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A COMPARISON OF GAINS MADE ON ACHIEVEMENT TESTS BY NINTH GRADE PUPILS OF DIFFERENT MENTAL ABILITY LEVELS

A THESIS

SUBMITTED TO THE DEPARTMENT OF EDUCATION AND THE GRADUATE COUNCIL OF THE KANSAS STATE TEACHERS COLLEGE OF EMPORIA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

BY

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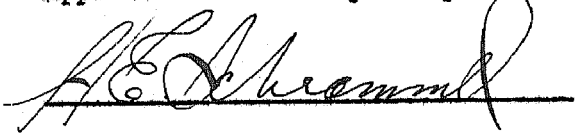
SEPTEMBER, 1939

Approved for the Major Department



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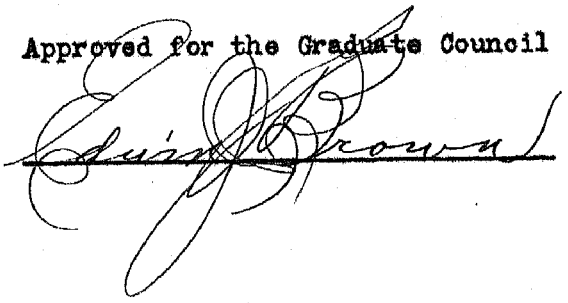

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ACKNOWLEDGEMENT

The writer wishes to express her sincere appreciation to Dr. H. E. Schrammel, Director of the Bureau of Educational Measurements of the Emporia State Teachers College, who suggested this problem and gave valuable suggestions concerning the statistical procedure employed and the organization of the material presented.

D. E.

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CHAPTER I

INTRODUCTION

General mental ability is generally conceded to be the most important single factor in school accomplishment. The mental ability of a pupil, as measured by his intelligence quotient, is usually considered an indication of the degree of achievement that can be expected of him by the school, thus giving a valuable aid in diagnosis of pupil difficulties and a guide to the adaptation of instruction to pupil needs. Many schools segregate pupils in instruction groups on the basis of mental ability believing that instruction can thus be related more effectively to individual capabilities. Measures obtained from intelligence testing are used, in conjunction with other measures, as a basis for prediction of success in future school work, thus making them an instrument of vocational guidance. It is known, however, that there is not a perfect correlation between mental ability and school achievement. Other factors such as school attendance, preparation, instruction, pupil interest, persistence and other personal factors are known to affect school achievement. The question of the extent that the intelligence quotient indicates the amount of achievement which can be expected from the pupil is one with which every educator is concerned, if the intelligence quotient is to be used for purposes of diagnosis, of instruction, and of prognosis.

I. The Problem

It is the purpose of this study to make a statistical comparison of

the achievement of a group of ninth grade pupils with the intelligence of those pupils. By comparing the test records of these pupils on an achievement test administered at the beginning of the school year with their achievement on another form of the same test given at the close of the year, it will be possible to compare their gains in achievement with their respective intelligence quotients. It is desired to find whether these pupils made a gain on the achievement test commensurate with their mental ability as measured by their intelligence quotients.

II. Related Studies

Many studies have been made comparing pupil achievement on subject tests with their intelligence test scores. A few of those which are more closely related to this study will be briefly mentioned here. Most of the studies have made comparisons by the method of correlating the achievement test scores or the school marks with the intelligence test scores. A recent study made by McDonald,[1] compared the achievement of ninety-six pupils in a 6A class with their intelligence by means of finding the correlation between their scores on the various sections of the Progressive Achievement Test and their intelligence scores on the California Mental Maturity Test. He found that reading comprehension could be used to predict language intelligence, non-language intelligence reading vocabulary, arithmetic fundamentals, and arithmetic reasoning, better than any of the other variables when the correlation technique was used. Language intelligence corre-

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[1] David McDonald, The Relation Between Test Intelligence and Test Achievement in Grade Six-A, Doctor's Thesis, University of Oregon, 1937, 81 pp.

lated highest with reading comprehension (.75) and lowest with arithmetic fundamentals (.47).

Flemming,[2] in a study made in 1925, found correlations of general intelligence as measured by objective mental tests, with achievement as measured by achievement tests, with achievement as measured by teachers' marks, with teacher estimates of physical and character traits, and with will and temperament tests. She found that general intelligence showed a high correlation with achievement in the junior high school and in the senior high school grades, the significance of intelligence as a factor in school accomplishment becoming greater as the pupil advanced through high school. The average correlation for the junior high school grades was .60, and that for the senior high school was .63.

A study was made by Hardin,[3] in 1921, of a group of 936 pupils in grades II to VIII. He gave each one an intelligence test, a reading test, and an arithmetic test and found the correlations between their performances on the three. The correlations he obtained between mental ability and achievement in reading and arithmetic ranged from .44 to .88, the highest correlations being obtained when the entire group was used.

Cowles,[4] in 1937, correlated the scores of tests in language and arithmetic with ratings of mental ability, using for her subject a group of ninety-six deaf children in the intermediate grades. She concluded that

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[2] Cecile White Flemming, A Detailed Analysis of Achievement in the High School, (Teachers College Contributions to Education, No. 196, New York: Teachers College, Columbia University, 1925). 209 pp.

[3] James Roy Hardin, A Study of the Relationship between Mental Ability and Achievement in Arithmetic, between Mental Ability and Reading Ability, and between Reading Ability and Achievement in Arithmetic. Unpublished Master's Thesis, Kansas University, Lawrence, 1929.

[4] Katherine Cowles, The Correlation of Non-Language Tests and Scholastic Achievement of Deaf Children. Unpublished Master's Thesis, Temple, 1937. 106 pp.

mental tests could not be regarded as reliable data on which to predict a pupil's achievement in language and arithmetic but might be used to segregate pupils capable of doing more work.

A study made of a first grade group by Cunningham[5] shows that the mental test can be used to predict achievement over a period of a year. She found that the middle 50% of the group was less well measured by the mental tests than were the upper and lower groups.

Embree,[6] on the other hand, found that in attempting to predict high school success by means of the intelligence quotients, ninth grade age, and ninth grade achievement there was a tendency for the prediction to be less decisive in the case of the pupils with the higher intelligence quotients, those above 130.

Franzen,[7] finding a comparative progress of achievement less among the brighter pupils than among those with less ability, attributed the lack of achievement to a deficiency in the course of study which did not provide sufficient material for those of exceptional ability. He concluded that intelligence is the most important determinant of individual differences.

In correlating achievement of grade children in reading rate, reading comprehension, spelling and arithmetic with composite measures of intelligence, Gates[8] obtained the following results: reading comprehension,

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[5] Bess V. Cunningham, The Prognostic Value of a Primary Group Test. (Teachers College Contributions to Education, No. 196. New York: Teachers College, Columbia University, 1923). 75 pp.

[6] Royal B. Embree, Jr., "The Prediction of Senior High School Success at Various Levels of Intelligence," Journal of Educational Psychology, 28:81-91, February, 1937.

[7] Raymond Franzen, The Accomplishment Ratio (Teachers College Contributions to Education No. 125. New York: Teachers College, Columbia University, 1922). 59 pp.

[8] Arthur I. Gates, "The Correlation of Achievement in School Subjects with Intelligence Tests and Other Variables," Journal of Educational Psychology, 13:139, March, 1922.

.72; reading rate, .68; arithmetic, .30; and spelling, .56. He found that the inter-correlations of the school subjects was not high with the exception of that of reading comprehension with reading rate. He concluded that the more verbal the material the better it correlated with school attainment.

McCall, in 1916, found that the more complex educational tests showed a higher correlation with mental ability than did the simple speed tests. He concludes:

> The power tests, or those which measured the upper threshold of ability, showed a higher correlation with mental ability than the speed tests or those which measured how rapidly a relatively easy task could be performed.[9]

In order to find those other factors which contribute to scholastic success, besides mental ability, others have made studies of persistence and its influence on scholastic achievement. One such study is that of Ryans.[10] He found the persistence test unrelated to the intelligence test, but positively related to assigned school marks. He found that by combining persistence scores and intelligence scores and correlating them with school marks that a high correlation was obtained.

III. Scope of the Study

A group of ninth grade pupils in the Lowther Junior High School of Emporia, Kansas, was used in this study. All of the ninth grade pupils who

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[9] William Anderson McCall, Correlation of Some Psychological and Educational Measurements, (Teachers College Contributions to Education, No. 79. New York: Teachers College, Columbia University, 1916, p. 67.)

