

A COMPARATIVE STUDY OF THE INDIVIDUAL
AND GROUP METHODS OF TEACHING NINTH GRADE ALGEBRA

by

ELIZABETH SPEARS HEPLER

A. B., University of Nebraska, 1924

A THESIS

submitted in partial fulfillment of the

requirements for the degree of

MASTER OF SCIENCE

KANSAS STATE COLLEGE
OF AGRICULTURE AND APPLIED SCIENCE

1931

Spec
Coll
LD
2668
.T4
1931
H43

TABLE OF CONTENTS

	Page
INTRODUCTION.	1
STATEMENT OF THE PROBLEM.	2
METHOD OF INVESTIGATION	4
PRESENTATION AND INTERPRETATION OF DATA	23
ADVANTAGES AND DISADVANTAGES OF INDIVIDUAL INSTRUCTION OBSERVED DURING THE EXPERIMENT.	47
CONCLUSIONS	52
REFERENCES.	54
APPENDIX.	56
ACKNOWLEDGMENT.	72

INTRODUCTION

The development and use of mental tests since the World War have emphasized the differences in mental make-up of any group of individuals and brought forcibly to the minds of those interested in education many questions regarding the relative efficiency of different methods of dealing with these varying individuals in the class room.

In the last two decades many new methods of instruction have been proposed and tried which are supposed to give each child a fairer chance for maximum development. The individual method is one which has received a great deal of attention. The Dalton plan, originated by Miss Helen Parkhurst, and the Winnetka plan, inaugurated in the schools of Winnetka, Illinois, over ten years ago by Mr. Carleton Wolsey Washburne, are probably the best known examples of this type of instruction although there are many other similar ones here and abroad.

The experiment which is reported in this study was made with the idea of presenting some experimental data relating to the use of the individual method in the teaching of ninth grade algebra in the junior high school.

A study was made by Miss Irma Long* in 1929 in the Junior High School of Lawrence, Kansas, of the comparative efficiency of the individual and group methods of instruction in seventh grade mathematics. She reported that pupils taught by the individual method showed greater improvement in the fundamental skills in arithmetic and also in reasoning than those taught by the group method. In this experiment the classes compared were taught by different teachers which might have effected the results although every effort was made to use teachers who had the same training and ability. The statement was also made, based on the opinion of the two teachers involved, that the individual method required more of the teacher's time.

The study herein reported deals with these questions as applied to ninth grade mathematics as well as some others stated in the following section. The two groups of students compared were in classes handled by the same teacher.

STATEMENT OF THE PROBLEM

This study deals with a comparison of two methods of

*A comparison of Two Methods of Instruction in Seventh Grade Mathematics. Irma Long's Thesis, University of Kansas, 1929.

instruction in ninth grade algebra--the individual method and the group method. These two methods as they were used are described in the following section.

The primary object of instruction is to teach, and thus the important question in a comparison of two methods is which of the two is responsible for the greater achievement of the pupils. There are also many other contributing factors which must be considered.

The following are the most important points which were checked either by testing or by observation.

1. Does an average size ninth grade algebra class gain more knowledge of the subject when taught by the individual method than when taught by the group method?

2. Does the individual method actually make more provision for individual differences than the group method?

3. Does the individual method train students to be more self-reliant in study--i.e. better able to comprehend and study an assignment without an instructor's explanation or direction?

4. Which of the two methods requires the greater amount of the student's time? of the instructor's time?

METHOD OF INVESTIGATION

The group observed in this study was composed of eighty-six ninth grade students of the West Junior High School of Parsons, Kansas. Of these fifty had been in attendance there since the seventh grade--the other thirty-six came in to the ninth grade from county and parochial schools. While their previous training may have been slightly different, approximately the same number was included in each of the two groups studied, the experimental and the control. So, in the few instances in which their scores were considered, the effect of this difference in training was equalized. Pupil numbers from 1-14, 28-45, and 59-76 are those of the group which had spent the two years previous in the junior high school.

To have a measure which would represent each student's potential ability to succeed in the study of algebra, a composite score was found by combining the scores made on the Terman Group Test of Mental Ability, the Stanford Achievement Test, and the Schorling--Clark--Potter Arithmetic Test.

When the students were still in the eighth grade, two

forms of the Stanford Achievement Test were given, form V on October 29, 1929, and form W on May 5, 1930. An average of these two scores was used as the achievement test score which gave a measure of the general knowledge of the student. On May 19, 1930 the Schorling--Clark--Potter Arithmetic Test was given, this score gave a measure of the pupils mathematical training and ability. On April 21, 1930, form A of the Terman Group Test of Mental Ability was given. On May 19, 1931, at the end of the experiment, form B of this test was given. The average of these two scores was taken as the measure of the students' mental ability.

These three scores were reduced to comparable measures by the method found in "Statistical Methods for Students in Education" by K. J. Holzinger.*

The formula used was

$$X_1 = M_1 + \frac{\sigma_1}{\sigma_2} (X_2 - M_2)$$

By means of this formula the achievement and arithmetic scores were converted so that they had the same mean as the Terman Group Test of Mental Ability Score.

These three scores were then added and the sum divided by three so that a composite score was obtained which had

*Statistical Methods for Students in Education,
K. J. Holzinger. P.121, (Formula 23).

Table I. Original Test Scores

Experimental Group - A

Pupil	Stanford Achievement Test - Form V Oct. 29, 1929	Stanford Achievement Test - Form W May 5, 1930	Achievement Test Average	Schorling--Clark-- Potter Arithmetic Test - May 19, 1930	Terman Group Test of Mental Ability Form A - April 21, 1930	Terman Group Test of Mental Ability Form B - May 19, 1931	Terman Group Test of Mental Ability Aver- age
			(Y)	(Z)			(X)
1	107.9	112.7	110.3	70	161	179	170
2	101.6	102.3	101.95	74	158	179	168.5
3	80.9	88.3	84.6	66	94	108	101.0
4	104.4	116.4	110.4	95	173	191	182.0
5	80.2	84.1	82.15	23	92	86	89.0
6	82.2	91.1	86.65	47	88	96	92.0
7	88.0	96.4	92.2	64	108	105	106.5
8	84.4	92.3	88.35	38	110	114	112.0
9	90.8	109.5	100.15	50	108	117	112.5
10	75.7	89.1	82.4	17	92	110	101.0
11	80.2	90.8	85.5	37	90	116	103.0
12	100.7	103.3	102.0	84	124	146	135.0
13	89.4	99.3	94.05	61	117	141	129.0
14	75.2	72.0	73.6	35	78	120	99.0

