his master's thesis at the state university of Iowa made an analysis of the "information and misinformation of high school seniors in general science."¹⁰ He did not indicate what effect the program of studies, or the grades made by the students in any science course, had on the actual knowledge the seniors possessed in general science. In 1936, Gerald V. Lannholm in his master's thesis at the state university of Iowa made a survey of "the knowledge of general science which high school seniors possess,"¹¹

8 Public Education in Oklahoma (Bureau of Education Bulletin, No. 14, 1923, p. 1)

9 Annual High School Bulletin, No. 112K, Dept. of Education, State of Oklahoma, p. 40

10 H. S. Pfeiffer, Information and Misinformation of High School Seniors in General Science, M. A. Thesis, State University of Iowa, 1929

11 G. V. Lannholm, Knowledge of General Science Which High School Seniors Possess, M. A. Thesis, State University of Iowa, 1936

the purpose of which was to determine whether senior students gained or lost knowledge in general science three years after studying the subject. The author of this study takes into account the average semesters of science studied in the three years after the ninth grade but does not refer to grade groupings and subjects in science studied by this group. In 1936, Arthur P. Jones in his master's thesis at the New York College for Teachers made a "survey of the educational and social adjustment of forty 'C' level students in the science courses in Albany High School."¹² This study mainly shows the effect of environment on the grades made in general science.

The purpose of this study is to determine whether marks given by teachers are an indication of general science knowledge, and whether the different science subjects, general science, biology, chemistry, and physics, contribute to the general scientific knowledge of three hundred seniors in Central High School, Muskogee, Oklahoma.

¹² A. P. Jones, Survey of the Educational and Social Adjustment of Forty "C" Level Students in Science Courses in Albany High School, M. A. Thesis, New York State College for Teachers, 1936

Chapter II

METHOD OF INVESTIGATION

The test used for this study was the Cooperative General Science Test, Form N, published by the Cooperative Test Service of the American Council on Education, New York City, New York. The items included in this test were formulated by Dr. O. E. Underhill, now a member of the faculty of the State Teachers College at New Britain, Connecticut, and Dr. S. R. Powers, a member of the faculty of Columbia University.¹ The test was tried out on an experimental population, composed of from 1,000 to 1,500 students, in order to discover the value of the individual items included. These experimental schools were located in larger cities, such as Philadelphia, Hartford, Providence, and New York, primarily because it was easier to assure representative samplings of ninth grade students in larger communities. The twelfth grade norm of this test is based on the score distribution of eighty schools and a total number of over seven thousand students, with an attempt made to weigh the results obtained according to the size of the schools and the geographical areas included, so as to make the final tables adequately representative of the performance of public secondary school students. In addition, the norms were revised in May, 1937, and were based on public secondary schools of the East, Middle West, and West. Dr. Underhill reports, "A careful analysis of five recently published textbooks was made. As many specific points as possible were listed. An attempt was made to frame ten items

1 Personal Letter from Ruth Eckert, Research Director, Cooperative Test Service

covering each of these points or a closely related one. These items were distributed into the two tests which formed the rough groundwork of the series. The test material was not limited to that subject matter which was common to all five texts, but rather represents a comprehensive sampling of all materials found in these texts. Because of the nature of general science, a test in this subject must be very comprehensive. It must cover a sufficiently wide area so that there will be enough items on that part of the subject matter studied in a particular class to sample the students' knowledge. The test is adopted to the measurement of growth because of this comprehensive character and can also be advantageously used as a survey test for students of varying instructional backgrounds. After some experimentation it was decided that the most useful types of questions were the multiple choice and a matching form in which a group of three questions is matched against five possible choices. Items were included in each form which involved the identification of objects in various diagrams and sketches. The test items were distributed into fifteen categories corresponding to the important topics of the subject and the proportion of items in each category adjusted to give a balance which, in the opinion of the authors, represented a proportionate sampling of the materials which are taught in a good program of general science. As it was planned to issue these tests over a period of years, account was taken of the probable future developments of general science courses, as evidenced by certain well defined trends. These tentative test forms were carefully edited and then tried out in a number of schools. On the basis of these results about 150 items were selected for the final forms."²

2 Handbook of Purpose, Content, and Interpretation of Cooperative Tests, Cooperative Test Service, New York

The immediate purpose of this test is to provide objective and reliable measures of individual differences in educational achievement. This test is so constructed and the norms and conversion tables established in a way to insure maximum comparability and meaningfulness for the results.

Because the three hundred seniors of Central High School, Muskogee, Oklahoma, constituted a group that had been offered all four science subjects, general science, biology, chemistry, physics, they were chosen for this study. For the purpose of providing a scientific basis for the study of the scientific knowledge of these three hundred seniors, the first step in the preparation was to obtain the intelligence quotient of each individual. Each student in Central High School must take the Otis Test of Mental Ability. As a record is kept for each person, the intelligence quotient was obtained for this study for each senior from the personal files in the school office. The range in intelligence quotient is from the highest 147 to the lowest 73. The mean intelligence quotient as shown on the correlation chart is 109.442.³ Of the three hundred seniors 4 or 1% are in the near genius class, 52 or 17% are very superior, 107 or 35% superior, 121 or 40% normal, 10 or 3.3% dull, 6 or 2% borderline.⁴ Of the three hundred seniors, 271 have attended Muskogee schools for the entire four year period used for this study, 13 have attended three years, 9 two years, and 7 only one year. For the purpose of careful study the class was divided into the following groups:

3 Correlation chart, p. 47

4 Frank Freeman, Mental Tests, p. 100

General Science

- Group 1. Those students who made a mark of "A" in general science.
- Group 2. Those students who made a mark of "B" in general science.
- Group 3. Those students who made a mark of "C" in general science.
- Group 4. Those students who made a mark of "D" in general science.
- Group 5. Those students who did not take general science.

Biology

- Group 1. Those students who made a mark of "A" in biology.
- Group 2. Those students who made a mark of "B" in biology.
- Group 3. Those students who made a mark of "C" in biology.
- Group 4. Those students who made a mark of "D" in biology.
- Group 5. Those students who did not take biology.

Chemistry

- Group 1. Those students who made a mark of "A" in chemistry.
- Group 2. Those students who made a mark of "B" in chemistry.
- Group 3. Those students who made a mark of "C" in chemistry.
- Group 4. Those students who made a mark of "D" in chemistry.
- Group 5. Those students who did not take chemistry.

Physics

- Group 1. Those students who made a mark of "A" in physics.
- Group 2. Those students who made a mark of "B" in physics.
- Group 3. Those students who made a mark of "C" in physics.
- Group 4. Those students who made a mark of "D" in physics.

Group 5. Those students who did not take physics.

The first group represents those students who have been given a mark of "A" by their teachers, as do the other groups represent respectively those who have been given "B", "C", and "D". These grade records were taken from the term sheets on file in the office which contain all the grades made by a student throughout his high school career. According to the key to grading for Central High School the numerical range for a grade of "A" is from 95 to 100, "B" from 89-94, "C" from 80-88, "D" from 75-79, "E" failed.

The findings of this study have been organized according to the following questions:

I. Correlation

1. In the entire group of three hundred seniors was there any correlation between their intelligence quotient and the scores made on the test?
2. In the entire group of 258 seniors who studied general science was there any correlation between the school marks made in general science and the scores made on the test?
3. In the entire group of 258 seniors who studied general science was there any correlation between their intelligence quotients and their school marks in general science?
4. In group 1, those students who made a mark of "A" in general science, was there any correlation between the students' grades and their intelligence quotients?
5. In group 2, those students who made a mark of "B" in general science, was there any correlation between the students' grades and their intelligence quotients?

6. In group 3, those students who made a mark of "C" in general science, was there any correlation between the students' grades and their intelligence quotients?
7. In group 4, those students who made a mark of "D" in general science, was there any correlation between the students' grades and their intelligence quotients?
8. In group 5, those students who did not take general science, was there any correlation between the students' grades and their intelligence quotients?

II. General Science

1. In group 1, those students who made a mark of "A" in general science, were the students above or below the mean score of the standardized test?
2. In group 2, those students who made a mark of "B" in general science, were the students above or below the mean score of the standardized test?
3. In group 3, those students who made a mark of "C" in general science, were the students above or below the mean score of the standardized test?
4. In group 4, those students who made a mark of "D" in general science, were the students above or below the mean score of the standardized test?
5. In group 5, those students who did not take general science, were the students above or below the mean score of the standardized test?

III. Biology

1. In group 1, those students who made a mark of "A" in biology,

were the students above or below the mean score of the standardized test?

2. In group 2, those students who made a mark of "B" in biology, were the students above or below the mean score of the standardized test?
3. In group 3, those students who made a mark of "C" in biology, were the students above or below the mean score of the standardized test?
4. In group 4, those students who made a mark of "D" in biology, were the students above or below the mean score of the standardized test?
5. In group 5, those students who did not take biology, were the students above or below the mean score of the standardized test?

IV. Chemistry

1. In group 1, those students who made a mark of "A" in chemistry, were the students above or below the mean score of the standardized test?
2. In group 2, those students who made a mark of "B" in chemistry, were the students above or below the mean score of the standardized test?
3. In group 3, those students who made a mark of "C" in chemistry, were the students above or below the mean score of the standardized test?
4. In group 4, those students who made a mark of "D" in chemistry, were the students above or below the mean score of the standardized test?