[10] David G. Ryans, "A Study of the Observed Relationship between Persistence Test Results, Intelligence Indices and Academic Success," Journal of Educational Psychology, 29:573-580, November, 1938.

were enrolled in the school during the spring term of the school year 1938-1939 were used in the study, with the exception of twenty pupils who did not take all of the tests on account of absence from school when the tests were given.

Of the 256 pupils used in this study, sixty-nine were in the B class and the remaining 187 were in the A class. The mid-year promotion system is in use in this school, hence the B class pupils are those who were promoted to the ninth grade in January. When the first test was given, in October, these B class pupils were beginning the last half of the eighth grade work. The A class pupils are those who began the ninth grade work in September and completed it in May.

Comparisons of these pupils were made on the basis of mental tests and achievement tests which were administered to the group in October and in May of the school year.

IV. Definition of Terms

Mean. The mean or average has been used in Tables I to VII as a measure of central tendency. It gives a more reliable result than other measures which might be used.

Standard deviation. The standard deviation is used to measure the amount of variability of the scores about the mean. In a distribution which has a mean of 129.6 and a standard deviation of 5.6, the 5.6 indicates that 68% of the scores in that distribution lie within the area which is ±5.6 points from the mean, or between 124 and 135.2.

Standard error. The standard error of the mean is a measure of the reliability of the mean, showing the degree of accuracy which the mean has.

In a distribution which has a mean of 133 and a standard error of the mean of .50, there are 68 chances in 100 that the obtained mean of 133 does not differ from the true mean by more than .50, or that the true mean is between 132.5 and 133.5. The chances are 100 in 100, or a virtual certainty, that the true mean does not differ from the obtained mean by more than 3 times the standard error of .50, or is between 131.5 and 134.5.

Sigma $gain_1$. The sigma $gain_1$ is the ratio of the actual gain in the mean to the standard deviation of the mean obtained on the first test by that group.

Sigma $gain_2$. The sigma $gain_2$ is the ratio of the actual mean gain to the standard deviation of the mean of the whole group on the first test.

Probability of the difference between two means. In table IX, a ratio has been used to show the chances for a true difference between the means. This ratio is the quotient of the obtained difference between the means, divided by the standard error of the difference. The size of the result indicates the degree of reliability which can be attributed to the obtained difference. If the quotient is 3, that is a guarantee that the true difference is greater than zero, and that the difference is in favor of the larger of the two means. If the difference is greater than 3.00, additional security is given as to a true difference. If the quotient is less than three, the result is interpreted as giving a certain number of chances in 100 of there being a true difference. The quotients obtained in this study have all been interpreted for the reader from the table given by Dr. Garrett.[11]

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[11] Henry E. Garrett, Statistics in Psychology and Education. (New York: Longmans, Green and Co., 1937), p. 213.

N. The letter "N" in Tables I and II refers to the number of pupils in the group.

Possible score. Possible score indicates the number of points it was possible to make on the particular test or section.

Correlation coefficient. The correlation coefficient as used in this study has been calculated by the product-moment method and has been employed for the purpose of studying the relationship of achievement in one test with that in another test. A coefficient of correlation of ± 1.00 indicates a perfect relationship. When the coefficient is positive, this indicates that the pupil ranking highest in one test also ranked highest in the other, and that each of the other pupils retained the same ranking on the second test as that which they had attained on the first. A negative correlation shows that a high degree of attainment in one test is associated with a low degree of attainment in the other, or that the pupil who ranks high on one test will rank low on the other. Positive coefficients range from .00 to 1.00, and the correlations which are made in this study would be considered as indicating a negligible correlation when less than .20; a low relationship when between .20 and .40; a marked relationship when between .40 and .70; and a high relationship when between .70 and 1.00.[12]

V. Method of Procedure

The group of 256 unselected ninth grade pupils mentioned above was tested with the Schrammel-Brannan Revision of the Army Alpha Group Intelli-

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[12] Ibid., pp. 342-343.

gence Examination, Form A.[13] The results of this test determined the grouping for study into three divisions. Those having intelligence quotients of 120 to 146 were placed in Group I, classed as the superior group. There were 66 of the pupils in this group. Those having intelligence quotients ranging from 102 to 119 were placed in Group II. There were 111 pupils in this middle group. Group III, consisting of 79 pupils, had intelligence quotients ranging from 70 to 101. The pupils who were classed as 9B were distributed by the above classification as follows: Group I contained 15 of these pupils, Group II, 25, and Group III, 29. A larger proportion of the third group, approximately 37%, consisted of 9B pupils as compared with approximately 23% for each of the other groups.

The Progressive Achievement Test-Intermediate Battery[14] was given to the group twice during the year, Form A in October and Form B in the following May. Both forms were given under similar conditions, being administered by the regular teacher during the activity period in each case. The achievements of the groups on the two tests were compared. The gains made by each group were computed and comparisons of the groups were made on the basis of the amount of gain evidenced in the mean score at the end of the school year, over the mean score made at the beginning of the year.

Other educational tests were given and the achievements of the groups on these tests were compared and correlations of these achievements were made.

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[13] H. E. Schrammel and Christine Brannan, Schrammel-Brannan Revision Army Alpha Intelligence Examination for Grades IV-VIII (Emporia: Kansas State Teachers College, 1938).

[14] Ernest Teigs and Willis W. Clark, Progressive Achievement Tests-Intermediate Battery (Los Angeles: Southern California School Depository, Ltd., 1937).

Other tests given were the Schrammel-Gray High School and College Reading Test,[15] Breslich Algebra Survey Test-First Semester,[16] and Compass Diagnostic Test XX: General Problem Scale: Advanced: Form A.[17]

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[15] H. E. Schrammel and W. H. Gray, Schrammel-Gray High School and College Reading Test, (Emporia: Kansas State Teachers College, 1938).

[16] E. R. Breslich, Breslich Algebra Survey Test, First Semester, Form A, (Bloomington, Illinois: Public School Publishing Co.).

[17] G. M. Ruch, and others, Compass Diagnostic in Arithmetic, Test XX: General Problem Scale Advanced: Form A (Chicago: Scott, Foresman and Company, 1926).

CHAPTER II

IMPROVEMENT ON THE PROGRESSIVE ACHIEVEMENT TEST

One of the main purposes of this study was to compare the achievements of pupils with varying intelligence quotients on the same scholastic tests. The Schrammel-Brannan Revision of the Army Alpha Examination was given to the entire group, the raw scores were converted into mental ages, and intelligence quotients were computed. A report of the divisions made of the pupils on the basis of these results, and a comparison of the achievements of the resulting groups on the two forms of the Progressive Achievement Test-Intermediate Battery, will be made in this chapter.

I. Division into Groups

The group of 256 unselected ninth grade pupils were divided, for the purpose of comparison, into three groups. Those pupils having intelligence quotients ranging from 120 to 146, were placed in Group I. Group II included those pupils whose intelligence quotients were between 102 and 119, and Group III, those between 70 and 101.

Table I shows the distribution by groups according to the intelligence quotients obtained. Group I consists of sixty-six pupils, Group II, one hundred eleven, and Group III, seventy-nine. The mean of 127.55 for Group I indicates that this group is definitely a superior one. The mean of Group II is 10.62 above the normal intelligence quotient of 100. The mean of Group III is 8.27 points below normal, indicating that this group

is below average in ability. The mean for the whole group shows that this group is slightly above normal in ability, having a mean of 109.08.

TABLE I

DISTRIBUTION OF INTELLIGENCE QUOTIENTS ACCORDING TO THE SCORES ON THE ARMY ALPHA INTELLIGENCE EXAMINATION OF MAY, 1939

Intelligence Quotients	Group I	Group II	Group III	Total
144-149	2	-	-	2
138-143	3	-	-	3
132-137	5	-	-	5
126-131	25	-	-	25
120-125	31	-	-	31
114-119	-	40	-	40
108-113	-	26	-	26
102-107	-	45	-	45
96-101	-	-	26	26
90-95	-	-	23	23
84-89	-	-	16	16
78-83	-	-	9	9
72-77	-	-	4	4
66-71	-	-	1	1
N	66	111	79	256
Mean	127.55	110.62	91.73	109.08
S. D.	5.24	5.22	7.62	15.27
S. E.	.64	.50	.86	.95