Table I. Continued

Control Group - B. Section I

28	76.2	87.9	82.05	46	69	93	81.0
29	76.7	79.4	78.05	34	52	70	61.0
30	80.6	91.3	85.95	42	101	111	106.0
31	93.4	99.8	96.60	80	130	152	141.0
32	90.6	102.4	96.5	67	121	137	129.0
33	98.7	102.6	100.65	76	129	166	147.5
34	81.4	88.2	84.80	55	76	91	83.5
35	75.4	80.4	77.9	50	81	94	87.5
36	89.3	95.8	92.55	73	103	124	113.5
37	59.3	80.9	70.1	25	61	95	78.0
38	60.1	69.9	65.0	21	68	79	73.5
39	91.5	100.2	95.85	68	118	122	120.0
40	53.4	67.4	60.40	21	52	41	46.5
41	95.8	103.9	99.85	64	122	152	137.0
42	91.4	98.0	94.7	79	118	131	124.5
43	75.6	86.7	81.15	42	93	95	94.0
44	89.2	80.9	85.55	71	96	128	112.0
45	82.2	89.2	85.7	43	72	88	80.0

Table I. Continued

Control Group - C. Section II

59	91.3	98.1	94.8	48	101	103	102.0
60	78.7	84.4	81.55	35	80	87	83.5
61	63	82.8	72.9	35	74	83	78.5
62	88.1	77.8	82.95	51	83	104	93.5
63	79.6	86.8	83.2	49	93	118	105.5
64	69.1	82.7	75.9	40	70	81	75.5
65	90.5	94.9	92.7	59	127	132	129.5
66	80.1	93.7	86.9	57	86	97	91.5
67	78.4	85.2	81.8	73	111	132	121.5
68	78.1	81.4	79.75	26	95	120	107.5
69	62.5	73.7	68.1	39	64	62	63.0
70	71.5	90.5	81.0	26	76	120	98.0
71	69.0	81.1	75.05	43	85	96	90.5
72	87.3	92.9	90.1	42	118	109	113.5
73	54.3	73.0	63.65	16	49	60	54.5
74	79.4	81.3	80.35	23	57	87	72.0
75	73.7	99.0	86.35	22	71	91	81.0
76	66.9	72.9	69.9	30	63	71	67.0

the same mean as the scores being added. This score, designated hereafter as the "Composite Score", was used as the basis for comparison between the groups. This plan gave equal weights to the three elements in the composite score.

The original test scores are given in Table I, and the computation of the composite score is shown in Table II, page 10.

Due to administrative difficulties it was impossible to control the division of these students into experimental and control groups; however, this does not affect the experiment as no assumption was made that the groups studied were normal or otherwise, all conclusions were drawn from the actual scores made. Fourteen of the students tested were placed in the experimental class--eighteen in each of the two control classes. Each of the classes numbered from thirty to thirty-five students during the entire year, the remainder of the classes being made up of those coming from the parochial and county schools. The scores of all students were included in this study with the exception of those who changed from one group to the other or were not present during the entire thirty-six weeks.

The teaching of the experimental and control groups was done by the same teacher--the same material identically was used in the two classes--the length of the class periods and

Table II. Conversion of Scores

Experimental Group - A

Pupil	Terman Group Test Average	Stanford Achievement Test	Schorling-Clark- Potter Arithme- tic Test				Converted Score	Converted Score		Composite Score
	(X)	(Y)	(Z)	(X ²)	(Y ²)	(Z ²)	(Y ¹)	(Z ¹)	(X+Y ¹ +Z ¹)	(X+Y ¹ +Z ¹)
1	170	110.3	70	28900.00	12166.09	4900	166.55	133.97	470.52	156.84
2	168.5	101.95	74	28392.25	10393.80	5476	145.12	139.79	453.41	151.14
3	101	84.6	66	10201.00	7157.16	4356	100.60	128.15	329.75	109.92
4	182	110.4	95	33124.00	12188.16	9025	166.81	170.36	519.17	173.06
5	89	82.15	23	7921.00	6748.62	529	94.31	65.56	248.87	82.96
6	92	86.65	47	8464.00	7508.22	2209	105.86	100.49	298.35	99.45
7	106.5	92.2	64	11342.25	8500.84	4096	120.10	125.24	351.84	117.28
8	112	88.35	38	12544.00	7805.72	1444	110.22	87.39	309.61	103.20
9	112.5	100.15	50	12656.25	10030.02	2500	140.50	104.86	357.86	119.29
10	101	82.4	17	10201.00	6789.76	289	94.95	56.82	252.77	84.26
11	103.0	85.5	37	10609.00	7310.25	1369	102.91	85.94	291.85	97.28
12	135	102	84	18225.00	10404.00	7056	145.25	154.35	434.60	144.87
13	129	94.05	61	16641.00	8845.40	3721	124.85	120.87	374.72	124.91
14	99	73.60	35	9801.00	5416.96	1225	72.36	83.03	254.39	84.80

Table II. Continued
Control Group - B. Section I

28	81	82.05	46	6561.00	6732.20	2116	94.05	99.04	274.09	91.36
29	61	78.05	34	3721.00	6091.80	1156	83.78	81.57	226.35	75.45
30	106	85.95	42	11236.00	7387.40	1764	104.06	93.21	303.27	101.09
31	141	96.6	80	19881.00	9331.56	6400	131.39	148.53	420.92	140.31
32	129	96.5	67	16641.00	9312.25	4489	131.14	129.60	389.74	129.91
33	147.5	100.65	76	21756.25	10130.42	5776	141.79	142.71	432.00	144.00
34	83.5	84.80	55	6972.25	7191.04	3025	101.11	112.14	296.75	98.92
35	87.5	77.9	50	7656.25	6068.41	2500	83.40	104.86	275.76	91.92
36	113.5	92.55	73	12882.25	8565.50	5329	121.00	138.34	372.84	124.28
37	78.0	70.1	25	6084.00	4914.01	625	63.38	68.47	209.85	69.95
38	73.5	65.0	21	5402.25	4225.00	441	50.29	62.65	186.44	62.15
39	120.0	95.85	68	14400.00	9187.22	4624	129.47	131.06	380.53	126.84
40	46.5	60.4	21	2162.25	3648.16	441	38.49	62.65	147.64	49.21
41	137.0	99.85	64	18769.00	9970.02	4096	139.74	125.24	401.98	133.99
42	124.5	94.7	79	15500.25	8968.09	6241	126.52	147.07	398.09	132.70
43	94.0	81.15	42	8836.00	6585.32	1764	91.74	93.21	278.95	92.98
44	112.0	85.55	71	12544.00	7318.80	5041	103.03	135.43	350.46	116.82
45	80.0	85.7	43	6400.00	7344.49	1849	103.42	94.67	278.09	92.70