5. In group 5, those students who did not take chemistry, were the students above or below the mean score of the standardized test?

V. Physics

1. In group 1, those students who made a mark of "A" in physics, were the students above or below the mean score of the standardized test?
2. In group 2, those students who made a mark of "B" in physics, were the students above or below the mean score of the standardized test?
3. In group 3, those students who made a mark of "C" in physics, were the students above or below the mean score of the standardized test?
4. In group 4, those students who made a mark of "D" in physics, were the students above or below the mean score of the standardized test?
5. In group 5, those students who did not take physics, were the students above or below the mean score of the standardized test?

TEST SCORES AND IQ'S OF 300 SENIORS

GRAPH I.

Chapter III

CORRELATIONS

The purpose of this chapter is to determine whether there is any relation between general intelligence as measured by a general intelligence test, scores made on the general science test, and school marks or grades made in general science.

In the correlation between the intelligence quotients and the scores made on the test of the entire group of 300 seniors the coefficient of correlation was .49.¹ This is a fair correlation and shows that those students with higher intelligence quotients tend to make a higher score on the test. The graph² of this group shows that the distribution is fairly normal; the curve for the distribution of the scores, however, approaches a more normal curve than the curve for the distribution of intelligence quotients.

In the correlation between the school marks made in general science and the scores made on the test of the 258 seniors who studied general science the coefficient of correlation was .32³. This is a fair correlation and shows that those students who have a higher mark in general science tend to make a higher score on the test.

In the correlation between the intelligence quotients and the school marks of the 258 seniors who studied general science the co-

1 Page 47

2 Page 13

3 Page 48

efficient of correlation was .38.⁴ This is a fair correlation and shows that those students having a higher intelligence quotient tend to make a higher school mark in general science. This finding coincides to some extent with the results published in the Teachers College Record, "The coefficient of correlation between results of intelligence tests and school marks hovers around .5".⁵ If C. H. Nettels in his master's thesis at the University of Southern California, using 498 cases of college freshmen, can make the statement that a correlation of .23 between scores made on intelligence tests and high school marks was a good correlation, surely a .38 coefficient could be considered a better correlation. He further drew the conclusion that students who completed the greater number of high school units with marks of "A" or "B" stood a better chance of making a success in first year college work. The coefficient of correlation in this case was only 0.37.⁶ W. L. Eldredge in his master's thesis, "Testing in General Science," correlated the marks made in general science by the students in the Freehold, New York, school with their intelligence quotients and found the coefficient of correlation to be .5.⁷

In the correlation between the intelligence quotients and test scores of the 13 students of group 1, those students who made a school

4 Page 49

5 Ruth Strang, Research in Technics, Teachers College Record, Nov. 1935, p. 101

6 C. H. Nettels, Master's Thesis, University of Southern California, Aug. 1931.

7 W. L. Eldredge, Master's Thesis, Columbia University, Teachers College, 1930.

TEST SCORES AND IQ'S OF GROUP 1

GRAPH 4 22

No

21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1

SIGMA.													
-2.50		-1.50			-0.50			+0.50			+1.50		+2.50
98	0%	106	107	39.4%	115	116	30.7%	124	125	30.7%	133	134	0%
IQ'S													
Scores.													
29	0%	39	40	30.7%	50	51	46.1%	61	62	15.3%	72	73	7.6%
													83

mark of "A" in general science, the coefficient of correlation was .12.⁸ This coefficient is much lower than that of the entire group, but the difference can possibly be accounted for in part by the fact that the group is small, and that the students with the highest intelligence quotients do not necessarily apply themselves as much as those with less intelligence, and therefore the higher grades are distributed. In the graph⁹ of this group there is some correlation between the distribution of the scores and intelligence quotients.

In the correlation between the intelligence quotients and test scores of the 99 students of group 2, those students who made a school mark of "B" in general science, the coefficient of correlation was .25.¹⁰ This result is still low but it shows that the correlation of this group has a tendency to increase as it approaches the middle group which is composed of the average or "C" students. In the graph¹¹ of this group the curve of the intelligence quotients forms almost a perfect normal curve. The curve of the scores deviates somewhat but still there is much evidence to show that a student with a high intelligence in group 2 would probably make a high score on the test.

In the correlation between intelligence quotients and test scores of the 118 seniors of group 3, those students who made a school mark of "C" in general science, the coefficient was .26.¹² This is a slight

8 Page⁵⁰

9 Page 16

10 Page⁵¹

11 Page 17

TEST SCORES AND IQ'S OF GROUP 3

GRAPH 4.

No

increase over group 2 but there is only a slight increase in the number of students. This coefficient is further evidence of the tendency of the correlation to increase with the median group. In the graph¹³ for this group both the intelligence quotient curve and the test score curve are fairly normal curves which shows that there is probably a more even distribution in this group than in the other groups.

In the correlation between intelligence quotients and test scores of the 28 seniors of group 4, those students who made a school mark of "D" in general science, the coefficient of correlation was .23.¹⁴ This correlation as compared to group 2 is lower; however, this can be accounted for by the fact that there are only 28 students in group 4 and 99 students in group 2. As group 2 is one step above the average group¹⁵ and group 4 is one step below the average group the distribution would be expected to be about equal in these two groups. In the graph¹⁶ of this group one finds that a student in group 4 with an average intelligence quotient would have a better chance to make an average score on the test than would a student with a higher or lower intelligence quotient.

In the correlation between the intelligence quotients and test scores of the 42 students of group 5, those students who have not

12 Page 52

13 Page 19

14 Page 53

15 The mark for the average student is "C"

16 Page 20

TEST SCORES AND IQ's OF GROUP 5

GRAPH 6

studied general science, the coefficient of correlation was .68.¹⁷ As this test was a general science test it is to be expected that most of the questions would deal with subject matter studied in general science. As the students of this group have never studied general science it is interesting to note that this group has the highest correlation. This shows that the relationship between the intelligence quotients and the scores made by this group were closer than they were in any other group. This result shows that the test given had a high validity and also that the courses and faculty of the Central High School Science Department are aiding the students in the field of general science. It is to be expected that the student with the highest intelligence would normally make the highest grade on the test. This tendency has been prevalent throughout the general science group; however, it is outstanding in group 5 which is composed of those students who did not study general science. The students of this group have accumulated knowledge of general science from everyday experiences in comparison with their intellectual ability. In the graph¹⁸ of this group the curves for the intelligence quotients and test scores are fairly equal in distribution and have more tendency to coincide than in any other graph of the general science group.

17 Page 54

18 Page 22

Chapter IV

GENERAL SCIENCE

With the school marks as the determining factor in the groups studied, this chapter shows the results of the mean scores made by students who had studied general science in comparison to the mean score of the standardized test given.

Table I

	Mean Score	Mean Standard	Points Below	Points Above	Mean IQ*	Mean Senior IQ*
Group 1	55.8	57.1	1.3	0	120	109.44
Group 2	52.35	57.1	4.75	0	114	109.44
Group 3	45.9	57.1	11.2	0	106.85	109.44
Group 4	44.36	57.1	12.74	0	103.34	109.44
Group 5	44.37	57.1	12.23	0	107.2	109.44

This table shows that the mean score of group 1, those students who made a mark of "A" in general science, is 1.3 points below the mean score of the standardized test.

There are 13 students in this group; 6 are above the mean score of the standard, and 7 are below. The range of scores of this group are from 40 to 72, and the mean score of the group is 55.8.

The mean score of group 2, those students who made a mark of "B" in general science, is 4.75 points below the mean score of the standardized test.

*Comparison of IQ's given for information only.

RED LINE - ACTUAL GRADE LINE

BLACK LINE - NORMAL GRADE LINE

1 SQUARE = 12 PERSONS

ENTIRE GROUP OF GENERAL SCIENCE STUDENTS

There are 99 students in this group; 28 are above the mean score of the standard, and 71 are below. The range of scores are from 30 to 77, and the mean score of the group is 52.35.

The mean score of group 3, those students who made a mark of "C" in general science, is 11.2 points below the mean score of the standardized test.

There are 118 students in this group; 11 are on or above the mean score of the standard, and 107 are below. The range of scores is from 11 to 69, and the mean score of the group is 45.9.

The mean score of group 4, those students who made a mark of "D" in general science is 12.74 points below the mean score of the standardized test.

There are 28 students in this group; 4 are on or above the mean score of the standard, and 24 are below. The range of scores is from 23 to 69, and the mean score of this group is 44.36.

The mean score of group 5, those students who did not study general science, is 12.25 points below the mean score of the standardized test.

There are 42 students in this group; 5 are on or above the mean score of the standard, and 37 are below. The range of scores is from 11 to 77, and the mean score of the group is 44.87.

In the graph¹ of the entire group of 258 students who studied general science, only 13 made a mark of "A" while according to normal expectancy 25 should have made "A". 99 were given a mark of "B" by

their teachers, while by normal distribution only 51 should have made a grade of "B". 118 were given "C" while by normal distribution only 103 should have made "C". 28 made "D" while 51 should have made "D". There were no "E's" while 25 should have received a mark of "E". In comparing the actual grade curve with the normal curve the "B" and "C" groups are above normal while the "A", "D", and "E" groups are below normal. The teachers' grades do not fall on a normal curve but show a negative "skewness" to the left with the high points on the "B" marks.