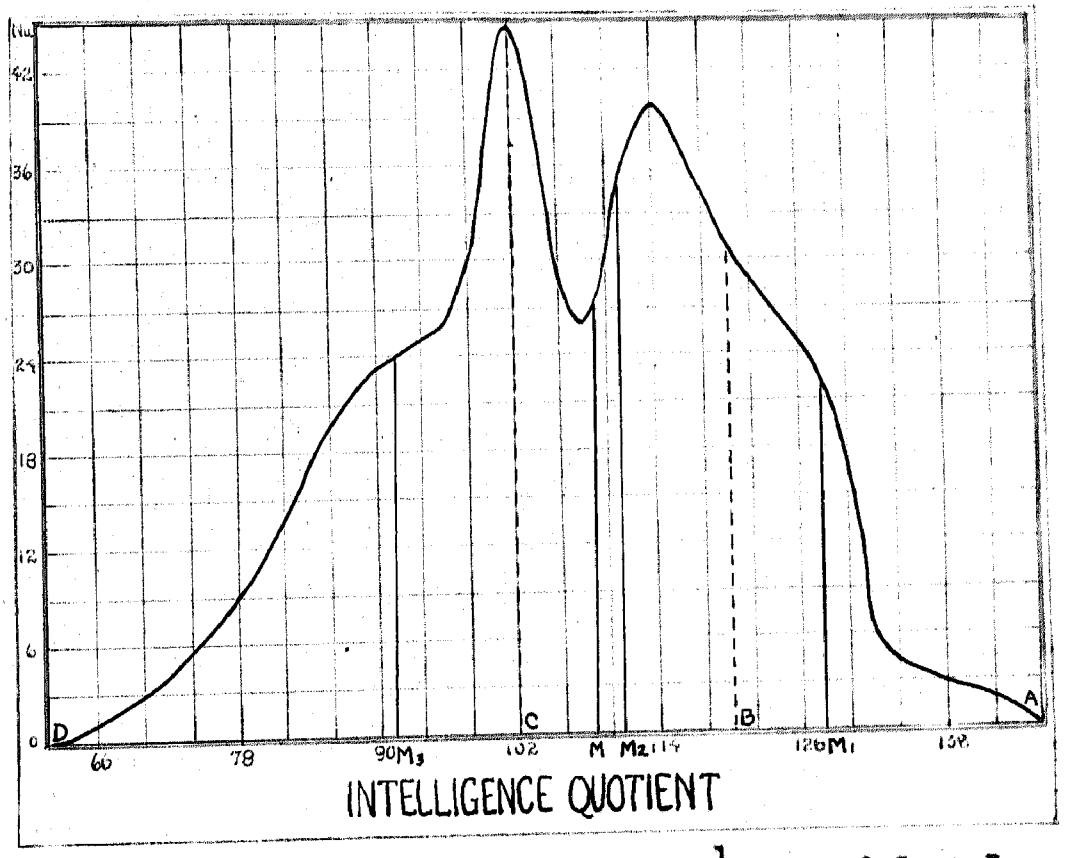
Read table thus: Two pupils in Group I had intelligence quotients between 144 and 149. The mean of group I was 127.55, the standard deviation was 5.24, and the standard error of the mean was .64.

It should be noted that Group III is much more variable than the other two groups, having a standard deviation of 7.62 as compared with 5.24

for Group I, and 5.22 for Group II. The middle 68% of the scores in Group III will be found between 84.11 and 99.35, which is below the normal intelligence quotient. Group II is the least variable, being grouped more closely about the mean.

The results obtained for the standard error of the mean indicate that the mean of Group II has the greatest reliability of .50 as compared with .64 for Group I, and .86 for Group III. It will be recalled that ± 3 times the standard error in each case will give the upper and lower limits of the area in which it is practically certain that the true mean lies. In the case of Group II, the true mean is between 109.12 and 111.12; that of Group I, between 125.63 and 129.47; and that of Group III, between 89.15 and 94.31.

Figure I shows the distribution of the intelligence quotients of all the pupils graphically by means of a frequency polygon. The limits of the areas of the respective groups are shown by the dotted lines. The means of the groups are marked by the solid lines so that they may be compared. The wider distribution of scores in the upper and lower groups is clearly apparent in the graph, as well as the comparative compactness of the middle group. The dip in the center of the middle group is unusual and shows fewer scores at the mean than above and below.



Key: Area (a-b) Group I
Area (b-c) Group II
Area (c-d) Group III
M mean of entire group

M^1 mean of Group I
M^2 mean of Group II
M^3 mean of Group III

FIGURE I

DISTRIBUTION OF INTELLIGENCE QUOTIENTS

II. Chronological Ages of the Groups

The means of the chronological ages of the pupils were computed by groups. The mean for Group I was 14 years, 5 months; that of Group II, 14 years, 11 months; and that of Group III, 15 years, 6 months. The mean for the entire group was 14 years, 11.8 months. Comparing these results with the intelligence quotients, it is seen that the group having the higher intelligence quotients is the younger group, chronologically. The middle group is likewise younger, chronologically, than the lower group. The oldest pupil was 19 years, 5 months of age and his intelligence quotient was 73, which places him fifth from the lowest in Group III. The youngest pupil was just 13 years of age and had an intelligence quotient of 137, placing him sixth from the highest in Group I. The pupil having the highest intelligence quotient was 14 years, 4 months of age and the pupil with the lowest intelligence quotient was 17 years, 1 month of age.

III. Raw Scores on the Intelligence Test

The raw scores on the intelligence test were examined to see if these scores also would classify this group as a superior ninth grade group. The medians of the groups were found so that they might be compared with the grade percentile norms as given in the Manual.[18] The median for Group I was 165.97, which is 39.97 points above the norm, and places this group in the 90 percentile rank for ninth grade. The median of this group exceeds the twelfth grade median and is only 4.03 points below that of the college freshmen. Group II, with a median of 142.98 exceeds the norm of the tenth grade

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[18] H. E. Schrammel and Christine V. Brannan, Manual of Directions, Schrammel-Brannan Revision, Army Alpha Intelligence Examination, (Bureau of Educational Measurements, Kansas State Teachers College, Emporia, Kansas, 1938).

and is only 2.02 points below the norm for the eleventh grade. The median of this group ranks them in the 70 percentile of the ninth grade. Group III with a median of 114.5 is below the ninth grade norm and only 4.5 points above that of the eighth grade. This places them in the 30 percentile rank of the ninth grade. The median for the entire group is 141.32, placing them in the 70 percentile rank. Only 54 of the whole group scored below the ninth grade norm. The results of this comparison show that this group is definitely superior in ability to the average ninth grade group.

IV. Progressive Achievement Test Results

The results of the Progressive Achievement test administered to the pupils in October and again in May, were used as a basis for comparison of the varying ability groups. This test is designed to measure achievement in the various school subjects at the intermediate-grade level. The subjects which are tested by this particular test include Reading Vocabulary, Reading Comprehension, Arithmetic Reasoning, Arithmetic Fundamentals, and Language. The Language section also tests achievement in Spelling and in Handwriting. The test items in this test measured only indirectly the school work of these pupils, since Spelling, Penmanship, Reading, and Arithmetic are not taught as separate subjects in the ninth grade. Each of these subjects is taught in connection with the various classes, each teacher instructing the pupils in the reading, writing, and spelling, which is essential to the pupils' needs. The arithmetic is taught in connection with the General Mathematics course, as the need for drill is evidenced. The Mathematics course at this time was about 75% Algebra and was required of all ninth grade pupils. Other courses required of all the pupils were Citizen-

ship and English. The fourth subject was chosen from the following: Latin, German, Vocational Agriculture, Business Training, Art, Music, Manual Training, or Domestic Science.

TABLE II

DISTRIBUTION OF SCORES ON THE PROGRESSIVE ACHIEVEMENT TESTS, FORMS A AND B, GIVEN IN OCTOBER AND MAY

Total Scores	Group I		Group II		Group III		Total	
	A	B	A	B	A	B	A	B
365-379	-	3	-	-	-	-	-	3
350-364	4	14	-	-	-	-	4	14
335-349	9	16	-	10	-	1	9	27
320-334	13	12	3	17	-	2	16	31
305-319	15	14	15	31	2	4	32	49
290-304	10	5	19	19	2	11	31	35
275-289	8	1	23	18	9	5	40	24
260-274	4	1	16	9	11	20	31	30
245-259	1	-	18	3	9	12	28	15
230-244	2	-	7	2	10	10	19	12
215-229	-	-	6	-	16	3	22	3
200-214	-	-	3	1	4	5	7	6
185-199	-	-	-	1	6	6	6	7
170-184	-	-	-	-	5	-	5	-
155-169	-	-	-	-	2	-	2	-
140-154	-	-	1	-	3	-	4	-
N	66		111		79		256	
Mean	309.09	332.5	275.99	301.42	234.84	260.09	271.36	296.68
S.D.	27.9	22.5	28.5	27.0	39.5	35.7	42.8	39.9
S.E.	3.43	2.77	2.71	2.56	4.42	4.02	2.70	2.49

Read table thus: Three pupils in Group I made a score between 365 and 379 on Form B of the test.