Table II. Continued
Control Group - C. Section II

59	102.0	94.8	48	10404.00	8987.00	2304	126.77	101.95	330.72	110.24
60	83.5	81.55	35	6972.25	6650.40	1225	92.77	83.03	259.30	86.43
61	78.5	72.9	35	6162.25	5314.41	1225	70.57	83.03	232.10	77.37
62	93.5	82.95	51	8742.25	6880.70	2601	96.36	106.32	296.18	98.74
63	105.5	83.2	49	11130.25	6922.24	2401	97.00	103.40	305.90	101.97
64	75.5	75.9	40	5700.25	5760.81	1600	78.27	90.30	244.07	81.36
65	129.5	92.7	59	16770.25	8593.29	3481	121.38	117.96	368.84	122.95
66	91.5	86.9	57	8372.25	7551.61	3249	106.50	115.05	313.05	104.35
67	121.5	81.8	73	14762.25	6691.24	5329	93.41	138.34	353.25	117.75
68	107.5	79.75	26	11556.25	6360.06	676	88.15	69.93	265.58	88.53
69	63.0	68.1	39	3969.00	4637.61	1521	58.25	88.85	210.10	70.03
70	98.0	81.0	26	9604.00	6561.00	676	91.36	69.93	259.29	86.43
71	90.5	75.05	43	8190.25	5632.50	1849	76.09	94.67	261.26	87.09
72	113.5	90.1	42	12882.25	8118.01	1764	114.71	93.21	321.42	107.14
73	54.5	63.65	16	2970.25	4051.32	256	46.83	55.37	156.70	52.23
74	72.0	80.35	23	5184.00	6456.12	529	89.69	65.66	227.25	75.75
75	81.0	86.35	22	6561.00	7456.32	484	105.09	64.10	250.19	83.40
76	67.0	69.9	30	4489.00	4886.01	900	62.87	75.75	205.62	68.54
Totals	5144.0	4274.5	2422	570848.50	371747.38	137942.00	5144.26	5144.02	15432.28	5144.14

5144.26	5144.02
50	50
102.88	102.88

Table II. Continued

Conversion Equations Used

$$N = 50 \quad M_x = \frac{\sum x}{N} = \frac{5144.0}{50} = 102.88$$

$$M_y = \frac{\sum y}{N} = \frac{4274.5}{50} = 85.49$$

$$M_z = \frac{\sum z}{N} = \frac{2422}{50} = 48.64$$

$$\sigma = \sqrt{\frac{x^2}{N} - \left(\frac{x}{N}\right)^2} \text{ or } \sqrt{\frac{x^2}{N} - M^2}$$

$$\sigma_x = \sqrt{\frac{570848.50}{50} - (102.88)^2}$$

$$\sigma_x = 28.8561$$

$$\sigma_y = \sqrt{\frac{371747.38}{50} - (85.49)^2}$$

$$\sigma_y = 11.2431$$

$$\sigma_z = \sqrt{\frac{137942}{50} - (48.64)^2}$$

$$\sigma_z = 19.8239$$

$$Y^1 = \frac{\sigma_x}{\sigma_y} Y + (M_x - \frac{\sigma_x}{\sigma_y} M_y)$$

$$Y^1 = \frac{28.8561}{11.2431} Y + \left[102.88 - \frac{28.8561}{11.2431}(85.49)\right]$$

$$Y^1 = 2.5665Y - 116.530085$$

$$Z^1 = \frac{\sigma_x}{\sigma_z} Z + (M_x - \frac{\sigma_x}{\sigma_z} M_z)$$

$$Z^1 = \frac{28.8561}{19.8239} Z + \left[102.88 - \frac{28.8561}{19.8239}(48.64)\right]$$

$$Z^1 = 1.4556Z + 32.079616$$

$$\text{Check: } \sum(X+Y^1+Z^1) = \sum x + \sum x^1 + \sum z^1$$

$$15432.28 = 5144 + 5144.26 + 5144.02 = 15432.28$$

the amount of study hall time allotted to the two groups were also the same. Thus, all controlling factors were kept as nearly constant as possible--the only variable being the method of instruction. The two types of instruction were kept clearly defined in the two groups.

In the control groups, the class met as a group each day--followed the regular group method with approximately fifteen minutes for recitation and review, twenty minutes for explanation and examples of work in the new assignment, and twenty-five minutes supervised study. All explanations and drill were given to the group as a whole.

In the experimental group a modified form of individual instruction was used. The previous year all assignments and tests were made out and tried on a group of one hundred students. The course was divided into units and each student was given a guide sheet of lesson assignments and study helps for each unit. The amount of time required for a class to cover each unit had been checked the previous year and this was also included on the guide sheet.

All assignments, except those in which the whole assignment was the minimum, were made in three steps--the C assignment being the minimum requirement, the B assignment the average, and the A assignment for those students who completed the previous unit in less than the allotted time.

At the end of each unit extra projects involving special applications of the material studied in the unit were also provided for these students. Since no provision could be made for those finishing the course before the end of the term, an attempt was thus made to enrich the course for the brighter, more industrious students.

A test was given when the lessons of the unit had been completed; if this was passed work was begun immediately on the next unit; if not, special drill work was assigned and a second form of the test given. The tests used were those on which the passing score had previously been determined.

All explanations were given to each pupil individually or to a small group as the need arose--all lesson papers were handed in--graded by the instructor and returned--conferences were held concerning errors made on these lessons and special drill work assigned if needed. Some use was made of student teachers in this connection in supervising drill work of pupils having difficulty.

On May 18, 1931, these students were all given a comprehensive test in algebra. The test used was the test prepared for the K.S.C. State Scholarship Contest for 1930 by Miss Ina Holroyd. This test was chosen as the one measuring separate skills in algebra more minutely than any others considered.