Conclusion

Group 1

It would be expected that those students who received a mark of "A" would be above the norm of the test. Evidently the students were given too high a grade by their instructors and therefore did not belong in group 1 or the course of study in general science did not emphasize the material of the test.

Group 2

This group was equally surprising in that the low grade was only ten points below the low grade of group 1 and the high grade was five points higher than the high grade made by group 1. The greater number of cases fall below the norm. Evidently this group has been graded too high or the course of study is inadequate.

Group 3

While the range in scores of group 3 was greater (from 13 to 67)

than the range of the other two groups, the students of group 3 evidently know as much of the material emphasized on the test as did the students of groups 1 and 2. Theoretically the students in groups 1 and 2 should have fallen far above the normal score.

Group 4

The students in group 4 are the most surprising of all. The range of scores here was from 23 to 69. The low range was ten points higher than the low range of group 3 and the high range was the same. Evidently the students of group 4 had been underestimated by their instructors. In the light of these facts a question can be raised as to whether the students of group 1 and 2 are receiving the proper attention from their instructors. In regard to the question as to whether the course of study in general science emphasizes the scientific facts brought out in the test, it is well to note that the students of groups 3 and 4 were more nearly normal than were the students of the two higher groups.

Group 5

While the group is relatively small, the fact that the greater number of cases below the norm is indicative that they required formal instruction to help them in gaining scientific knowledge.

Chapter V

BIOLOGY

With the school marks as the determining factor in the groups studied, this chapter shows the results of the scores made by students who had studied biology in comparison to the mean of the standardized test given.

Table 2

	Mean Score	Mean Standard	Points Below	Points Above	Mean IQ*	Mean Senior IQ*
Group 1	60.6	57.1	0	3.5	114	109.44
Group 2	63.2	57.1	0	6.1	110	109.44
Group 3	52.8	57.1	3.3	0	107	109.44
Group 4	51.5	57.1	5.6	0	108	109.44
Group 5	46.7	57.1	10.4	0	109.2	109.44

This table shows that the mean score of group 1, those students who made a mark of "A" in biology, is 3.5 points above the mean score of the standardized test.

There are 6 students in this group; 4 are above the mean score of the standard, and 2 are below. The range of scores of this group is from 39 to 72, and the mean score of the group is 60.6.

The mean score of group 2, those students who made a mark of "B"

*Comparison of IQ's given for information only.

No

63
60
57
54
51
48
45
42
39
36
33
30
27
24
21
18
15
12
9
6
3

RED LINE-ACTUAL GRADE CURVE

BLACK LINE-NORMAL GRADE CURVE

1 SQUARE = 3 PERSONS

ENTIRE GROUP OF BIOLOGY STUDENTS

in biology, is 6.1 points above the mean score of the standardized test.

There are 12 students in this group; 8 are above the mean score of the standard and 4 are below. The range of scores is from 52 to 77, and the mean score of the group is 63.2.

The mean score of group 3, those students who made a mark of "C" in biology, is 3.3 points below the mean score of the standardized test.

There are 22 students in this group, 7 are on or above the mean score of the standard, and 15 are below. The range of scores is from 40 to 67, and the mean score of the group is 52.8.

The mean score of group 4, those students who made a mark of "D" in biology, is 5.6 points below the mean score of the standardized test.

There are 13 students in this group; 2 are on or above the mean score of the standard, and 11 are below. The range of scores is from 42 to 69, and the mean score of the group is 51.5.

The mean score of group 5, those students who did not study biology, is 10.4 points below the mean score of the standardized test.

There are 247 students in this group; 33 are on or above the mean score of the standard, and 217 are below. The range of scores is from 11 to 77, and the mean score of the group is 46.5.

According to the graph¹ of the 53 students who studied biology we find 6 students who made a mark of "A" in biology and only 5 should

have made an "A" by normal expectancy. 12 made a mark of "B" and only 10 should have made "B". 22 made a mark of "C" and 21 should have made "C". 13 made "D" and only 10 should have been given a "D". There were no "E's" and there should have been 5. This is a fairly good comparison with the normal expectancy as it will be noted that the actual grade curve for biology follows, with a few exceptions, a normal grade curve. The number of students who made grades of "A", "B", "C", and "D" are a little high, while there were no "E's".

Conclusion

Group 1

As 27 questions out of the 30 included in the standard test dealt directly with biology it would be expected that students having studied biology, and especially having received a mark of "A" in biology would be far above the norm of the test. As only 4 of the 6 "A" grade students were above the norm, and the mean for the group was 3.5 points above the standard and the mean for those who had never studied biology was only 10.4 points below the norm, it is evident that the teachers of biology were unable to judge correctly this group. Possibly the course offered in biology did not emphasize the material of the test, or the test was too complicated.

Group 2

The lowest score for this group was 52 as compared to a low score of 39 for group 1. The high score was 77 as compared to the high score of 72 for group 1. In the light of the fact that 4 people

of this group fell below the norm of the test when they should have been well above the norm to have received a grade of "B" it is concluded that the teachers of biology graded too leniently, or the course of study was inadequate.

Group 3

The results for this group show that the teachers graded more accurately this group than they did the other two groups. As this group was only 3.5 points below the norm of the test, it is apparent that the group approaches more nearly the average "C" group of the standard. The group showed the same tendency, that is, to be graded too high, but to a lesser degree than the other two groups.

Group 4

There are 5 people less above the norm, but the range was 2 points higher on both the high and low scores than in group 3. The "D" students evidently attained more knowledge than the teachers estimated. It is possible, therefore, that some of the "D" students were actually "C" students in biology.

Group 5

Approximately 14% of those who had never studied biology are on or above the norm of the test. While the average score, which was 10.4 points below the norm, tended to show that those who had studied biology knew more of the material of this test, yet there were individuals in this group who knew more than the students who had received a grade of "A" in biology. As a whole the study of biology tended to raise the scores made on the test.

Chapter VI

CHEMISTRY

With the school marks as the determining factor in the groups studied, this chapter shows the results of the mean scores made by students who had studied chemistry in comparison to the mean score of the standardized test given.

Table 3

	Mean Score	Mean Standard	Points Below	Points Above	Mean IQ*	Mean Senior IQ*
Group 1	64.1	57.1	0	7	120.8	109.44
Group 2	54.5	57.1	2.6	0	118.6	109.44
Group 3	51.0	57.1	6.1	0	110.9	109.44
Group 4	42.5	57.1	14.6	0	103.8	109.44
Group 5	53.1	57.1	4.0	0	106.8	109.44

This table shows that the mean score of group 1, those students who made a mark of "A" in chemistry, is 7 points above the mean score of the standardized test.

There are 9 students in this group; 6 are above the mean score of the standard, and 3 are below. The range of scores is from 50 to 74, and the mean score of the group is 64.1.

The mean score of group 2, those students who made a mark of "B"

*Comparison of IQ's given for information only.

RED LINE - ACTUAL GRADE CURVE

BLACK LINE - NORMAL GRADE CURVE

1 SQUARE = 6 PERSONS

ENTIRE CHEMISTRY GROUP

in chemistry, is 2.6 points below the mean score of the standardized test.

There are 52 students in this group; 18 are above the mean score of the standard, and 34 are below. The range of scores is from 34 to 77, and the mean score of the group is 54.5.

The mean score of group 3, those students who made a mark of "C" in chemistry, is 6.1 points below the mean score of the standardized test.

There are 61 students in this group; 9 are on or above the mean score of the standard, and 52 are below. The range of scores is from 25 to 69, and the mean score of the group is 51.0.

The mean score of group 4, those students who made a mark of "D" in chemistry, is 14.6 points below the mean score of the standardized test.

There are 26 students in this group and all are below the mean score of the standard. The range of scores is from 11 to 56, and the mean score of the group is 42.5.

The mean score of group 5, those students who did not study chemistry, is 4 points below the mean score of the standardized test.

There are 152 students in this group; 19 are on or above the mean score of the standard, and 143 are below. The range of scores is from 11 to 69, and the mean score of the group is 53.1.

In the graph¹ of the entire group of 148 students who studied chemistry there were 9 "A's" given by the instructors while according

to normal expectancy there should have been 15; 52 "B's" when there should have been only 29; 61 "C's" when there should have been 59; 26 "D's" when there should have been 29; no "E's" when there should have been 15. It is evident, therefore, in comparison to a normal distribution there were too many "B's" and not enough "A's" or "E's".

Conclusion

Group 1

Since there are 25 questions on the test that dealt directly or indirectly with the study of chemistry we would expect the study of this course to affect the scores made on the test. In this group only 6 students out of the 9 are above the norm. It is possible that the study of chemistry had some effect on the scores, but the teachers' grades are far too high as there are actually no "A" students in this group as compared to the requirements of the test. The teachers of chemistry either graded too high, or the course of study was inadequate, or the test was too complicated.

Group 2

The scores are lower (34 as compared to 50 for group 1) and the group as a whole was 2.6 points below the norm of the test. The teachers have graded this group too high or the subject material in chemistry does not follow the material of the test, or the test was too complicated.

Group 3

Only 9 of the 61 people of this group are above the norm, and the

group was 6.1 points below the norm. In order to have a fairly accurate "C" group, approximately 30 of these people should have been above 57.1, the norm of the test. It is evident that the grading was too high, or the course of study in chemistry inadequate, or the test too complicated.