The results of the Achievement Tests, forms A and B, given in October and May, respectively, are shown in Table II. The distribution of scores in both tests arranged in the three intelligence groups is given as well as the mean, standard deviation, and standard error for each group. A comparison of the means of the three groups on the first test shows that Group I has the greater achievement with a mean of 309.09, as compared with 273.99 for Group II, and 234.84 for Group III. The mean for the entire group is slightly lower than that of Group II, being 271.36. All groups show a substantial gain on the spring test, form B, with a mean of 332.5 for Group I; 301.42 for Group II; 260.09 for Group III; and 296.68 for all of the pupils. On both forms there is less difference between the means of the upper and middle group than there is between those of the middle and lower groups, which might have been expected from the results of the intelligence test. It will be recalled that the means of the groups on the raw scores of the intelligence test placed the first group in the 90 percentile, the second group in the 70 percentile, and the third group only in the 30 percentile rank for ninth grade. From these results a wider divergence of achievement would be expected from the third group to the second, than from the second to the first.

In comparing the standard deviations of each group on Form A, it is seen that Group III is the most variable, deviating 39.3 from the mean, as compared with 28.5 and 27.9 for Groups II and I, respectively. On Form B there is less variability evident in each group. Group I has decreased to 22.5; Group II to 27.0; and Group III to 35.7; with the least change apparent in Group II. The greatest accuracy of the mean is in Group II, which has the smallest standard error on both tests.

The coefficient of correlation of the intelligence quotients of the pupils with their scores on the Progressive Achievement Test should indicate the relationship existing between their performances on the two tests. When correlated with Form A of the test the following coefficients were obtained:

Group I	.44	± .07
Group II	.45	± .05
Group III	.56	± .05
Total	.41	± .04

When correlated with Form B the following were the results:

Group I	.38	± .07
Group II	.33	± .05
Group III	.49	± .05
Total	.75	± .02

The usual correlation obtained between intelligence scores and school grades is from .40 to .60;[19] therefore none of these indicate a high relationship existing between the intelligence quotients and the achievement scores on either test, with the exception of the performance of the whole group together on the second test. All of the group coefficients are higher on Form A than on Form B. When the whole group is thrown together, however, a higher correlation is obtained with Form B. The coefficient of .75 on Form B is high enough to indicate a high relationship, signifying that those who had high intelligence quotients tended to make high scores on the second test and that those with low scores on the intelligence test also ranked low on the

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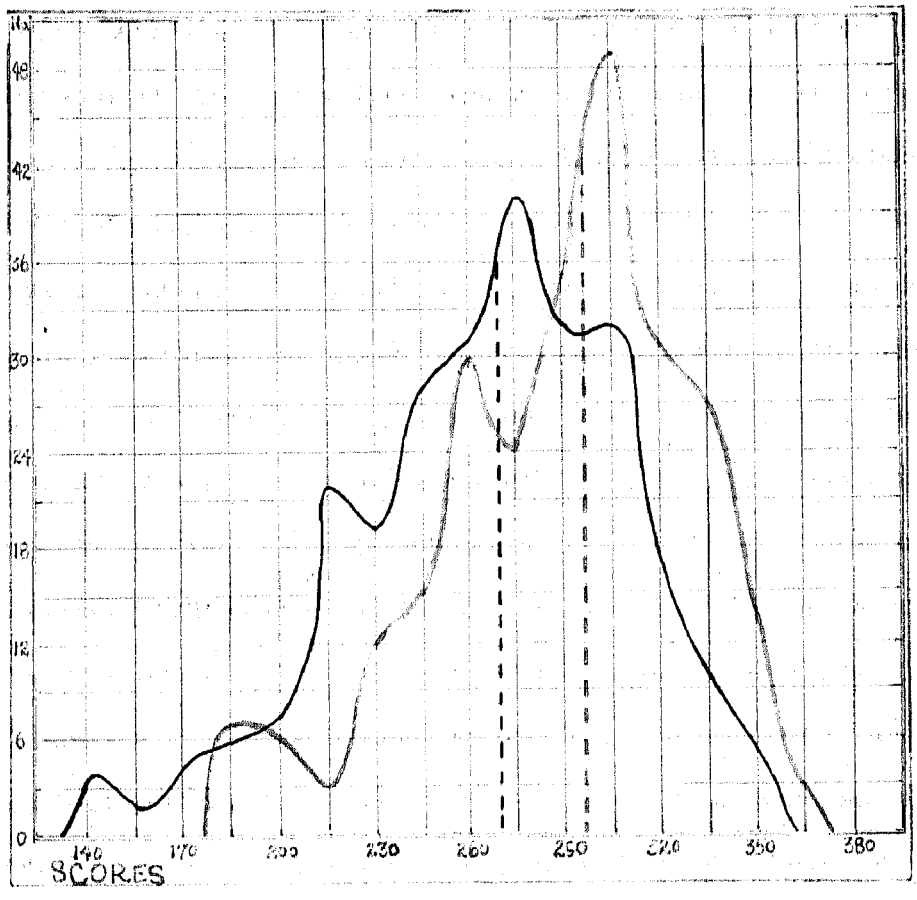
[19] Henry E. Garrett, Statistics in Psychology and Education (New York: Longmans, Green and Co., 1937), pp. 342-343.



Key:

—— Form A
- - - Form B

FIGURE 2

ACHIEVEMENT OF ALL THE PUPILS ON THE TWO FORMS OF THE PROGRESSIVE ACHIEVEMENT TESTS

achievement test which was given in May.

The correlation of the scores on the Progressive Achievement Test, Form A with those on Form B was also computed, in order to find whether the achievements of pupils on one test had a high relationship with their achievements on the other, and in order that the groups might be compared in this respect. The coefficient of correlation on the two forms of the test for Group I was .84; for Group II, .68; for Group III, .74; and for the whole group, .89. These all show a high relationship, with Group II the lowest; and the highest being obtained when the whole group was considered. The results seem to indicate that the pupils who made high scores on the first test seemed to rank high on the next test, and likewise those making low scores on the first tended to make low scores on the second. The relationship, however, is not a perfect one of 1.00; and the rank of a pupil on the first test would not coincide with his ranking on the second.

Figures 2 to 4 show graphically the distribution of the scores on the two forms of the achievement tests. Figure 2 shows the shift of the scores from the black polygon, representing the achievement on the first test, definitely upward to the yellow polygon, representing the achievement on the second test. More progress seems to be shown at the left end, among the low scores, than at the right end, or among the high scores. The dotted lines indicate the means of the respective tests. Figures 3 and 4 picture the three groups in comparison with one another, the lower graph representing the scores on the first test, the upper the scores on the second test. The curve of Group III has shifted 40 points upward, attaining the same range of scores on the second test as did Group II. The shifting of scores in Group II seems to be more in the middle part of the group making a good increase in the mean. The lower scores of Group I have shifted upward 30 points, but

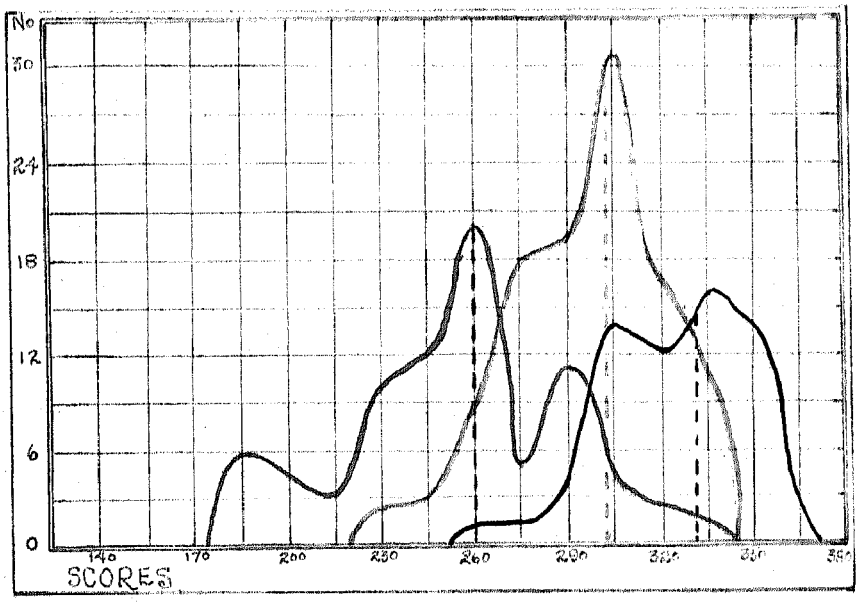
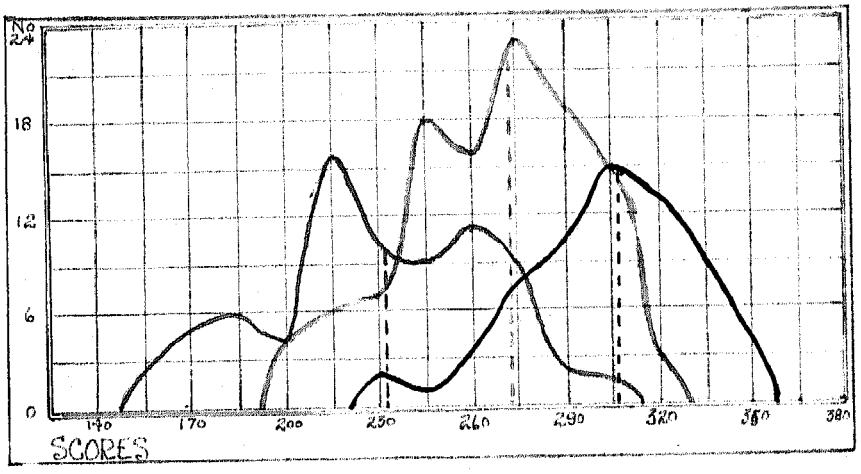