Table III.
Conversion of Algebra Test Scores
Experimental Group - A

Pupil	Algebra Test Scores A	A ²	Converted Score A ¹
1	69	4761	149.83
2	52	2704	124.95
3	14	196	69.34
4	82	6724	168.85
5	52	2704	124.95
6	32	1024	95.68
7	39	1521	105.92
8	49	2401	120.56
9	35	1225	100.07
10	13	169	67.87
11	19	361	76.65
12	51	2601	123.49
13	48	2304	119.10
14	39	1521	105.92

$$M_A = \frac{\sum A}{N} = \frac{1846}{50} = 36.92$$

$$\sigma_A = \sqrt{\frac{\sum A^2}{N} - M_A^2}$$

$$\sigma_A = \sqrt{\frac{87590}{50} - (36.92)^2}$$

$$\sigma_A = 19.7158$$

$$A^1 = \frac{\sigma_x}{\sigma_A} A + (M_x - \frac{\sigma_x}{\sigma_A} M_A)$$

(For σ_x and M_x see
Table II)

$$A^1 = \frac{28.8561}{19.7158} A + \left[102.88 - \frac{28.8561}{19.7158} M_A \right]$$

$$A^1 = 1.4635A + 48.84758$$

(check)

$$MA^1 = \frac{\sum A^1}{N} = \frac{5144}{50} = 102.88$$

Table III. Continued
Control Group - B. Section I

28	15	225	70.80
29	34	1156	98.61
30	38	1444	104.46
31	49	2401	120.56
32	76	5776	160.07
33	69	4761	149.83
34	16	256	72.26
35	47	2209	117.63
36	68	4624	148.37
37	38	1444	104.46
38	15	225	70.80
39	46	2116	116.17
40	12	144	66.41
41	69	4761	149.83
42	64	4096	142.51
43	25	625	85.44
44	39	1521	105.92
45	16	256	72.26

Table III. Continued
Control Group - C. Section II

59	30	900	92.75
60	5	25	56.17
61	11	121	64.95
62	48	2304	119.10
63	38	1444	104.46
64	18	324	75.19
65	57	3249	132.27
66	29	841	91.29
67	62	3844	139.58
68	22	484	81.04
69	20	400	78.12
70	10	100	63.48
71	43	1849	111.78
72	40	1600	107.39
73	18	324	75.19
74	15	225	70.80
75	30	900	92.75
76	20	400	78.12
N 50	1846	87590	5144.00

Table IV.

Differences in Achievement

Experimental Group					Control Group			
Interval	Pupil Number	Composite Score	Algebra Score	Difference	Pupil Number	Composite Score	Algebra Score	Difference
170-179.99	4	173.06	168.85	-4.21				
160-169.99								
150-159.99	1	156.84	149.83	-7.01				
	2	151.14	124.95	-26.19				
*140-149.99	12	144.87	123.49	-21.38	33	144	149.83	+5.83
					31	140.31	120.56	-19.75
130-139.99					41	133.99	149.83	+15.84
					42	132.70	142.51	+9.81
*130-129.99					32	129.91	160.07	+30.16
					39	126.84	116.17	-10.67
	13	124.91	119.10	-5.81	36	124.28	148.37	+24.09
					65	122.95	132.27	+9.32
*110-119.99	9	119.29	100.07	-19.22				
	7	117.28	105.92	-11.36	67	117.75	139.58	-21.83

Table IV. Continued

					44	116.82	105.92	-10.90
					59	110.24	92.75	-17.49
*100-109.99	3	109.92	69.34	-40.58				
					72	107.14	107.39	+2.25
					66	104.35	91.29	-13.06
	8	103.20	120.56	+17.36				
					63	101.97	104.46	+2.49
					30	101.09	104.46	+3.37
*90-99.99	6	99.45	95.68	-3.77				
					34	98.92	72.26	-26.66
					62	98.74	119.10	+20.36
	11	97.28	76.65	-20.63				
					43	92.98	85.44	-7.54
					45	92.70	72.26	-20.44
					35	91.92	117.63	+25.71
					28	91.36	70.80	-20.56

Table IV. Continued

*80-89.99					68	88.53	81.04	-7.49
					71	87.09	117.78	+24.69
					60	86.43	56.17	-30.26
					70	86.43	63.48	-22.95
	14	84.80	105.92	+21.12				
	10	84.26	67.87	-16.39				
					75	83.40	92.75	+9.35
	5	82.96	124.95	+41.99				
					64	81.36	75.19	-6.17
70-79.99					61	77.37	64.95	-12.42
					74	75.75	70.80	-4.95
					29	75.45	98.61	+23.16
					69	70.03	78.12	+8.09
					37	69.95	104.46	+34.51
					76	68.54	78.12	9.58

Table IV. Continued

					38	62.15	70.80	48.65
					73	52.23	75.19	22.96
					40	49.21	66.41	17.20
				$\Sigma = -58.60$				$\Sigma = -80.25$

*Comparable intervals--those in which there are pupils in each group.

Experimental *

$$M = \frac{-58.60}{11} = -5.33 \pm .456$$

$$\sigma = 22.446$$

Control *

$$M = \frac{-80.25}{25} = -3.21 \pm .244$$

$$\sigma = 18.052$$

$$\text{Difference} = -3.21 - (-5.33) = 2.12 \pm .517$$

Formulae:

**Statistical Methods for Students in Education, K. J. Holzinger.

$$M = \frac{\sum X}{N} \text{ (Formula 5)}$$

$$S.D. = \sqrt{\frac{\sum X^2}{N}} \text{ (Formula 15)}$$

$$P.E.M = .6745 \frac{\sigma_X}{\sqrt{N}} \text{ (Formula 88)}$$

$$P.E.M_1 - M_2 = \sqrt{(P.E.M_1)^2 + (P.E.M_2)^2} \text{ (Formula 89)}$$

While the reliability of this test had never been statistically determined and so cannot be reported, attention is called to the fact that the correlations between this test and the Terman Group Test of Mental Ability were found to be between $\pm .70$ and $\pm .80$ in each of the classes. Also the highest scores and lowest scores on the test were made by the students who had been ranked as the best and the poorest, respectively, by the teacher's judgment and the other tests given during the year.

The test was given to the entire group of students under the same conditions. The scores made were used as the basis for comparison between the two groups. They were changed by the use of the same conversion formula that was used to derive the composite score so that they would be directly comparable to it. The conversion of these scores is shown in Table III.

PRESENTATION AND INTERPRETATION OF DATA

In Table IV, the composite score was subtracted from the algebra score showing a difference either positive or negative between the predicted success, as given by the composite score, and the actual success, as shown by the algebra score. (It will be remembered that this score had

already been converted into one comparable with the composite score by making the means of the two sets of data the same. See Table III).