Group 4

The people who compose this group have been graded fairly accurately even though they are 14.6 points below the norm of the test. None was above the norm of the test, but approximately 8 should have possibly received a mark of "E" in comparison to the results of this test.

Group 5

Approximately 12% of the 152 students who did not study chemistry are above the norm of the test. The average score was only 4 points below the norm of the test. In comparison to score made in the "A" and "B" groups it is evident that the study of chemistry had some effect on the scores made on the test. The low score of groups 1 and 2 was 34 as compared to the low score of 11 for this group.

Chapter VII

PHYSICS

With the school marks as the determining factor in the groups studied, this chapter shows the results of the scores made by students who had studied physics in comparison to the mean score of the standardized test given.

Table 4

	Mean Score	Mean Standard	Points Below	Points Above	Mean IQ*	Mean Senior IQ*
Group 1	67.7	57.1	0	10.6	121.0	109.44
Group 2	62.7	57.1	0	5.6	117.3	109.44
Group 3	49.6	57.1	7.5	0	110.5	109.44
Group 4	56.5	57.1	.6	0	113.5	109.44
Group 5	46.4	57.1	10.7	0	109.2	109.44

This table shows that the mean score of group 1, those students who made a mark of "A" in physics, is 10.6 points above the mean score of the standardized test.

There are 12 students in this group, and all but 1 are above the mean score of the standard. The range of scores is from 48 to 77, and the mean score of the group is 67.7.

The mean score of group 2, those students who made a mark of "B" in physics, is 5.6 points above the mean score of the standardized test.

*Comparison of IQ's given for information only.

RED LINE - ACTUAL GRADE CURVE

BLACK LINE - NORMAL GRADE CURVE

1 SQUARE = 3 PERSONS

ENTIRE PHYSICS GROUP

There are 15 students in this group; 12 are above the mean score of the standard, and 3 are below. The range of scores is from 40 to 70, and the mean score of the group is 62.7.

The mean score of group 3, those students who made a mark of "C" in physics, is 7.5 points below the mean score of the standardized test.

There are 21 students in this group, and only 3 are above the mean score of the standard. The range of scores is from 30 to 65, and the mean score of the group is 49.6.

The mean score of group 4, those students who made a mark of "D" in physics, is .6 of a point below the mean score of the standardized test.

There are 12 students in this group; 5 are above the mean score of the standard, and 7 are below. The range of scores is from 42 to 69, and the mean score of the group is 56.5.

The mean score of group 5, those students who did not study physics, is 10.7 below the mean score of the standardized test.

There are 240 students in this group, and all but 24 are below the mean score of the standard. The range of scores is from 11 to 77, and the mean score of the group is 46.4.

In the graph¹ of the entire group of students who studied physics there were 12 "A's" given, and by normal expectancy there should have been 6 "A's". 15 "B's" were given and there should have been 12. 21 "C's" were given and there should have been 24. The "D's" fall correct. There should have been 6 "E's" and none were given.

Conclusion

Group 1

This group was 10.6 points above the norm of the test, and all but 1 of the 12 students are above the norm. This is by far the best group, and having made a grade of "A" in physics definitely aided in the scores made on the test. In comparison to the requirements of the test, however, these people are not "A" students. There are 29 questions dealing with physics, but the teachers of physics are grading too high even in this group, or the course of study was inadequate, or the test too complicated.

Group 2

13 people out of the 15 in this group are above the norm, and possibly 3 or 4 could be considered "B" students in comparison to the test. The study of physics aided the scores made by this group, but the teachers' grading was a little high but they are fairly accurate in comparison to the results of the other groups.

Group 3

Only 3 people out of the 21 students who made a grade of "C" in physics are above the norm of the test, and the mean score was 7.5 points below the norm. This group was definitely graded too high for the most part as there should have been an approximate 10 above the norm for this group. There are 6 students in this group who are "D" or "E" students. The teachers of physics were grading too high, or the course of study in physics was inadequate, or the test too complicated.

Group 4

This group who have a school mark in physics of "D" range above the "C" group. The lowest grade was 42 as compared with 30 of the "C" group. There were 5 people in this group above the norm. 2 people made a score of 69 as compared with only 65 in the "C" group. The students of this group have been graded too low for they are actually "C" students (excepting possibly 3). The teachers of physics have misjudged the intelligence of this group. It is evident that the study of physics had a definite bearing on the scores by the results shown for group 1; therefore, these people have been mis-graded by their teachers.

Group 5

Of the 240 students who did not study physics approximately 9% are above the norm of the test, but the mean was 10.7 points below. This definitely shows that the study of physics had much to do with the scores made on the test.

Chapter VIII

SUMMARY AND CONCLUSIONS

Correlation

IQ's of 300 seniors—Scores of 300 seniors	0.49
Marks of 258 seniors in general science—Scores of 258 seniors	0.32
IQ's of 258 seniors—Marks in general science of 258 seniors	0.38
IQ's of Group 1 ¹ —Scores of Group 1	0.12
IQ's of Group 2 ² —Scores of Group 2	0.25
IQ's of Group 3 ³ —Scores of Group 3	0.26
IQ's of Group 4 ⁴ —Scores of Group 4	0.23
IQ's of Group 5 ⁵ —Scores of Group 5	0.68

Group 1

Those students who made a school mark of "A"

	Mean Score	Mean Standard	Points Below	Points Above
General Science	55.8	57.1	1.3	0
Biology	60.6	57.1	0	3.5
Chemistry	64.1	57.1	0	7
Physics	67.7	57.1	0	10.6

- 1 Those students who made a mark of "A" in general science.
- 2 Those students who made a mark of "B" in general science.
- 3 Those students who made a mark of "C" in general science.
- 4 Those students who made a mark of "D" in general science.
- 5 Those students who did not study general science.

Group 2

Those students who made a school mark of "B"

	Mean Score	Mean Standard	Points Below	Points Above
General Science	52.35	57.1	4.75	0
Biology	63.2	57.1	0	6.1
Chemistry	54.5	57.1	2.6	0
Physics	62.7	57.1	0	5.6

Group 3

Those students who made a school mark of "C"

	Mean Score	Mean Standard	Points Below	Points Above
General Science	45.9	57.1	11.2	0
Biology	52.3	57.1	3.3	0
Chemistry	51.0	57.1	6.1	0
Physics	49.6	57.1	7.5	0

Group 4

Those students who made a school mark of "D"

	Mean Score	Mean Standard	Points Below	Points Above
General Science	44.56	57.1	12.74	0
Biology	51.5	57.1	5.6	0
Chemistry	42.5	57.1	14.6	0
Physics	56.5	57.1	.6	0

Group 5

Those students who did not study

	Mean Score	Mean Standard	Points Below	Points Above
General Science	44.87	57.1	12.23	0
Biology	46.7	57.1	10.4	0
Chemistry	53.1	57.1	4.0	0
Physics	46.4	57.1	10.7	0

In each group according to the scores made on the test the students were either to a great degree or to a small degree out of their class; e. g. those classed as "A" students in general science made scores on the test far below normal. In comparing the grades the students received with the scores made on the standardized test, in practically every case the students were either graded too high, or the course of study was inadequate, or the test was too complicated. To determine which of these was the cause would require a new study of entirely different nature.

APPENDIX

X	73	76	79	82	85	88	91	94	97	100	103	106	109	112	115	118	121	124	127	130	133	136	139	142	145	r_y	d_y	rd_y	rd_y^2	$\sum f_{yx}d_x$	$\sum f_{yx}d_x^2$
Y	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10	+11	+12						
83																										0	+12	0	0		
80																										0	+11	0	0		
77																										2	+10	20	200	9	90
74																										1	+9	9	81	5	45
71																										2	+8	16	128	9	72
68																										10	+7	70	490	19	133
65																										11	+6	66	396	25	150
62																										5	+5	25	125	2	10
59																										11	+4	44	176	35	140
56																										24	+3	72	216	32	96
53																										34	+2	68	136	19	38
50																										37	+1	37	37	11	11
47																										32	0	427	21		
44																										34	-1	34	34	41	41
41																										18	-2	36	72	1	2
38																										37	-3	111	333	67	201
35																										15	-4	60	240	13	52
32																										7	-5	35	175	19	95
29																										6	-6	36	216	3	18
26																										4	-7	28	196	19	133
23																										9	-8	72	576	47	376
20																										0	-9	0	0		
17																										0	-10	0	0		
14																										0	-11	0	0		
11																										1	-12	12	144	9	108
$\sum x$	2	3	1	1	5	9	10	8	9	19	34	25	45	40	23	17	19	15	7	2	1	0	1	1	3	300	11	424	3971	1781	30
d_x	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10	+11	+12	d_x					
rd_x	24	33	10	9	40	63	60	40	36	57	68	25	465	40	46	51	76	75	42	14	8	0	10	11	36	409	$\sum rd_x$				
$\sum (d_x)^2$	288	363	100	81	320	441	360	200	144	151	136	25	465	40	92	153	304	375	252	98	64	0	100	121	432	4660	$\sum (d_x)^2$				

Calculation for Means (M_y , M_x)

$\sum rd_y$	427
$\sum rd_y$	424
$\sum rd_y$	3
$\sum rd_y$	.01
$\frac{\sum rd_y}{N}$	.0001
$\frac{\sum rd_y}{N}$	3
$c_y \times i_y$	.03
M_y	48
$M_y + c_y$	48.03