FIGURE 4

ACHIEVEMENT OF THE GROUPS ON FORM B



— Group I
— Group II
— Group III

FIGURE 3

ACHIEVEMENT OF THE GROUPS ON FORM A

the upper scores show only an increase of 15 points.

The graph shows a considerable overlapping of scores in the three groups. On the first test three of the pupils in Group I were below the mean of Group II, and on the second test two pupils were still below the mean for Group II.

On the first test ten scores of Group II were below the mean of Group III, and on the second test seven were below the mean of Group III. At the other extreme of Group II are found three scores which exceeded the mean of Group I on the first test, and ten which exceeded the mean of Group I on the second test.

On the first test there were three scores of Group III which exceeded the mean of Group II; and on the second test there were seven such scores, one of these exceeding the mean of Group I as well.

V. Comparison of Gains on the Two Forms of the Test

A better comparison of the three groups might be made on the basis of the amount of gain actually made by them. Table III shows the actual amount of gain made in the mean of each group. Group II shows the most gain with 27.43 points; Group III, nearly as much with 25.25; and Group I has the least with 23.46 points. The gain in mean for the whole group is 25.32. In order to have a better basis for comparison, the sigma gain (Sigma $Gain_1$ in the table), or the quotient of the actual gain in mean of the group, divided by the standard deviation of the first test, was computed. Group II again ranks ahead with .96 sigma gain, compared with .84 for Group I and .64 for Group III. The sigma gain for the whole group is .59.

In the quotients of Sigma $Gain_1$, the differences in the sigma of the groups, affect the quotients thus obtained. This difference was eliminated in finding Sigma $Gain_2$, which is the quotient obtained by dividing the mean difference of each group by the standard deviation of the entire group, thus insuring a common divisor. Group II still remains the highest with .65, but Group III shows a greater gain than Group I, .59 as compared with .55.

Finding the reliability of the difference between the means of the tests ranks the groups, as they were by the Sigma $Gain_1$ method with Group II, first; Group I, second; and Group III, last. The reliability of the difference of the means was found by dividing the obtained difference of the two means by the standard error of the difference. All of the quotients so obtained in this case are large enough to be interpreted as indicative of a significant difference; or to state it another way, the chances are 100 in 100 that the true difference between the mean scores is greater than zero, and that this difference is in favor of Form B.

TABLE III

AMOUNT OF GAIN IN THE MEANS ON THE TWO FORMS OF THE PROGRESSIVE ACHIEVEMENT TESTS

	Group I	Group II	Group III	Total
Gain	23.46	27.43	25.25	25.32
Sigma $Gain_1$	.84	.96	.64	.59
Sigma $Gain_2$	.55	.65	.59	.59
D/σ_D	5.3	7.4	4.2	6.9

Read table thus: The gain for Group I was 23.46, the sigma $gain_1$ was .84, the sigma $gain_2$ was .55, and the reliability of the difference was 5.3.

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The comparatively small gain shown by Group I may be partially explained by the fact that many of these pupils had scored high on the first test; and there was not a large gain possible on the second, some having scored more than 350 of the 390 possible points on the first test. There were some sections on which these pupils had made perfect scores on Form A. The test was not designed for grades beyond the ninth; hence did not contain enough material to test adequately those of superior achievement.

VI. Sections of the Progressive Achievement Test

The Progressive Achievement Test is designed to measure achievement in Reading Vocabulary, Reading Comprehension, Arithmetic Reasoning, Arithmetic Fundamentals, and Language. Each of these sections are subdivided and test various phases of the subject. The Reading Vocabulary section contains words which form the vocabulary of mathematics, science, social science, and a general vocabulary. The Reading Comprehension section tests the following of directions, organizing and interpreting data. The Arithmetic Reasoning section deals with the number concept, symbols, rules, numbers, equations, and problems. The Arithmetic Fundamentals consists of tests in the four fundamental operation with integers, common fractions, and decimal fractions. The Language section is devoted to capitalization, punctuation, words and sentences, parts of speech, spelling, and handwriting. The improvement made on each of these sections will now be considered.

The distribution of the test scores on the sections of the Progressive Achievement Tests is shown in Tables IV to VII. As will be noted from a study of the tables, the means of Group I are higher than those of Group II

throughout, varying from 6.01 to 8.66 points higher on Form A, and 3.87 to 7.11 points higher on Form B. Likewise the means of Group II are higher than the corresponding means of Group III, varying from 6.85 to 11.10 points higher in Form A, and 5.80 to 11.68 points higher in Form B. The least difference in means between the groups is found in Arithmetic Reasoning and Reading Comprehension, the greatest between Language and Reading Vocabulary.

Comparing the means of Group I with the highest score it was possible to make on the section, the mean on the Reading Comprehension is found to be only 6.06 points less than the possible score; Arithmetic Reasoning, 7.48 less; Arithmetic Fundamentals, 9.85; Language, 15.83; and Reading Vocabulary, 16.74 points less than the possible scores of their respective sections. A similar comparison of the Form B means of Group II with the possible scores, show differences ranging from 9.93 on Reading Comprehension to 23.85 on Reading Vocabulary, the rank of subjects being the same as that of Group I with the exception of the last two, the Reading Vocabulary difference being greater than that of the Language. In Group III, the differences range from 15.73 on Reading Comprehension to 33.64 on Reading Vocabulary, the subjects ranking in the same order as in Group I.

Comparing the standard deviations, it is seen that Group III has a greater spread of scores about the mean and that Group I shows less variability than Group II. The section showing the least variability in all groups is the Reading Comprehension; and the one showing the most is the Language. The ranking of the other sections from least to greatest variability is Arithmetic Reasoning, Arithmetic Fundamentals, and Reading Vocabulary. The sections of Group I show the greatest reliability of the mean of the three groups, and the means of Group III seem to be the least reliable.

TABLE IV

DISTRIBUTION OF SCORES MADE BY GROUP I ON SECTIONS OF THE PROGRESSIVE ACHIEVEMENT TESTS

Score	Reading Vocabulary		Reading Comprehension		Arithmetic Reasoning		Arithmetic Fundamentals		Language	
	A	B	A	B	A	B	A	B	A	B
105	-	-	-	-	-	-	-	-	-	4
100	-	-	-	-	-	-	-	-	7	16
95	-	-	-	-	-	-	-	-	11	17
90	-	-	-	-	-	-	-	-	11	9
85	-	2	-	-	-	-	-	-	12	10
80	5	5	-	-	-	-	1	-	15	3
75	18	27	-	-	-	-	5	19	6	5
70	17	12	-	-	-	-	19	21	1	2
65	18	11	-	-	-	-	16	13	2	-
60	5	6	-	-	-	-	11	6	1	-
55	2	2	2	3	-	1	6	3	-	-
50	-	1	12	22	5	25	6	4	-	-
45	1	-	22	33	18	18	2	-	-	-
40	-	-	18	7	19	18	-	-	-	-
35	-	-	10	1	14	2	-	-	-	-
30	-	-	2	-	8	2	-	-	-	-
25	-	-	-	-	2	-	-	-	-	-
Possible Score	90		55		55		80		110	
Mean	71.67	73.26	45.38	48.94	41.89	47.42	66.21	70.15	88.33	94.17
S.D.	6.65	7.10	5.60	3.85	6.15	5.25	7.90	7.10	9.15	8.90
S.E.	.82	.87	.69	.47	.76	.65	.97	.87	1.13	1.10

Read table thus: Four pupils in Group I made a score between 105 and 109 on the Language test, Form B. The other lines of the table are read in like manner.