A study of this table showed that the range of deviation in individual scores in comparable ranges of ability for the experimental group was from +41.99 to -40.58, while in the control group it was from +30.16 to -30.26. The comparable range was taken from 80 to 150 as there were cases in both groups within this limit. The conclusions reached from consideration of the scores within this range do not apply to either exceptionally bright or exceptionally slow students as there were not comparable cases in the two groups at either extreme of the scale.

The difference in the range of deviation noted above showed that the greatest and likewise the least advancement was made in the group taught by the individual method. If the student was inclined to do better than the measure of his ability as represented by the composite score indicated he would do, the individual method of instruction provided a greater opportunity for him. But if he were of the group that fell below his expected achievement the individual method provided an opportunity for him to do less than he would have had a chance to do if taught by the group method. It cannot be said just what characteristic determined

whether the student did more or less than his expected achievement. It might be the degree of industry or lack of industry he possessed. If this were the characteristic involved the individual method was better for the industrious student but the group method provided less opportunity for the lazy student to display his laziness.

If any use of this finding were to be made some means of determining this characteristic would have to be devised. However, due to the small number of cases involved in this part of the study it may be presented here only as a tendency which might be present in all such data.

Also from Table IV the sum of the deviations for the experimental group, within the comparable range of 80 to ± 50 , was found to be -58.60; this, divided by 11, the number of students gave a mean deviation of -5.33 $\pm .46$ for the experimental group. The mean deviation for the control group, found in the same way, was $\frac{-80.25}{25}$ or -3.21 $\pm .24$. The difference between these two means was 2.12 $\pm .52$.

Since this difference was slightly more than four times the probable error it may be considered a significant difference.

This result showed that the individual method did not secure quite as great quantitative achievement of the pupils as was secured by the group method. It also applied to the comparable group and did not include either the extremely

Table V. Correlation Between
Composite Scores and Algebra Scores

Experimental Group			Control Group		
Pupil	Composite Score	Algebra Score	Pupil	Composite Score	Algebra Score
1	470.52	69	28	274.09	15
2	453.41	52	29	226.35	34
3	329.75	14	30	303.27	38
4	519.17	82	31	420.92	49
5	248.87	52	32	389.74	76
6	298.35	32	33	432.00	69
7	351.84	39	34	296.75	16
8	309.61	49	35	275.76	47
9	357.86	35	36	372.84	68
10	252.77	13	37	209.85	38
11	291.85	19	38	186.44	15
12	434.60	51	39	380.53	46
13	374.72	48	40	147.64	12
14	254.39	39	41	401.98	69
			42	398.09	64
			43	278.95	25
			44	350.46	39
			45	278.09	16
			59	330.72	30

$$r = .7081 \pm .0899$$

Table V. Continued

(Formulae Used)

$$r = \frac{\sum f_{xy} d_x d_y - \frac{(\sum f_x d_x)(\sum f_y d_y)}{N}}{\left[\sum f_x d_x^2 - \frac{(\sum f_x d_x)^2}{N} \right] \left[\sum f_y d_y^2 - \frac{(\sum f_y d_y)^2}{N} \right]}$$

$$P.E.r = \frac{.6745 (1-r^2)}{\sqrt{n}}$$

60	259.30	5
61	232.10	11
62	296.18	48
63	305.90	38
64	244.07	18
65	368.84	57
66	313.05	29
67	353.25	62
68	265.58	22
69	210.10	20
70	259.29	10
71	261.26	43
72	321.42	40
73	156.70	18
74	227.25	15
75	250.19	30
76	205.62	20

$$r = .8020 \pm .04011$$

Table VI. Correlation Between
Algebra Scores and Terman Group Test Scores

Experimental Group			Control Group		
Pupil	Terman Test	Algebra Test	Pupil	Terman Test	Algebra Test
1	179	69	28	93	15
2	179	52	29	70	34
3	108	14	30	111	38
4	191	82	31	152	49
5	86	52	32	137	76
6	96	32	33	166	69
7	105	39	34	91	16
8	114	49	35	94	47
9	117	35	36	124	68
10	110	13	37	95	38
11	116	19	38	79	15
12	146	51	39	122	46

Table VI. Continued

13	141	48	40	41	12
14	120	39	41	152	69
15	33	3	42	131	64
16	108	46	43	95	25
17	73	13	44	128	39
18	115	19	45	88	16
19	30	3	46	113	61
20	114	71	47	115	44
21	144	35	48	83	23
22	102	26	49	110	52
23	104	55	50	88	15
24	106	32	51	122	41
25	78	19	52	109	39
26	52	21	53	71	32
27	148	59	54	139	65

$r = .7296 \pm .06082$

Table VI. Continued

Control Group

55	81	16	71	96	43
56	188	78	72	109	40
57	123	52	73	60	18
58	84	28	74	87	15
59	103	30	75	91	30
60	87	5	76	71	20
61	83	11	77	149	46
62	104	48	78	134	55
63	118	38	79	105	56
64	81	18	80	125	47
65	132	57	81	64	10
66	97	29	82	107	35
67	132	62	83	121	30
68	120	22	84	74	28
69	62	20	85	110	61
70	120	10	86	105	55

$$r = .7750 \pm .03499$$

bright or slow pupils. This result was corroborated by the correlation found between the composite score and the algebra test score which did include pupils of all ranges of ability. This correlation between the composite score and the algebra test score was $\pm .71 \pm .09$ for the experimental group and $\pm .80 \pm .04$ for the control group. The correlation between the algebra test and the Terman Group Test of Mental Ability for the experimental group was $\pm .73 \pm .06$ and for the control group was $\pm .78 \pm .04$. The scores used in finding these correlations are given in Tables V and VI. The product moment method, developed originally by Karl Pearson, was used for computing the correlations.*

The lower correlation for the experimental group meant that this group, taught by the individual method, deviated more from the standard set by the composite and Terman scores, than the control group deviated from this standard. Since these deviations were primarily negative as will be noticed in Table IV, it also may be interpreted to mean that the achievement of this group was slightly less than that of the other group. The size of the probable errors found for these correlations indicated that this difference also was only a tendency which might be present in all

*Statistical Methods in Education, K. J. Holzinger.
P.143-154.