$\sum rd_x$	409
$\sum rd_x$	465
$\sum rd_x$	56
$\sum rd_x$	.186
$\frac{\sum rd_x}{N}$	.034596
$\frac{\sum rd_x}{N}$	3
$c_x \times i_x$	.558
M_x	110
$M_x + c_x$	109.442

Calculation for Sigmas (σ_y , σ_x)

$\sum (d_y)^2$	3971
$\sum (d_y)^2$	13.23
$\frac{\sum (d_y)^2}{N}$	.0001
$\frac{\sum (d_y)^2}{N}$	13.2299
$\sqrt{\frac{\sum (d_y)^2}{N} - c_y^2}$	3.63
$\frac{\sum (d_y)^2}{N} - c_y^2$	10.89
$\sum (d_x)^2$	4660
$\sum (d_x)^2$	15.53
$\frac{\sum (d_x)^2}{N}$	.034596
$\frac{\sum (d_x)^2}{N} - c_x^2$	15.495404
$\sqrt{\frac{\sum (d_x)^2}{N} - c_x^2}$	3.69
$\frac{\sum (d_x)^2}{N} - c_x^2$	11.07

Calculation for Coefficient of Correlation (r_{xy}) and errors (σ_r , P.E._r)

$\sum (f_{yx}d_x^2)$	1751
$\sum (f_{yx}d_x^2)$	5.836
$c_y \times c_x$	.00186
Numerator	5.83414
$\frac{\sum (f_{yx}d_x^2)}{N}$	13.3947
Denominator	.49
r_{xy}	

Subtract

[illegible]

Calculation for Means (M_y , M_x)

$\Sigma r d_y$		371	
$\Sigma r d_y^2$		328	
$\Sigma r d_y$	+	43	
$\Sigma r d_y$	+	.166	C_y
N			
s_y^2		.027556	
s_y		3	
$C_y \times s_y$	+	.498	C_y
M_y		48.000	
$M_y - C_y$		48.498	M_y

Σfd_x	595	
$\Sigma -fd_x$	645	
Σfd_x^2	150	
$\frac{\Sigma fd_x}{N}$	.581	C_x
C_x^2	.337561	
1_x	1	
$C_x \times 1_x$	.581	C_x
M_x	8.7	
$M_x \times C_x$	86.419	M_x

Calculation for Sigmas (σ_y , σ_x)

$\frac{\Sigma f(d_y)^2}{N}$	34.1	
$\frac{\Sigma f(d_y)^2}{N} - c_y^2$	12.17	
c_y^2	0.2756	
$\frac{\Sigma f(d_y)^2}{N} - c_y^2$	12.1424	
$\sqrt{\frac{\Sigma f(d_y)^2}{N} - c_y^2}$	3.48	d_y
	10.44	c_y
$c_d \cdot c_y$		
$\frac{\Sigma f(d_x)^2}{N}$	8362	
$\frac{\Sigma f(d_x)^2}{N}$	32.410000	
c_x^2	3.37561	
$\frac{\Sigma f(d_x)^2}{N} - c_x^2$	32.072439	
$\sqrt{\frac{\Sigma f(d_x)^2}{N} - c_x^2}$	5.66	d_x
$c_d \cdot c_x$	5.66	c_x

Calculation for Coefficient of Correlation (r_{xy}) and errors (σ_r , P.E.r)

$\Sigma(Zf_{yz}d_{xy}^2x_{dy})$	1605	Subtract
$\Sigma(Zf_{yz}d_{xy}^2d_{xy})$	6.2200	
$c_y \times c_x$	.0964	
Numerator	6.3164	
$d_{dy} \times d_{dx}$	17.6468	
$\frac{\text{Numerator}}{\text{Denominator}}$	.32	r_{xy}

[illegible]

Calculation for Means (M_Y , M_X)

$\Sigma x d_y^2$	530	
$\Sigma x f d_y^2$	697	
$\Sigma f d_y^2$	167	
$\frac{\Sigma f d_y^2}{N}$	.647	C_y
σ_y^2	.4185	
σ_y	.647	
$C_y \times \sigma_y$	.4185	C_y
μ_y	87.0000	
$\mu_y + C_y$	86.5815	M_y

$\Sigma f d_x^1$	364	
$\Sigma f d_x^2$	390	
$\Sigma f d_x^3$	26	
$\frac{\Sigma f d_x^3}{N}$	.1	C_x
C_x^2	.01	
i_x	3	
$C_x \cdot i_x$	.33	C_x
M_x^1	110	
$M_x^1 \cdot C_x$	109.67	M_x

Calculation for Sigmas (σ_y , σ_x)

$\frac{E_f(d_y^2)^2}{N}$	8309	
$\frac{E_f(d_y^2)^2}{N}$	32.000	
$\frac{E_f(d_y^2)^2}{N} - \frac{C_y^2}{C_y}$	.4185	
$\frac{E_f(d_y^2)^2}{N} - \frac{C_y^2}{C_y}$	31.7815	
$\sqrt{\frac{E_f(d_y^2)^2}{N} - \frac{C_y^2}{C_y}}$	5.63	σ_{d_y}
$\frac{C_{d_y} \times I_y}{C_{d_y}}$	5.63	σ_y
$\frac{E_f(d_x^2)^2}{N}$	4080	
$\frac{E_f(d_x^2)^2}{N}$	15.81	
$\frac{E_f(d_x^2)^2}{N} - \frac{C_x^2}{C_x}$	.01	
$\frac{E_f(d_x^2)^2}{N} - \frac{C_x^2}{C_x}$	15.80	
$\sqrt{\frac{E_f(d_x^2)^2}{N} - \frac{C_x^2}{C_x}}$	3.97	σ_{d_x}
$\frac{C_{d_x} \times I_x}{C_{d_x}}$	11.91	σ_x

Calculation for Coefficient of Correlation
(r_{xy}) and errors (σ_r , P.E._r)

$\sum (Zf_{xy}x^2y)$	2225	} Subtract
$\sum (Zf_{xy}xy^2)$	8.6200	
$c_y \times c_x$	.0647	
Numerator	8.5553	
$c_d y \times c_d x$	22.3511	
$\frac{\text{Numerator}}{\text{Denominator}}$	.38	r_{xy}

Coefficient of Correlation between (X) INTELLIGENCE QUOTIENTS OF GROUP I and (Y) SCORES OF GROUP I

X	101	103	105	107	109	111	113	115	117	119	121	123	M _x	125	127	129	131	133	135	137	139	141	143	145	147	149	f _y	d _y	fd _y	fd _y ²	Σf _y x ^{d_y}	Σf _y x ^{d_y} × d _y
Y	102	104	106	108	110	112	114	116	118	120	122	124	126	128	130	132	134	136	138	140	142	144	146	148	150							
	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10	+11	+12							
77																										0	+12	0	0			
75																										0	+11	0	0			
73																										0	+10	0	0			
71																										2	+9	18	162	3		27
69																										2	+8	16	128	2		16
67																										0	+7	0	0			
65																										0	+6	0	0			
63																										0	+5	0	0			
61																										1	+4	4	16	7		28
59																										0	+3	0	0			
57																										1	+2	2	4		6	12
55																										0	+1	0	0			
53																										2	0	40	Σrd _y	7		
51																										0	-1	0	0			
49																										0	-2	0	0			
47																										3	-3	9	27	7		21
45																										0	-4	0	0			
43																										1	-5	5	25	7		35
41																										0	-6	0	0			
39																										1	-7	7	49	8		56
37																										0	-8	0	0			
35																										0	-9	0	0			
33																										0	-10	0	0			
31																										0	-11	0	0			
29																										0	-12	0	0			
Σ	0	0	0	0	2	1	1	0	1	2	2	1	0	1	0	1	0	0	0	1	0	0	0	0	0	13	Σ	21	411		140	55
d _x	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10	+11	+12	Σ	Σrd _x	Σd _y ²				
rd _x	0	0	0	0	16	7	6	0	4	6	4	1	44	1	0	3	0	0	0	7	0	0	0	0	0	11	Σrd _x	Σrd _x ²				
r(d _x) ²	0	0	0	0	128	49	36	0	16	18	8	1	Σrd _x	1	0	27	0	0	0	49	0	0	0	0	0	333	Σrd _x ²					

Calculation for Means (M_y, M_x)

Σrd _y	40
Σrd _y	21
Σrd _y	19
Σrd _y	1.4
N	1.96
c _y	2
c _y × i _y	2.8
M _y	53
M _y + c _y	55.8

Σrd _x	11
Σrd _x	44
Σrd _x	33
Σrd _x	2.5
N	6.25
c _x	2
c _x × i _x	5
M _x	12.5
M _x + c _x	120

Calculation for Sigmas (σ_y, σ_x)

Σf(d _y) ²	411
Σf(d _y) ²	31.6
N	1.96
Σf(d _y) ² - c _y ²	29.64
Σf(d _y) ² - c _y ²	5.44
c _y × i _y	10.88
Σf(d _x) ²	333
Σf(d _x) ²	25.61
N	6.25
Σf(d _x) ² - c _x ²	19.36
Σf(d _x) ² - c _x ²	4.4
c _x × i _x	8.8

Calculation for Coefficient of Correlation (r_{xy}) and errors (σ_r, P.E._r)