TABLE V

DISTRIBUTION OF SCORES MADE BY GROUP II ON SECTIONS OF THE PROGRESSIVE ACHIEVEMENT TESTS

	Reading Vocabulary		Reading Comprehension		Arithmetic Reasoning		Arithmetic Fundamentals		Language	
Score	A	B	A	B	A	B	A	B	A	B
105	-	-	-	-	-	-	-	-	-	1
100	-	-	-	-	-	-	-	-	-	6
95	-	-	-	-	-	-	-	-	15	24
90	-	-	-	-	-	-	-	-	11	27
85	-	-	-	-	-	-	-	-	20	13
80	-	2	-	-	-	-	-	-	20	22
75	5	7	-	-	-	-	-	6	7	9
70	23	27	-	-	-	-	8	27	9	3
65	21	28	-	-	-	-	24	20	8	2
60	33	26	-	-	-	-	17	24	12	-
55	15	15	-	-	-	-	26	17	4	1
50	6	3	1	17	-	10	17	7	2	2
45	3	3	13	47	10	30	13	6	2	1
40	4	-	36	26	29	26	3	3	1	-
35	1	-	40	19	25	32	1	1	-	-
30	-	-	15	1	23	3	1	-	-	-
25	-	-	4	1	14	7	-	-	-	-
20	-	-	2	-	7	3	-	-	-	-
15	-	-	-	-	2	-	-	-	-	-
10	-	-	-	-	1	-	1	-	-	-
Possible Score	90		55		55		80		110	
Mean	63.62	66.15	39.12	45.07	35.88	41.55	58.35	63.67	79.67	88.04
S.D.	8.30	7.15	5.5	5.15	7.60	7.05	9.45	8.85	13.45	10.65
S.E.	.79	.68	.52	.49	.72	.67	.90	.84	1.28	1.01

Read table thus: One pupil in Group II made a score between 105 and 109 in the Language section of Form B. The other lines are read in like manner.

TABLE VI

DISTRIBUTION OF SCORES MADE BY GROUP III ON SECTIONS OF THE PROGRESSIVE TESTS

	Reading Vocabulary		Reading Comprehension		Arithmetic Reasoning		Arithmetic Fundamentals		Language	
Score	A	B	A	B	A	B	A	B	A	B
100	-	-	-	-	-	-	-	-	-	1
95	-	-	-	-	-	-	-	-	1	2
90	-	-	-	-	-	-	-	-	3	8
85	-	-	-	-	-	-	-	-	4	10
80	-	-	-	-	-	-	-	-	8	14
75	1	-	-	-	-	-	-	1	10	13
70	3	4	-	-	-	-	3	6	15	8
65	6	9	-	-	-	-	3	10	8	8
60	15	22	-	-	-	-	10	17	9	7
55	18	11	-	1	-	-	20	15	8	-
50	15	19	-	1	-	-	14	8	6	6
45	9	7	2	11	1	11	9	5	2	1
40	7	1	13	24	9	13	4	5	3	-
35	1	3	16	20	14	12	5	3	1	1
30	3	3	16	20	12	20	4	3	1	-
25	-	-	14	1	17	18	2	3	-	-
20	-	-	13	1	16	5	2	2	-	-
15	-	-	4	-	8	-	1	1	-	-
10	1	-	-	-	1	-	2	-	-	-
5	-	-	-	-	1	-	-	-	-	-
0	-	-	1	-	-	-	-	-	-	-
Possible Score	90		55		55		80		110	
Mean	54.84	56.80	31.87	39.27	29.05	35.22	50.47	54.91	68.57	76.36
S.D.	10.4	9.0	8.4	6.06	8.55	7.25	13.25	13.45	13.60	15.0
S.E.	1.17	1.01	.95	.68	.96	.82	1.49	1.51	1.53	1.68

Read table thus: One pupil in Group III made a score between 105 and 109 on the Language section of the Form B of the test. The rest of the table is read in like manner.

A comparison of the achievement of the whole group on the various sections can be made by a study of Table VII. Finding the difference between the means of Form B and the possible scores on the respective sections gives the following results: Reading Comprehension, 10.72; Arithmetic Reasoning, 13.89; Arithmetic Fundamentals, 17.36; Language, 24.06; and Reading Vocabulary, 24.90. A comparison of the standard deviations and of the standard errors shows a ranking of sections from highest to lowest as follows: Reading Comprehension, Arithmetic Reasoning, Arithmetic Fundamentals, Reading Vocabulary, and Language.

A study of the gains made by each group on the various sections of the test can be made by means of the results shown in Table VIII. As to actual gain in score points, the gains of Groups II and III both exceed the gains of Group I, and the gains of Group II exceed those of Group III, except in Reading Comprehension and in Arithmetic Reasoning, in which Group II is exceeded by Group III. In the Sigma $Gain_1$, which is the quotient of the actual gain of a group divided by the group's own initial sigma, Group I was exceeded by Group II in all sections except those of Arithmetic Reasoning and Language. Group III was exceeded by Group II on all sections, and by Group I on all sections except that of Reading Comprehension. In Sigma $Gain_2$, which is the quotient of the actual gain of a group divided by the total group's initial sigma, however, Group II exceeded Group I in every section, and exceeded Group III in all sections except those of Reading Comprehension and Arithmetic Reasoning. The sigma gains of Group III by this method exceeded all those of Group I.

A comparison of the sigma gains on the various sections of the test shows the greatest gain made in Reading Comprehension by Groups II and III, with Arithmetic Reasoning second, and Language, Arithmetic Fundamentals,

TABLE VII

DISTRIBUTION OF SCORES ON ALL GROUPS ON SECTIONS OF THE PROGRESSIVE ACHIEVEMENT TESTS

	Reading Vocabulary		Reading Comprehension		Arithmetic Reasoning		Arithmetic Fundamentals		Language	
Score	A	B	A	B	A	B	A	B	A	B
105	-	-	-	-	-	-	-	-	-	5
100	-	-	-	-	-	-	-	-	7	23
95	-	-	-	-	-	-	-	-	27	43
90	-	-	-	-	-	-	-	-	25	44
85	-	2	-	-	-	-	-	-	36	33
80	5	7	-	-	-	-	1	-	43	39
75	24	34	-	-	-	-	5	26	23	27
70	43	43	-	-	-	-	30	54	25	13
65	45	48	-	-	-	-	43	43	18	10
60	53	54	-	-	-	-	38	47	22	7
55	35	28	2	4	-	1	52	35	12	-
50	21	23	13	40	5	35	37	19	8	7
45	13	10	37	91	29	59	24	11	4	3
40	11	1	67	57	57	57	7	8	4	1
35	2	3	66	40	53	46	6	4	1	1
30	3	3	33	21	43	25	5	3	1	-
25	-	-	18	2	33	25	2	3	-	-
20	-	-	15	1	23	8	2	2	-	-
15	-	-	4	-	10	-	1	1	-	-
10	1	-	-	-	2	-	3	-	-	-
5	-	-	-	-	1	-	-	-	-	-
0	-	-	1	-	-	-	-	-	-	-
Possible Score	90		55		55		80		110	
Mean	62.99	65.10	38.49	44.28	35.47	41.11	57.95	62.64	78.46	85.94
S.D.	10.69	9.9	8.25	6.34	8.88	6.90	12.0	11.25	14.55	11.89
S.E.	.67	.62	.52	.40	.56	.43	.75	.70	.91	.74

Read table thus: Five pupils made a score between 105 and 109 in Language on Form B of the test. Other lines in the table are read in like manner.