Table VII. Comparison of
Eleven Matched Pairs of Students

Experimental Group				Control Group			
Pupil	Sex	Composite Score	Converted Algebra Score	Pupil	Sex	Composite Score	Converted Algebra Score
12	Boy	144.87	123.49	33	Girl	144	149.83
13	Boy	124.91	119.10	36	Girl	124.23	148.37
9	Girl	119.29	100.07	65	Boy	122.95	132.27
7	Girl	117.28	105.92	67	Boy	117.75	139.58
3	Girl	109.92	69.34	59	Girl	110.24	92.75
8	Girl	103.20	120.56	66	Boy	104.35	91.29
6	Girl	99.45	95.68	34	Boy	98.92	72.26
11	Boy	97.28	76.65	62	Boy	98.74	119.10
14	Girl	84.80	105.92	60	Boy	86.43	56.17
10	Boy	84.26	67.87	75	Girl	83.40	92.75
5	Girl	82.96	124.95	64	Girl	81.36	75.19
Totals		1168.22	1109.55	Totals		1172.37	1169.56

$$\sigma_1 = 20.3601$$

$$\sigma_2 = 31.4267$$

$$M_{\text{Comp.}} = \frac{1168.22}{11} = 106.20$$

$$M_{\text{Comp.}} = \frac{1172.37}{11} = 106.58$$

$$M_{\text{Alg. Ex.}} = \frac{1109.55}{11} = 100.87 \pm 4.14$$

$$M_{\text{Alg. Con.}} = \frac{1169.56}{11} = 106.32 \pm 6.39$$

such data.

Correlation Between Algebra Scores
for the Experimental and Control Groups

$$r = .6314 \pm .158$$

$$\text{Difference} = 106.32 - 100.87 = 5.45 \pm 4.95$$

$$*P.E. \text{Diff.} = \sqrt{(P.E.M_1)^2 + (P.E.M_2)^2 - 2R(P.E.M_1)(P.E.M_2)}$$

$$P.E. \text{Diff.} = \pm 4.95$$

In Table VII, eleven members of the experimental group were matched with eleven students from the control group whose composite scores were very nearly the same. This number was chosen from the experimental group because they were the only ones whose scores could be matched in the other group. The mean composite score for the two groups varied only .38. The control group exceeded the experimental group to that extent. The mean algebra score for the experimental group was 100.87 ± 4.14 , for the control group it was 106.32 ± 6.39 , a difference of 5.45 ± 4.95 . This showed also that the achievement of the control group on the algebra test was

*Concerning the Standard Error of a Difference,
Helen M. Walker. Journal of Educational Psychology 20:53-60
Ja. '29.

Table VIII. Biserial Correlation
Between Algebra Grades and Methods of Instruction

Algebra Grades	Methods of Instruction		f _y Total	d	fd	fd ²	Class Value	Class Value
	f ₁ Individual	f ₂ Group					Times f ₁	Times f ₂
80 - 84	1	0	1	8	8	64	82.5	0.0
75 - 79	0	2	2	7	14	98	0.0	155.0
70 - 74	1	0	1	6	6	36	72.5	0.0
65 - 69	1	4	5	5	25	125	67.5	270.0
60 - 64	0	4	4	4	16	64	0.0	250.0
55 - 57	1	4	5	3	15	45	57.5	230.0
50 - 54	3	2	5	2	10	20	157.5	105.0
45 - 49	4	6	10	1	10	10	190.0	285.0
40 - 44	0	4	4	0	0	0	0.0	170.0
35 - 39	4	6	10	-1	-10	10	150.0	225.0
30 - 34	2	5	7	-2	-14	28	65.0	162.5
25 - 29	1	4	5	-3	-15	45	27.5	110.0

Table VIII. Continued

20 - 24	1	4	5	-4	-20	80	22.5	90.0
15 - 19	3	9	12	-5	-60	300	52.5	157.5
10 - 14	3	4	7	-6	-42	252	37.5	50.0
5 - 9	0	1	1	-7	-7	49	0.0	7.5
0 - 4	2	0	2	-8	-16	128	5.0	0.0
Total	27 N_1	59 n_2	86 N		-80	1354	987.5	2267.5

Computation

$$\bar{Y}_1 = \frac{\sum(\text{class value} \times f)}{N} = \frac{987.5}{27} = 36.5740$$

$$\bar{Y}_2 = \frac{2267.5}{59} = 38.4322$$

$$\frac{n_1}{N} = q = \frac{27}{86} = .3140$$

$$\frac{n_2}{N} = p = \frac{59}{86} = .6860$$

$$p-.5 = .6860-.5 = .1860$$

(K. J. Holzinger. Table XII)

$$z = .3548$$

with Sheppard's correction

$$\sigma_y^2 = \left[\left(\sqrt{\frac{fd^2}{N} - \left(\frac{fd}{N} \right)^2} \right)^2 - \frac{h^2}{12} \right]$$

$$\sigma_y^2 = \left[\left(\sqrt{\frac{1354}{86} - \left(\frac{80}{86} \right)^2} \right)^2 - \frac{25}{12} \right]$$

$$\sigma_y^2 = \left[\left(\sqrt{15.74418604 - .86533261} \right)^2 - \frac{25}{12} \right]$$

$$\sigma_y^2 = 369.88800242$$

$$\sigma_y = 19.2325$$

Computation Continued

$$r_{\text{bis.}} = \frac{\bar{Y}_2 - \bar{Y}_1}{\sigma_Y} \left(\frac{Pq}{z} \right)$$

$$r = \frac{(38.4322 - 36.5740)}{(19.2325)} \left(\frac{.6860 \times .3140}{.3548} \right) = \frac{(1.8582)}{(19.2325)} \left(\frac{.215404}{.3548} \right)$$

$$= \frac{.4002637128}{6.82369100} = .05865 + .095043795$$

$$P.E.(bis.r) = \frac{.6745 \left(\sqrt{\frac{Pq}{z^2}} - r^2 \right)}{n}$$

$$P.E.(bis.r) = \frac{.6745 \sqrt{\frac{(.6860)(.3140)}{(.3548)^2} - (.05865)^2}}{86}$$

$$P.E.(bis.r) = \pm .095043795$$

slightly greater than that of the experimental group. However, this difference could not be considered significant as it was not four times the probable error.*¹

By finding the "biserial r", a method of calculating a correlation between a series of variates and a dichotomous series it was possible to check the tendency for higher algebra grades to be found in the control group. In this correlation the scores of the entire group of eighty-six students were used. Using the formula

$$r_{\text{bis.}} = \frac{\bar{Y}_2 - \bar{Y}_1}{\sigma_Y} \left(\frac{PQ}{Z} \right)$$

the*² correlation was found to be $\pm .06$. The formula for the probable error

$$(P.E. (bis.r)) = \frac{.6745 \sqrt{\left(\frac{pq-r^2}{Z} \right)}}{\sqrt{n}} \quad *^3$$

showed it to be $\pm .09$. (See Table VIII). The correlation $\pm .06$ was the degree of the tendency for the higher grades to be found in the control group. Since the probable error was found to be larger than the correlation it may be interpreted to mean that this tendency was not significant. If this

*¹Statistical Methods for Students in Education, K. J. Holzinger. P.237.