Σ(Σf _y x ^{d_y} × d _y)	85
Σ(Σf _y x ^{d_y} × d _y)	6.53
c _y × c _x	3.50
Numerator	3.03
σ _y × σ _x	23.936
Numerator	.12
Denominator	r _{xy}

Subtract

Coefficient of Correlation between (X) INTELLIGENCE QUOTIENTS OF GROUP II and (Y) SCORES OF GROUP II

X	81	84	87	90	93	96	99	102	105	108	111	114	117	120	123	126	129	132	135	138	141	144	147	150	153	f_y	d_y^1	$f d_y^1$	$f d_y^2$	$2f y x d_x^1$	$2f y x d_x^2$		
Y	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10	+11	+12					+	-	+	-
76																										1	+12	12	144	2		24	
74																										1	+11	11	121	2		22	
72																										0	+10	0	0				
70																										3	+9	27	243	8		72	
68																										3	+8	24	192	3		24	
66																										2	+7	14	98	1		7	
64																										6	+6	36	216	5		30	
62																										4	+5	20	100	8		40	
60																										4	+4	16	64	2		8	
58																										4	+3	12	36	3		9	
56																										6	+2	12	24	11		22	
54																										6	+1	6	6	9		9	
52																										6	0	190	$2 f d_y^1$				
50																										11	-1	11	11	29	29		
48																										8	-2	16	32	21	42		
46																										7	-3	21	63	11	33		
44																										5	-4	20	80	20	80		
42																										4	-5	20	100	1	5		
40																										6	-6	36	216	16	96		
38																										7	-7	49	343	10	70		
36																										1	-8	8	64	8		64	
34																										1	-9	9	81	1	9		
32																										1	-10	10	100	5	50		
30																										2	-11	22	242	9	99		
28																										0	-12	0	0				
Σf_x	0	0	1	1	0	1	4	10	7	10	16	14	6	11	9	4	2	0	0	0	1	1	1	0	0	99	11	222	2576	653	191		
d_x^1	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10	+11	+12	d_x^1							
$f d_x^1$	0	0	10	9	0	7	24	50	28	30	32	14	204	11	18	12	8	0	0	0	8	9	10	0	0	76	$\Sigma f d_x^1$						
$f(d_x^1)^2$	0	0	100	81	0	49	144	250	112	90	64	14	204	11	36	36	32	0	0	0	64	81	100	0	0	1264	$\Sigma f(d_x^1)^2$						

Calculation for Means (M_y , M_x)

$\Sigma f d_y^1$	190
$\Sigma f d_y^2$	222
$\Sigma f d_y^3$	32
$\Sigma f d_y^4$	323
$\frac{\Sigma f d_y^1}{N}$	1.90
c_y	1.04329
Σf_y	2
$c_y \times 1_y$	.646
M_y	53
$M_y + c_y$	52.354

$\Sigma f d_x^1$	76
$\Sigma f d_x^2$	204
$\Sigma f d_x^3$	128
$\Sigma f d_x^4$	129
$\frac{\Sigma f d_x^1}{N}$	1.29
c_x	1.6641
Σf_x	3
$c_x \times 1_x$	3.87
M_x	118
$M_x + c_x$	114.13

Calculation for Sigmas (σ_y , σ_x)

$\Sigma f(d_y^1)^2$	2576
$\frac{\Sigma f(d_y^1)^2}{N}$	26.02
c_y^2	.104329
$\frac{\Sigma f(d_y^1)^2}{N} - c_y^2$	25.915671
$\sqrt{\frac{\Sigma f(d_y^1)^2}{N} - c_y^2}$	5.09
σ_y	10.18
$\Sigma f(d_x^1)^2$	1264
$\frac{\Sigma f(d_x^1)^2}{N}$	12.76
c_x^2	1.6641
$\frac{\Sigma f(d_x^1)^2}{N} - c_x^2$	11.0959
$\sqrt{\frac{\Sigma f(d_x^1)^2}{N} - c_x^2}$	3.33
σ_x	9.99

Calculation for Coefficient of Correlation (r_{xy}) and errors (σ_r , P.E.r)

$\Sigma (\Sigma f_{yx} d_x^1 d_y^1)$	462
$\frac{\Sigma (\Sigma f_{yx} d_x^1 d_y^1)}{N}$	4.66
$c_y \times c_x$	1.6667
Numerator	4.24333
$\sigma_y \times \sigma_x$	16.9497
Denominator	.25
r_{xy}	

Subtract

$$\Sigma(\Delta f_{yx} d_x^i \times d_y^i)$$

$\Sigma(Zf_{yx}d_x^2d_y)$	+	45	} Subtract
$\Sigma(Zf_{yx}d_x^2d_y)$	+	.38	
$c_y \times c_x$		2.415	
Numerator	+	2.795	
$d_y \times d_x$		10.374	
Numerator Denominator		.26	r_{xy}

Coefficient of Correlation between (X) INTELLIGENCE QUOTIENTS OF GROUP IV and (Y) SCORES OF GROUP IV

X	73	75	77	79	81	83	85	87	89	91	93	95	97	99	101	103	105	107	109	111	113	115	117	119	121	r_y	d_y	rd_y	rd_y^2	$\sum f_{yx}d_x$	$\sum f_{yx}d_x^2$
Y	74	76	78	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110	112	114	116	118	120	122	+	-	+	-	+	-
70	71																									0	+12	0	0		
68	69																									1	+11	11	121	4	44
66	67																									0	+10	0	0		
64	65																									0	+9	0	0		
62	63																									0	+8	0	0		
60	61																									1	+7	7	49	3	21
58	59																									1	+6	6	36	7	42
56	57																									1	+5	5	25	8	40
54	55																									1	+4	4	16	6	24
52	53																									1	+3	3	9	9	27
50	51																									5	+2	10	20	41	82
48	49																									1	+1	1	1	6	6
46	47																									2	0	41			
44	45																									0	-1	0	0		
42	43																									1	-2	2	4	7	14
40	41																									2	-3	6	18	7	21
38	39																									4	-4	16	64	3	12
36	37																									2	-5	10	50	5	25
34	35																									1	-6	6	36	3	18
32	33																									0	-7	0	0		
30	31																									0	-8	0	0		
28	29																									0	-9	0	0		
26	27																									1	-10	10	100		
24	25																									2	-11	22	242	5	55
22	23																									1	-12	12	144	12	144
$\sum x$	1	0	1	0	0	0	1	0	1	0	2	1	2	0	1	6	1	0	3	3	1	1	1	2	0	28	84	935		443	132
$\sum x^2$	12	0	10	0	0	0	6	0	4	0	4	1	37	0	2	18	4	0	18	21	8	9	10	22	0	112					
$\sum (d_x)^2$	144	0	100	0	0	0	36	0	16	0	8	1	37	0	4	54	16	0	108	147	64	81	100	242	0	113					

Calculation for Means (M_y , M_x)

$\sum f d_y$	+47
$\sum f d_y$	-84
$\sum f d_y$	37
$\sum f d_y$	1.32
c_y	1.7424
$\sum x$	2
$c_y \times \sum x$	2.64
M_y	47
$M_y + c_y$	44.36

$\sum f d_x$	+112
$\sum f d_x$	-37
$\sum f d_x$	75
$\sum f d_x$	2.67
c_x	7.1289
$\sum x$	2
$c_x \times \sum x$	5.34
M_x	98
$M_x + c_x$	103.34

Calculation for Sigmas (c_y , c_x)

$\sum f (d_y)^2$	935
$\sum f (d_y)^2$	33.3
c_y^2	1.7424
$\sum f (d_y)^2 - c_y^2$	31.5576
$\sqrt{\sum f (d_y)^2 - c_y^2}$	5.61
$c_y \times \sum x$	11.22
$\sum f (d_x)^2$	1113
$\sum f (d_x)^2$	39.7
c_x^2	7.1289
$\sum f (d_x)^2 - c_x^2$	32.5711
$\sqrt{\sum f (d_x)^2 - c_x^2}$	5.7
$c_x \times \sum x$	11.4

Calculation for Coefficient of Correlation (r_{xy}) and errors (c_r , P.E._r)

$\sum (f_{yx} d_x d_y)$	311
$\sum (f_{yx} d_x d_y)$	11.11
$c_y \times c_x$	3.5244
Numerator	7.5856
$c_y \times d_x$	31.9770
Denominator	.23
r_{xy}	

Subtract

Coefficient of Correlation between (X) INTELLIGENCE QUOTIENTS OF GROUP Y and (Y) SCORES OF GROUP X