TABLE VIII

GAINS ON THE SECTIONS OF THE PROGRESSIVE ACHIEVEMENT TESTS

Section		Group I	Group II	Group III	Total
READING VOCABULARY	Gain	1.59	2.53	1.96	2.11
	Sigma $Gain_1$	.24	.30	.19	.19
	Sigma $Gain_2$	.15	.24	.18	.19
READING COMPREHENSION	Gain	3.56	5.95	7.40	5.79
	Sigma $Gain_1$	.62	1.08	.88	.70
	Sigma $Gain_2$	.43	.72	.89	.70
ARITHMETIC REASONING	Gain	5.53	5.67	6.19	5.64
	Sigma $Gain_1$	.69	.75	.72	.64
	Sigma $Gain_2$	.62	.64	.71	.64
ARITHMETIC FUNDAMENTALS	Gain	3.94	5.32	4.44	4.69
	Sigma $Gain_1$	.50	.56	.34	.38
	Sigma $Gain_2$	.32	.43	.36	.38
LANGUAGE	Gain	5.84	8.37	7.79	7.48
	Sigma $Gain_1$	.64	.62	.57	.51
	Sigma $Gain_2$	.40	.58	.53	.51

Read table thus: Group I made a mean gain of 1.59 on the Reading Vocabulary section. The sigma $gain_1$ was .24 and sigma $gain_2$ was .15.

and Reading Vocabulary following in the order named. In Group I, the greatest sigma gain is apparent in Arithmetic Reasoning with Language second, and Reading Comprehension, third. The other two subjects place in the same relative positions as in the other groups. The ranking of the sections as to sigma gain in the total group is as follows: Reading Comprehension, first, with .70 gain; Arithmetic Reasoning, second, with a gain of .64; Language, third, with a gain of .51; Arithmetic Fundamentals, fourth, with a gain of .38; and Reading Vocabulary lowest, with a gain of only .19.

Table IX gives a measure of the reliability of the difference between the means on the two forms of the test, computed for the different sections, and arranged in groups for the purpose of comparison. The figures shown in the table are the ratios of the obtained difference between the means, to the standard errors of those differences. Each ratio should be interpreted as indicating a significant difference when it is equal to 3.00. A ratio of 3.00, in other words, guarantees that the true difference is greater than zero. A ratio greater than 3.00 guarantees additional significance. A ratio of less than 3.00 is interpreted as having a certain number of chances in 100 of being a significant difference. The five ratios in the table which are less than 3.00 are interpreted as follows:[20]

1.84 -- 90 chances in 100 of a significant difference

2.43 -- 99 chances in 100 of a significant difference

1.67 -- 94 chances in 100 of a significant difference

2.32 -- 99 chances in 100 of a significant difference

2.10 -- 98 chances in 100 of a significant difference.

All of the ratios in the table are high and those which are not high enough to indicate a certainty of a significant difference are nevertheless high enough to show a high degree of probability that they are significant. It will be noted that four of these lower ratios are in the Language section, none of the groups showing a certainty of a difference greater than zero.

From the table it is seen that Group II has the highest ratios indicating that this group has made more significant gains in all the sections covered by the test than have the other groups. The ratios of Group I exceed those of Group III except in the two sections of the Reading.

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[20] Ibid., p. 213.

TABLE IX

TABLE SHOWING THE RELIABILITY OF THE DIFFERENCE BETWEEN THE MEANS ON THE TWO FORMS OF THE PROGRESSIVE ACHIEVEMENT TEST

Sections	Group I	Group II	Group III	Total
Reading Vocabulary	1.34	2.43	1.67	2.32
Reading Comprehension	4.24	8.38	6.32	8.77
Arithmetic Reasoning	5.53	5.78	4.91	7.94
Arithmetic Fundamentals	3.03	4.32	2.10	4.47
Language	3.70	5.14	3.43	6.39

Read table thus: The quotient of the obtained difference of the two means on the Reading Vocabulary section divided by the probable error of the difference, for Group I, is 1.34, Group II is 2.43, Group III is 1.67, and for the entire group is 2.32.

Making a comparison of the sections of the test in regard to reliability of the difference between the means, shown in Table IX, Reading Comprehension shows the highest ratio, with Arithmetic Reasoning somewhat less, Language, third, and Arithmetic Fundamentals, fourth from highest in the degree of significance guaranteed in the gain. The ratio obtained for Reading Vocabulary for the whole group is the only one which does not guarantee a gain which is greater than zero; but there is a probability of 99 chances in 100 that this gain is also significant.

VII. Conclusion

All of the comparisons of the three groups made above seem to show a superior achievement gain on the part of the middle group. It will be recalled that the intelligence quotients of this group ranged from 102 to 119 and averaged 110.62. This group surpassed the gain of each of the other groups throughout the tests. The achievement of this group in no section of either test has surpassed the achievement of the upper group. There is a possibility that the comparative lack of gain on the part of Group I may be due to the fact that the test did not contain enough items to test the brighter group, some of whom made perfect scores on sections of the test on the first application. Since the test was not a timed one, each section allowing enough time for at least 90% of the group to finish, it is obvious that many of the pupils could have covered more items.

The greatest achievement gain by subjects was made in Reading Comprehension, followed by Arithmetic Reasoning and Language. The smallest gains were made in Arithmetic Fundamentals and Reading Vocabulary.

CHAPTER III

OTHER MEASURES OF ACHIEVEMENT

Certain other tests were given to the ninth grade pupils and the means of the various groups computed. The results obtained on these tests are presented in this section and comparisons of the groups are made on the basis of the means of the tests. Some correlations have been made in order that the achievements on these tests could be compared with the respective achievements on similar sections of the Progressive Achievement Tests.

I. Achievement in Reading as Measured by the Schrammel-Gray Reading Test

The Schrammel-Gray Reading test for high school and college students was given to all the pupils in May. This test measures the rate and comprehension of reading, as do many of the silent reading tests, but in addition gives a comprehension-efficiency score which is a measure of the efficiency of the pupil's reading ability. This score is the ratio of the comprehension score, or the number of items correct, to the number of items attempted, expressed in percent. An example will show how this score is obtained. If a pupil attempted 40 items and answered 40 correctly his score would be 100. If he had answered only 20 correctly of the 40 attempted items, his score would have been 50.

From Table X comparisons of the means of the three groups can be made on the three scores obtained from the reading test. On the comprehension

score, the mean of 65.07 for Group I is 9.29 points higher than the mean of Group II, and the mean of Group II, 55.78, is 12.84 higher than the mean of 42.94 for Group III. The greatest variability of the mean of the three groups is shown in Group I.

TABLE X

THE MEANS OF THE THREE GROUPS ON THE SCHRAMMEL-GRAY READING TEST

	Group I	Group II	Group III	Total
Comprehension score				
Mean	65.07	55.78	42.94	54.21
Standard deviation	13.9	13.45	12.55	15.73
Standard error	1.71	1.28	1.41	.98
Rate score				
Mean	148.88	139.56	119.88	135.92
Standard deviation	23.4	26.7	31.3	29.69
Standard error	2.88	2.53	3.52	1.85
Comprehension-efficiency				
Mean	81.06	74.98	67.56	74.26
Standard deviation	8.00	9.15	10.9	10.74
Standard error	.98	.87	1.23	.67

Read table thus: Group I has a mean of 65.07, a standard deviation of 13.9, a standard error of 1.71 on comprehension score. Read in like manner for other items and other groups.

The same relative positions of the groups is shown in the means of the rate score, the means being respectively 148.88, 139.56, and 119.88. The entire group has a rate score of 135.92. The greatest variability of the mean in the rate score was found in Group III and the least in Group I.

The mean of Group I on the comprehension-efficiency score is 18.94 points below the highest possible score of 100. The mean of 74.98 is only 6.08 points below that of Group I, and the mean of 67.56 for Group III is 7.42 below that of Group II. The greatest variability again is found in Group III and the least in Group I.

It will be noted that the difference between the means of the middle and low group are consistently more than the differences between the means of the high and middle groups. When the percentage of difference is figured in each case the greatest is obtained on the comprehension scores and the least on the comprehension-efficiency scores.

The correlations between the comprehension-efficiency scores and the scores made on the total reading score on the Progressive Avhievement Test, Form B were computed. These results were obtained:

Group I	.45 $\pm$ .07
Group II	.45 $\pm$ .05
Group III	.37 $\pm$ .06
Total	.72 $\pm$ .02

None of these correlations are high with the exception of the one obtained for the entire group. It shows a rather high relationship between performances on the two tests, probably showing the similarity of ability needed in the two tests.

II. Achievement in Mathematics as Measured by the Algebra and Problem Solving Tests

The Breslich Algebra Survey Test was given to this group of pupils in May. They had not studied algebra as a separate subject but the General Mathematics course in which they were all enrolled contained much of the material commonly studied in first semester algebra. Of course the 9B pupils had not covered more than half of the material at the time the tests were given.

The means of the three groups can be seen in Table XI. The mean of Group I is the highest, 58.07, and the means of the second and third groups are 47.25 and 31.58, respectively. The mean of the entire group, 45.19, is slightly below that of the second group. An examination of the standard deviation shows the first group to be the most variable, 21.5, as compared with 15.6 for the second and 16.0 for the third. Group II has the smallest standard error of the mean.