*²Statistical Methods for Students in Education, K. J. Holzinger. Pp.271-273.

*³Statistical Method, T. L. Kelley. Pp.246-249.

correlation had been negative it would have meant that the tendency was for the higher grades to be found in the experimental group. Thus, the result obtained may be interpreted to mean that there was no significant tendency for higher grades to be associated with either of the two groups. This meant that neither of the methods proved to be more efficient than the other in procuring the greater achievement of the pupils.

This method was probably the best of the methods used in comparing the two groups. It confirmed the variation found by the others and also showed that while this variation did exist in this data it was not a significant difference.

After these students had been divided into the two groups for thirty-four weeks, an attempt was made to find out whether or not those taught by the individual method for this length of time were better able to comprehend and study an assignment without explanation or direction from an instructor. For this purpose two exercises were used--one taken from "Junior English" by Rose Buhlig,*¹ and one from the Appendix of the Schorling--Clark Modern Algebra.*² Copies

*¹Junior English, Rose Buhlig. Pp.250-252.

*²Modern Algebra, Schorling--Clark. P.351.

Table IX. Results of
English and Multiplication Exercises

Experimental Group				Control Group			
Pupil	Terman Score	Spelling Exercise	Multipli- cation Exercise	Pupil	Terman Score	Spelling Exercise	Multipli- cation Exercise
1	179	62	7	30	111	29	7
2	179	23	29	31	152	68	19
3	108	38	11	32	137	33	21
4	191	46	21	33	166	27	22
5	86	54	1	34	91	22	0
6	96	26	1	35	94	29	7
7	105	25	0	36	124	27	18
8	114	27	8	37	95	49	0
9	117	33	23	39	122	44	15
10	110	8	0	40	41	17	1
11	116	15	0	41	152	47	15
12	146	46	8	42	131	42	28
13	141	0	5	44	128	33	19

Table IX. Continued

14	120	36	9	46	113	45	3
15	33	20	0	47	115	17	5
16	108	52	20	48	83	25	2
17	73	25	0	49	110	50	6
18	115	57	0	51	122	38	6
19	30	7	2	54	139	44	8
20	114	51	11	56	188	27	24
21	144	36	9	57	123	10	3
22	102		0	59	103	50	7
23	104	60	13	60	87	7	0
24	106	10	7	62	104	32	22
25	78	6	5	63	118	52	17
26	52	27	5	64	81	37	1
27	148	30	20	65	132	48	14
	N=27	N=26	N=27	66	97	26	0
	$\Sigma=3015$	$\Sigma=820$	$\Sigma=215$				

$$M_T = \frac{3015}{27} = 111.666$$

$$M_E = \frac{820}{26} = 31.538$$

$$M_M = \frac{215}{27} = 7.9629$$

Table IX. Continued

67	132	23	13
68	120	13	7
70	120	20	7
71	96	27	0
72	109		3
73	60	51	3
74	87	25	7
76	71	13	1
77	149	20	4
78	134	5	1
79	105	34	1
80	125	20	12
82	107	41	8
83	121	27	9
84	74	70	7
85	110	37	21
N=44	N=44	N=43	N=44
	$\Sigma=4879$	$\Sigma=1401$	$\Sigma=394$

$$M_T = \frac{4879}{44} = 110.88 \quad M_E = \frac{1401}{43} = 32.581 \quad M_M = \frac{394}{44} = 8.954$$

of these exercises will be found in the Appendix. They had never in any way been called to the attention of the students before. The exercise in English was a spelling rule for forming participles. The students were given a limited time in which to study the rule and write the participles of certain words. In mathematics the procedure was practically the same--in this case the exercise used was a short-cut in multiplication--a limited time was allowed in which the students studied the rule and found certain products by using this rule. The score used for each of these was the number of points actually made. In the multiplication exercise each step in finding the product was counted as one point. The results obtained from these tests are given in Table IX. In the spelling rule exercise the mean for the experimental group was found to be 31.538, for the control group it was 32.581. In the multiplication rule exercise the mean for the experimental group was found to be 7.9629, for the control it was 8.954. The basis for making a direct comparison between these results is that the means for the Terman Group Test of Mental Ability are very nearly the same for the two groups. (Table IX). These results may thus be interpreted to mean that a school year's training in a class taught by individual instruction does not increase the student's ability to work out an assignment without help.

Table X. Time Spent

Outside of Classroom as Reported by Students

Experimental Group--Time in Minutes

Pupil	5th Week	9th Week	14th Week
1	65	30	195
2	20	30	30
3	120	60	40
4	50	0	20
5	60	60	60
6	120	30	30
7	270	90	60
8	120	60	30
9	90	0	30
10	0	60	0
11	25	105	40
12	90	120	30

Control Group--Time in Minutes

Pupil	5th Week	9th Week	14th Week
30	60	60	45
31	120	45	90
32	120	90	90
33	120	100	60
34	90	60	20
35	210	180	90
36	90	55	60
37	30	45	50
39	60	45	60
40	0	0	0
41	90	50	20
42	90	60	45

Table X. Continued

13	120	120	90	44	30	60	30
14	30	45	30	46	180	120	60
15	90	0	0	47	60	80	40
16	30	0	30	48	120	100	45
17	90	90	90	49	135	105	90
18	120	235	100	51	45	20	45
19	60	60	60	54	90	60	60
20	210	30	60	56	30	40	20
21	0	15	30	57	0	20	0
22	0	0	0	59	40	0	20
23	120	120	120	60	45	15	0
24	20	30	20	62	120	180	90
25	40	60	30	63	20	0	40
26	60	120	60	64	100	60	90

Table X. Continued

27	60	60	60
Totals	2080	1630	1345

$\frac{2080}{27} = 77$ min. Average for 5th week

$\frac{1630}{27} = 60.37$ min. Average for 9th week

$\frac{1345}{27} = 49.81$ min. Average for 14th week

3 $\overline{187.18}$
62.39 Average time per week

65	180	105	75
66	200	90	0
67	180	90	120
68	0	15	0
70	0	0	0
71	45	60	60
72	90	60	60
73	20	0	0
74	30	45	20
76	45	30	30
77	60	30	45
78	60	45	60
79	120	60	90
80	20	40	0
82	105	45	60

Table X. Continued

83	30	80	30
84	60	45	90
85	120	60	60
Totals	3460	2550	2060

$$\frac{3460}{44} = 78.63 \text{ min. Average for 5th week}$$

$$\frac{2550}{44} = 57.95 \text{ min. Average for 9th week}$$

$$\frac{2060}{44} = 46.81 \text{ min. Average for 14th week}$$

$$\begin{array}{r} 3 \overline{)183.39} \\ 61.13 \end{array} \text{ Average time per week}$$

The amount of time spent by the students of the two groups in study on the subject outside of the class room could not be found accurately as the only data available was that taken from their own statements. However, these were given with the understanding that they in no way affected their grade so may be considered fairly reliable. A check was made of this time at three different times during the experiment and each time the average amount of time spent by each of the two groups was practically the same. (Table X).