X	60	63	66	69	72	75	78	81	84	87	90	93	96	99	102	105	108	111	114	117	120	123	126	129	132	f_y	d_y	fd_y	d_y^2	$\sum f_y d_y$	$\sum f_y d_y^2$	$\sum f_y d_y^3$	$\sum f_y d_y^4$
Y	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10	+11	+12								
19																										0	+12	0	0				
76																										1	+11	11	121	8			88
73																										0	+10	0	0				
70																										0	+9	0	0				
67																										2	+8	16	128	12			96
64																										1	+7	7	49	10			70
61																										0	+6	0	0				
58																										0	+5	0	0				
55																										6	+4	24	96	35			140
52																										5	+3	15	45	25			75
49																										7	+2	14	28	37			74
46																										1	+1	1	1	2			2
43																										3	0	88					
40																										1	-1	1	1	4			4
37																										5	-2	10	20	4			8
34																										3	-3	9	27	4			12
31																										0	-4	0	0				
28																										2	-5	10	50	6			30
25																										2	-6	12	72	5			30
22																										0	-7	0	0				
19																										0	-8	0	0				
16																										1	-9	9	81	1			9
13																										0	-10	0	0				
10																										1	-11	11	121	5			55
7																										1	-12	12	144	2			24
f_x	0	0	0	0	0	1	1	1	0	1	2	1	1	2	4	4	5	7	4	1	2	4	1	0	0	42							
d_x	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10	+11	+12	d_x							
fd_x	0	0	0	0	0	7	6	5	0	3	4	1	26	2	8	12	20	35	24	7	16	36	10	0	0	170							
$f(d_x)^2$	0	0	0	0	0	49	36	25	0	9	8	1	26	2	16	36	80	175	144	49	128	324	100	0	0	1182							

Calculation for Means (M_y , M_x)

$\Sigma f d_y$	88
$\Sigma f d_y$	74
$\Sigma f d_y$	14
$\Sigma f d_y$	.33
$\frac{\Sigma f d_y}{N}$	.99
$\frac{1}{N}$	3
$c_y \times 1_y$	.59
M_y	44
$M_y + C_y$	44.99

$\Sigma f d_x$	170
$\Sigma f d_x$	26
$\Sigma f d_x$	144
$\Sigma f d_x$	3.4
$\frac{\Sigma f d_x}{N}$	11.56
$\frac{1}{N}$	3
$c_x \times 1_x$	10.2
M_x	97
$M_x + C_x$	107.2

Calculation for Sigmas (σ_y , σ_x)

$\Sigma f(d_y)^2$	984
$\frac{\Sigma f(d_y)^2}{N}$	23.42
$\frac{\Sigma f(d_y)^2}{N} - c_y^2$	.99
$\sqrt{\frac{\Sigma f(d_y)^2}{N} - c_y^2}$	4.73
$\sigma_y \times 1_y$	14.19
$\Sigma f(d_x)^2$	1182
$\frac{\Sigma f(d_x)^2}{N}$	28.82
$\frac{\Sigma f(d_x)^2}{N} - c_x^2$	11.56
$\sqrt{\frac{\Sigma f(d_x)^2}{N} - c_x^2}$	17.26
$\sigma_x \times 1_x$	4.15
σ_x	12.45

Calculation for Coefficient of Correlation (r_{xy}) and errors (σ_r , P.E.r)

$\Sigma (f_{yx} d_x^1 d_y^1)$	609
$\Sigma (f_{yx} d_x^1 d_y^1)$	14.500
$c_y \times c_x$	1.122
Numerator	13.378
$\sigma_y \times \sigma_x$	19.6295
Denominator	.68
r_{xy}	

Subtract

GENERAL TABLE

CASE	I.Q.	TEST (SCALED SCORE)	GENERAL SCIENCE	BIOLOGY	CHEMISTRY	PHYSICS
1.	147	61	B		B	
2.	146	65	B			B
3.	145	51	C			D
4.	143	37	B		B	
5.	139	61	A			A
6.	134	59	C			B
7.	132	47	A		C	
8.	130	39	B		B	
9.	129	52	B		B	
10.	128	50	C		B	
11.	127	46	B		B	
12.	127	65	B		B	B
13.	127	48	C		C	D
14.	127	70	A		A	
15.	127	43	B			
16.	126	46	B			C
17.	126	65		B		A
18.	126	56	C		B	
19.	125	57			B	
20.	125	51	C		B	
21.	125	69	B			
22.	125	53	B		B	
23.	125	68	B		A	

GENERAL TABLE

CASE	I.Q.	TEST	GENERAL SCIENCE	BIOLOGY	CHEMISTRY	PHYSICS
24.	125	39	C			
25.	124	74	B	B	A	A
26.	124	72	A	A	A	A
27.	124	65	B	B	B	
28.	124	55	C		B	
29.	124	53			A	
30.	124	77	B	B	B	A
31.	123	46	B	C	C	
32.	123	51			B	
33.	123	56				
34.	123	63	B		B	
35.	123	43	B		B	
36.	122	55		B		
37.	122	59	B		B	
38.	122	45	C		C	
39.	122	72	A		B	A
40.	122	50	C		A	
41.	122	39	C			
42.	122	47	A		B	
43.	121	54	B		C	
44.	121	65	B		C	C
45.	121	77			B	
46.	121	56	B		B	
47.	121	53	B			B

GENERAL TABLE

CASE	I.Q.	TEST	GENERAL SCIENCE	BIOLOGY	CHEMISTRY	PHYSICS
48.	121	52	B		C	
49.	121	38	B			
50.	120	52	B	B	B	
51.	120	51	B			
52.	120	69	A		B	A
53.	120	56	B		D	
54.	120	50	D			
55.	120	61	B		B	
56.	120	54	A		B	
57.	119	53	C			
58.	119	56	C		C	
59.	119	50	D			
60.	119	57	C			C
61.	119	37	C		C	
62.	119	61	B	C	C	
63.	118	68		C	C	B
64.	118	50	B		B	
65.	118	40	B			
66.	118	66	B	B		D
67.	117	35	C			C
68.	117	39	C			
69.	117	53	C		C	
70.	117	54	A		B	B
71.	117	50	B			

GENERAL TABLE

CASE	I.Q.	TEST	GENERAL SCIENCE	BIOLOGY	CHEMISTRY	PHYSICS
72.	117	67	C	C	B	
73.	117	50	D	D		D
74.	117	49	B		B	
75.	117	50	C			
76.	116	51		A	B	
77.	116	39	C			
78.	116	59	B			
79.	116	54	C	D		C
80.	115	51	B			
81.	115	69	B	B	C	B
82.	115	53	D			
83.	115	39	B		C	
84.	115	44				C
85.	115	54	B	C	D	
86.	115	49	C		B	
87.	115	58	B	B	C	C
88.	115	70	B	B	B	A
89.	115	41	C		C	
90.	114	67	B	B	C	B
91.	114	39	B	B	B	
92.	114	39			C	
93.	114	53			B	
94.	114	35	B		C	
95.	114	49	B		C	

GENERAL TABLE

CASE	I.Q.	TEST	GENERAL SCIENCE	BIOLOGY	CHEMISTRY	PHYSICS
96.	114	58	C			A
97.	114	40	B		B	
98.	114	60	B		A	A
99.	114	41	C	C		
100.	114	57	D	D	C	
101.	114	40	B			
102.	113	56	B	C	C	C
103.	113	46	C		C	C
104.	113	32	C			
105.	113	53	C		D	
106.	113	69				A
107.	113	58	A		C	
108.	113	39	C		C	
109.	113	41	C		D	
110.	113	49			B	
111.	113	57	C	C		
112.	113	56	C			
113.	113	49				
114.	113	45	B			
115.	113	45	B			
116.	112	70	B	A	B	A
117.	112	48	B		C	
118.	112	58	D	C	C	
119.	112	39	C		C	

GENERAL TABLE

CASE	I.Q.	TEST	GENERAL SCIENCE	BIOLOGY	CHEMISTRY	PHYSICS
120.	112	62	B			B
121.	112	49	C		C	
122.	112	43	D			
123.	112	52				
124.	112	41	C		C	
125.	112	53	C		C	
126.	112	44	C			
127.	112	50	B		C	
128.	112	44	C			
129.	112	56		D	C	
130.	111	34			B	
131.	111	38	B			
132.	111	65	B	C	B	
133.	111	46	B		B	
134.	111	58	B			B
135.	111	51		D	C	C
136.	111	60	B	A	B	
137.	111	40	B			B
138.	111	35	C		C	
139.	111	44	A		C	
140.	111	48	B	D	D	
141.	111	46	C			
142.	111	60	C			B
143.	111	45	C		D	

GENERAL TABLE

CASE	I.Q.	TEST	GENERAL SCIENCE	BIOLOGY	CHEMISTRY	PHYSICS
144.	111	52	B			D
145.	111	43	C		D	
146.	111	46	C			
147.	111	63	B			
148.	111	41	D			
149.	110	38	D			
150.	110	51	C			
151.	110	39	C			
152.	110	65	B		A	
153.	110	47	A		B	
154.	110	34	C			
155.	110	54	C			
156.	110	40	A			
157.	110	50	D		D	
158.	110	44	C		C	
159.	110	46	C		C	C
160.	110	50	C			
161.	110	54	B		C	
162.	110	38				
163.	110	55	B			
164.	109	41	C			
165.	109	50			C	
166.	109	50	C	D	D	
167.	109	48	D		C	

GENERAL TABLE

CASE	I.Q.	TEST	GENERAL SCIENCE	BIOLOGY	CHEMISTRY	PHYSICS
168.	109	50	C			C
169.	109	44	B			C
170.	109	49	C			
171.	109	54	C			
172.	109	48	B		B	
173.	109	55	C	C	C	
174.	109	44		C		
175.	108	56	B		A	
176.	108	40	C		C	
177.	108	41	C			
178.	108	65	B		B	B
179.	108	50	B			
180.	108	43	C		B	
181.	108	43	B	D	D	
182.	108	30				
183.	108	42				D
184.	108	43	B		B	
185.	108	48	C		C	
186.	107	51	B		B	
187.	107	54	C		C	C
188.	107	56	C			
189.	107	55				D
190.	107	45	C			
191.	106	37	C			