In order to see whether those pupils who ranked high in the Arithmetic Reasoning Test section of the Progressive Achievement also ranked high in the algebra test and if other pupils made similar ranks on the two tests, the correlation of the two tests was found. The correlations were as follows:

Group I	.87 ± .02
Group II	.42 ± .05
Group III	.53 ± .05
Total	.69 ± .02

Group I shows a high correlation of performances on the two tests and the other groups show a substantial amount of correlation with that of the middle group being the least.

TABLE XI

THE ACHIEVEMENT OF THE THREE GROUPS OF PUPILS ON THE BRESLICH ALGEBRA AND THE PROBLEM SOLVING TESTS

	Group I	Group II	Group III	Total
Breslich Algebra				
Mean	58.07	47.25	31.58	45.19
Standard deviation	21.5	15.6	16.0	18.40
Standard error	2.65	1.48	1.80	1.15
Problem Solving				
Mean	7.58	6.07	4.91	6.10
Standard deviation	2.04	2.27	2.20	2.41
Standard error	.25	.22	.25	.15

Read table thus: On the Breslich Algebra test, Group I had a mean of 58.07, a standard deviation of 21.5, and a standard error of 2.65.

The Compass Problem Solving Test, also given in May, is a diagnostic test of the ability to solve problems. The test consists of fifteen word problems arranged in order of difficulty with the easier problems at the beginning. The time limit for the test is twenty minutes. As seen in Table XI, the mean of Group I is the highest, 7.58, that of Group II, second, with 6.07, and Group III, lowest, with 4.91. In this test, unlike that of the others, there is less difference between the lower and middle groups than between the middle and higher groups. This may mean that the lower group has made a comparatively higher score or that the records of one or both of

the other groups are comparatively lower. Another unusual feature of the comparisons of the groups is to find the largest standard deviation in the mean of Group II.

Correlations were obtained between this test and the Arithmetic Reasoning test, also. The correlation coefficients were:

Group I	.55 ± .06
Group II	.42 ± .05
Group III	.63 ± .04
Total	.57 ± .03

With the exception of Groups II and III, these correlations are not as high as those found when the Arithmetic Reasoning was correlated with the algebra test. Group III has a correlation of .63 with this test and .53 with the algebra test, while the correlations coefficients for Group II are equal. The correlation coefficient for the entire group is .11 higher when the Arithmetic Reasoning was correlated with the algebra test. This cannot be due to the fact that the Arithmetic Reasoning Test stressed the subject of algebra as only one-fifth of the questions in the reasoning test were algebraic in nature.

Correlations were also computed between the Algebra test and the Problem Solving test with the following results:

Group I	.52 ± .06
Group II	.74 ± .03
Group III	.53 ± .05
Total	.65 ± .02

The correlation of Group II is high, in this case, as would have been expected considering its correlation in both cases with the Arithmetic Reasoning Test.

Since it was possible to translate the means of the groups into educational ages by means of the Manual,[21] other comparisons could be made of the groups regarding their performances on the Problem Solving Test. The medians of the groups were translated into educational ages and comparisons of these with the median mental ages of the respective groups is given in Table XII. According to this comparison the lower group has made the best achievement on this test in respect to their ability, and the high intelligence group has made the least achievement in respect to their ability, achieving 22% below the point which is indicated by their ability rating.

TABLE XII

A COMPARISON OF THE GROUPS ON THE BASIS OF MEAN EDUCATIONAL AGES ATTAINED ON THE PROBLEM SOLVING TEST

	Group I	Group II	Group III	Total
Educational age	14 yr., 2 mo.	13 yr., 7 mo.	13 yr., 1. mo.	13 yr., 8 mo.
Mental age	18 yr., 2 mo.	16 yr., 4 mo.	14 yr., 1 mo.	16 yr., 2 mo.
Difference	48 mo.	26 mo.	12 mo.	30 mo.
Percent of difference	22%	13%	7%	15%

Read table thus: The median educational age of Group I was 14 years, 2 months, their median mental age was 18 years, 2 months, the difference between the medians was 48 months, and the percent of difference was 22 below the median mental age.

[21] G. M. Ruch, and others, Manual of Directions for Compass Diagnostic Tests in Arithmetic. (Chicago: Scott, Foresman and Co., 1925.) P. 56.

A total score was computed for each pupil by finding the sum of the scores made on the three tests of this section, the reading comprehension, the problem solving, and the algebra. Correlations were then found between this total score and with the intelligence quotients obtained on the Army Alpha. The correlation coefficients were as follows:

Group I	.60	± .06
Group II	.20	± .04
Group III	.58	± .04
Total	.70	± .02

It will be noted that the highest correlation was obtained when the entire group was used, as was the case in the correlations of the Progressive Achievement with intelligence quotients. (See page 19.) This coefficient is higher than that obtained with Form A (.41) but not as high as that obtained with Form B (.75). However, there is a high degree of relationship signified, in the correlation obtained for the entire group, between the total of these three tests and the intelligence quotients. The coefficients of correlation obtained for Groups I and III are higher on these tests than on either of the forms of the Progressive Achievement, but that of Group II is somewhat lower, the correlation of .20 indicating only a slight degree of relationship existing between the performances on the two tests.

CHAPTER IV

CONCLUSIONS

The purpose of this study was to compare the achievements of a group of ninth grade pupils of varying abilities. The pupils were divided into three ability groups according to intelligence quotients; Group I including those whose intelligence quotients ranged from 120 to 146, Group II those ranging from 102 to 119, and Group III those from 70 to 101. Comparisons of these groups were made on the basis of the achievement they had made on certain tests which were given them during the year. These tests for which more than one score was available from each pupil have more significance in this comparison than do those for which only one score is available. Consequently a greater stress is placed upon the results obtained on the Progressive Achievement Tests, which were given at the beginning and again at the end of the year, than on those tests given only once during the year.

The gains in achievement were greater in the middle group, those having intelligence quotients ranging from 102 to 119, than in the high group in all sections of the test. The gains of the middle group surpassed those of the low group except in Reading Comprehension and Arithmetic Reasoning.

The gains in achievement in the low group were greater than those in the high group in all sections and surpassed those of the middle group in the two sections mentioned above.

The comparative lack of gain on the part of the high group may be due

to a lack of enough material in the test to accurately test the brighter pupils. Other studies should be made with many tests containing sufficient material to test all of the pupils in order to test the validity of this argument.

Another possible explanation for the lack of gain on the part of the high group may be that the course of study does not provide enough material to challenge the capabilities of the bright pupils. The course of study may be planned for the middle group. The higher group, lacking the incentive to greater achievement, are content to be safely above the median in achievement instead of striving toward a goal of achievement commensurate with their abilities. If the intelligence tests had been given at the beginning of the year, and the results made available to the teachers at that time, the bright pupils might have been stimulated to greater accomplishment.

The two sections of the Progressive Achievement Tests showing the most improvement were those of Reading Comprehension and Arithmetic Reasoning. Reading was a subject of special emphasis throughout the Lowther Junior High School during the school year, each teacher stressing the reading of the particular subject which he taught. The comparatively high gain in Reading Comprehension may be due to the training thus received. The Arithmetic Reasoning gain was probably influenced by the study of algebra in which all the pupils were engaged during the year. About twenty percent of the problems in the reasoning test were algebra problems and the solution of many of the other problems could be simplified by the use of algebraic methods. It will be recalled that the actual class work of the pupils was not tested by this particular test. If an experiment could be worked out by which the achievement gain in actual class work could be measured, the results might

be quite different.

The comparison of actual scores made on all of the tests given shows the greatest mean score for the high group and the least for the low group as would be expected from the mental ability ranks. Comparisons made with grade norms show that the high group is consistently above the median grade norms, and the low group is below those norms. However it seems that when the abilities of the groups are considered, that the high group should greatly surpass the median and that the other group should not be expected to reach it.

According to the results obtained in this study there appears to be some factor or factors other than mental ability, as measured by tests, which affects the achievement of pupils in school. The regularity of the pupil's attendance, his home environment, and such personal qualities as industry, persistence, concentration, and interest, all undoubtedly have their effect on his performance of school tasks. No attempt has been made in this study to measure the effect of these factors; however, some such studies have been made. Dr. Kelley[22] attributes the production of a school mark to three factors, namely: the mental capacity of the pupil, his preparation for the particular course, and his effort and interest in the subject.

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[22] Truman Lee Kelley, An Experimental Study in the Analysis and Prediction of Ability of High School Pupils (Teachers College Contributions to Education, No. 71, New York: Teachers College, Columbia University, 1914), p. 19.

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