GENERAL TABLE

CASE	I.Q.	TEST	GENERAL SCIENCE	BIOLOGY	CHEMISTRY	PHYSICS
192.	106	49	C		C	
193.	106	37	C			
194.	106	50				
195.	106	44	C	C	C	
196.	106	48	B			
197.	106	45	B			
198.	106	37				
199.	106	49	C			
200.	105	34	C			
201.	105	53				
202.	105	30	B			
203.	105	30	C			C
204.	105	59	C	C	B	B
205.	105	48	B			C
206.	105	52	C	B	C	C
207.	105	69	D	D	D	D
208.	105	55	B		C	
209.	105	39	C			
210.	105	51	B		C	
211.	104	48	C	C		
212.	104	57	C			
213.	104	37	C		D	
214.	104	48	B		C	
215.	104	47	D			

GENERAL TABLE

CASE	I.Q.	TEST	GENERAL SCIENCE	BIOLOGY	CHEMISTRY	PHYSICS
216.	104	30	B			
217.	104	35	D			
218.	104	50	B			
219.	104	40	B			
220.	103	25	D			
221.	103	27				
222.	103	46		D	C	
223.	103	28			D	
224.	103	44	C	D		
225.	103	51	D			
226.	103	32	B			
227.	103	39	D			
228.	103	13	C			
229.	103	70	B	A	B	B
230.	103	60	D			D
231.	103	35	C		D	
232.	103	64	C			
233.	103	55	B			
234.	102	47	B			
235.	102	25	D		C	
236.	102	25	C		D	
237.	102	41	C	C		
238.	102	45	C	D	D	
239.	102	50	B			

GENERAL TABLE

CASE	I.Q.	TEST	GENERAL SCIENCE	BIOLOGY	CHEMISTRY	PHYSICS
240.	102	51	C			
241.	102	54				
242.	102	39	B			
243.	101	46	B			C
244.	101	54	C	C	C	
245.	101	53	C			C
246.	101	43	C			
247.	100	47	B			
248.	100	48	C		C	
249.	100	56	C	C		
250.	100	35			D	
251.	100	50	C			C
252.	100	45	C		D	
253.	99	38	C			
254.	99	50	B			
255.	99	39	B			
256.	99	55			C	
257.	98	40	D			
258.	98	37	D		D	
259.	97	40	C		D	
260.	97	43				
261.	97	40	B			
262.	96	63	C	C		D
263.	96	37	D			
264.	95	53	C	C	C	

GENERAL TABLE

CASE	I.O.	TEST	GENERAL SCIENCE	BIOLOGY	CHEMISTRY	PHYSICS
265.	95	49	C			
266.	95	47	C			
267.	94	46	D			
268.	94	40	C	C	D	
269.	94	53	C	C	C	
270.	93	18				
271.	93	24	C			
272.	93	45	C		D	
273.	93	45	C	C		
274.	93	50	C			
275.	93	39	D			
276.	92	47	C	D	D	D
277.	92	11			D	
278.	91	47	C			
279.	91	35				
280.	90	45	B			C
281.	90	37	D		D	
282.	90	49	C			
283.	90	48	C		C	
284.	90	25	C			
285.	89	56	B			
286.	89	46	C			
287.	89	38	C		D	
288.	88	39			B	

GENERAL TABLE

CASE	I.Q.	TEST	GENERAL SCIENCE	BIOLOGY	CHEMISTRY	PHYSICS
289.	87	33	C			
290.	87	45	C		C	
291.	86	38	C			
292.	86	55	D			
293.	85	33	C			
294.	83	11				
295.	79	38				
296.	77	38	D			
297.	76	39	C		C	
298.	76	26				
299.	74	44	C			
300.	73	23	D			

BIBLIOGRAPHY

BIBLIOGRAPHY

Books

- Curtis, Francis D. A Digest of Investigations in the Teaching of Science. P. Blakiston's Son & Company, 1926.
- Douglass, Harl R. Modern Methods in High School Teaching. Houghton Mifflin, 1926.
- Downing, E. R. Teaching Science in the School. University of Chicago Press, 1925.
- Elliott, R. Teaching Science in the Schools. University of Chicago Press, 1925.
- Eikenberry, W. L. The Teaching of General Science. University of Chicago Press, 1922.
- Freeman, Frank N. Mental Tests. Houghton Mifflin, 1926.
- Frank, J. O. How to Teach General Science. Castle-Pierce Press, 1925.
- Garrett, Henry E. Statistics in Psychology and Education. Longmans, Green and Company, 1926.
- Monroe, Paul. Principles of Secondary Education. Macmillan Company, 1926.
- Morrison, Henry C. The Practice of Teaching in the Secondary School. University of Chicago Press, 1926.
- McCall, Wm. A. How to Measure in Education. Macmillan Company, 1923.
- Pentner, Rudolf. Intelligence Testing. Harper and Brothers, 1904.
- Ruch, G. M. The Objective or New-Type Examination. Scott, Foresman & Company, 1929.
- Russell, Charles. Classroom Tests. Ginn and Company, 1926.
- Symonds, Percival M. Measurement in Secondary Education. Macmillan Company, 1927.
- Starch, Daniel. Educational Measurements. Macmillan Company, 1916.
- Williams, Henry S. A History of Science. Harper and Brothers, 1904.

Magazines

- Ruch, G. M., "A Range of Information Test in General Science." *General Science Quarterly*, IV (November, 1919), 257-62.
- Ruch, G. M., "Range of Information Test in General Science; Preliminary Data on Standards." *General Science Quarterly*, V (November, 1920), 15-19.
- Ruch, G. M., "A New Test in General Science." *General Science Quarterly*, VI (March, 1923), 188-197.
- Herring, J. P., "Measurements in Scientific Thinking." *Journal of Educational Psychology*, IX (December, 1919), 535-38.
- Revelt, B. J., "Testing Results in Chemistry." *School Science and Mathematics*, 19 (November, 1919), 742-45.
- Palmer, Frederic, "The College Physics Testing Program and Its Significance for Guidance in Secondary Schools." *Educational Record*, 16 (January, 1936) 82-96.
- Chapman, J. C., "The Measurement of Physics Information." *School Review*, 12 No. 7, 601-613.
- Greer, N. M., "Range of Information Test in Biology." *Journal of Educational Psychology*, 9 (April, 1918), 210-16; 388-93.
- Ohlson, David, "School Marks vs. Intelligence Ratings." *Educational Administration and Supervision*, XIII (February, 1927), 90-102.
- Powers, Samuel R., "Objective Measurements in General Science." *Teachers College Record*, XXIX (January, 1928), 345-49.
- Hunter, George W., "Is There a Sequence in Secondary School Science?" *School and Society*, 22 (December, 1924) 762-766.
- Clement, J. A., "Report of Sub-Committee on General Introductor or Elementary Science." *North Central Association Quarterly*, 1 (March, 1927) 77.
- Curtis, Francis D., "Report of the Sub-Committee on General Science." *North Central Association Quarterly*, 5 (December, 1930) 410.
- Lee, J. Murray, "New Type or Objective Tests, A Summary of Recent Investigations." *Journal of Educational Psychology*, XXIV (January, 1933), 21-38.
- Odell, C. W., "Educational Measurement in the Secondary School." *Journal of Educational Research*, XXVI (October, 1932) 81-89.

Bulletins

Research Bulletin of the National Education Association, vol. 7, no. 4 (September, 1929), 218.

National Survey of Secondary Education, U. S. Bulletin, 1932, No. 17, Monograph No. 19.

Public Education in Oklahoma, no. 14 (1923) 1.

Cardinal Principles of Secondary Education, U. S. Bureau of Education, no. 35 (1918).

Annual High School Bulletin, Department of Education, State of Oklahoma, no. 112K40 (1936).

Theses

Lannholm, G. V. The Knowledge of General Science Which High School Seniors Possess. M. A. Thesis, State University of Iowa, 1936.

Carlson, E. R. The Avowed Success of General Science Teachers in Relation to Their Science Training. M. A. Thesis, Pennsylvania State College, 1936.

Burlingame, Mrs. Paul. Some Evidence of the Interests of Eighth Grade Children in the Materials of Science. M. A. Thesis, University of Louisville, 1936.

Ketchum, C. B. Reconstruction of Secondary School Science Teaching. M. A. Thesis, Lawrence College, Appleton, Wisconsin, 1936.

Pfeiffer, H. S. Information and Misinformation of High School Seniors in General Science. M. A. Thesis, State University of Iowa, 1929.

Nettels, C. H. Some Correlations Between High School Grades, Thorndike Intelligence Examination Scores, and College Success. M. A. Thesis, University of Southern California, 1925, page 103.

Eldredge, W. L. Testing in General Science. Master's Thesis, Columbia University Teachers College, 1930.

Jones, A. P. Survey of the Educational and Social Adjustment of Forty "C" Level Students in Science. M. A. Thesis, New York State College for Teachers, 1936.

Manuals

Rinsland, Henry D. Manual for Constructing Objective Tests and Improving Grading in Elementary and High School Subjects. John S. Swift Company, 1935.

Greene, Harry A. Work-Book in Educational Measurements. Form B. Longmans, Green and Company, 1928, p. 130.

Typist — Lucy W. Victor