The instructor kept a careful record of the amount of her time spent in teaching each of the two types of classes and found that individual instruction required approximately one hour a day more time than the group method. This was exclusive of the time already spent in organizing the course, and preparing the guide sheets and tests to be mimeographed, as it was spent in grading the lesson and test papers and in conferences with the pupils.

ADVANTAGES AND DISADVANTAGES OF INDIVIDUAL INSTRUCTION OBSERVED DURING THE EXPERIMENT

The following material is not presented in this study as experimental data but is included only as observations of

the instructor of some facts concerning the relative efficiency of the individual and group methods of instruction.

The problem of discipline is always one worthy of consideration particularly when dealing with pupils of the junior high school age. The class taught by the individual method of instruction was noticeably lacking in disciplinary problems and it was possible to handle the few which did arise with less difficulty and greater satisfaction to every one concerned than in the other classes. The difference in the way in which the class time was spent as well as the difference in the attitude of the two groups toward the subject seemed to be the explanation.

The students in the class taught by the individual method seemed to be happier in their work and more willing to do the drill required than those in the other classes. Only one of the thirty-five who were in the class all or part of the year expressed a desire to be in one of the other classes. He was allowed to change at the end of the first semester. The others were all very emphatic in their expressions of approval of the method.

Due to the present organization of the school, it was impossible to give partial credit to those pupils completing only part of the work, or to make arrangements for them to start next year at the place where they left off as would be

the ideal arrangement. It was for this reason that the course was organized with the maximum and minimum requirements. All but four of the class were able to complete at least the minimum requirements and thus received a passing grade--the amount more than the minimum completed was used to determine whether the final grade should be A, B, C, or D. These four people, who were not able to complete the minimum requirements, were three colored girls who were shown both by teacher's ratings and the Terman Group Test to be decidedly below the average in ability, and one boy who through lack of ability and application had had difficulty with all his junior high school work and especially mathematics. However, these people did complete and pass the tests for every unit in the first half of the work and thus it was possible to give them credit for one semester's work in algebra, whereas they would have failed, undoubtedly, in the entire year's work had they been in a class where they had to keep pace with the group.

There were five people who were able not only to complete the maximum lesson assignments but also to work on the extra projects suggested at the end of each unit. Altogether thirty-five of these projects were completed which, it is to be hoped, gave these pupils a better insight into the value of the study of algebra and the use to which it

may be put. Also during the spring term a number of the members of this group were in school plays, operettas, and music contests. It was possible to arrange for those people who were well along in their work to spend part of their algebra period in work on other subjects when it was needed and thus none of their work suffered from the extra outside activities.

The class taught by this method was necessarily more informal than the other and the pupils could be allowed more freedom. Those who were having difficulty in the same work grouped together at times and were assisted by the instructor or if there were several needing help, by those who had successfully completed that part of the work and were willing to give the time. A spirit of cooperation and helpfulness pervaded the entire class. A few of the poorest students were assigned to other members of the class to whom they could go for help and encouragement and for explanations of instructions which were sometimes confusing to them. In this way a great deal of time was saved for the instructor and while great care had to be exercised in such pairing, the results on the whole proved to be entirely satisfactory. This arrangement seemed to help both the slower student and the brighter one as each was an incentive to the other to work.

Pupils who had to be absent because of illness or for some other reason were often able, due to the organization of the course, to keep up with their work while forced to remain at home, or found it much easier to get caught up when they returned to school.

One of the noticeable disadvantages of the individual method was the confusion resulting when it was necessary for a student to change to a class taught by a different method in the same school or in a different school. The pupils were not, and might not be in many cases, working at the same place as the group when it was necessary for the change to be made and consequently either had to wait for the group to catch up or had to miss part of the work which in such a subject as algebra, built up as it is step by step, was a difficult thing to do.

Such a method of instruction requires very careful organization, and the course as it was used could probably be improved upon in many ways through practice in its use particularly in providing means for saving the time of the teacher. If lessons and tests were worked out that would in themselves point out the pupil's weaknesses and show him the drill work needed to help him correct his errors, a great deal of the instructor's time spent in grading papers and pointing out errors could be saved.

Unless there are courses published suitable for this type of instruction, a great deal of mimeographing is required. Since only one class was involved in this experiment, it was possible to arrange for this to be done by the regular school staff but if a number of classes were included some other provision would have to be made. The materials needed as well as the additional time required for this work would be an expense which would have to be considered.

CONCLUSIONS

1. There is no significant difference between the knowledge of algebra gained by an average size ninth grade algebra class taught by the individual method and one taught by the group method.

2. The group method of instruction keeps the students closer to the standard set by natural ability, previous training, and achievement in arithmetic. For those who, through some natural characteristic are inclined to do better than this standard, the individual method provides a greater opportunity. For those who are inclined to do less than this standard, it also offers a greater opportunity in this direction, so consequently would not be as satisfactory as the group method.

3. A year's experience in a class taught by the individual method does not aid the students in their ability to comprehend and study an assignment without an instructor's explanation or direction.

4. There is no difference in the amount of time spent by the respective groups of students taught by the two methods.

The individual method requires more of the teacher's time, however, through experience with the method it might be possible to lessen if not altogether eliminate the extra time required.

5. While the particular problems studied do not indicate that either of the two methods is superior, there were other advantages of the individual methods observed which outweighed the disadvantages which were primarily administrative; therefore, the tentative conclusion of the author is that the individual method, if not better, is at least as good as the group method of teaching ninth grade algebra and by the improvement which should come from use might be made the superior.

6. The results of this study show that further experimentation with the method would not be working a hardship on the students involved as there was no real loss in quantitative achievement when it was used for the first time.

REFERENCES

- Abelson, H. H.
 "Achievement of Dull Pupils Under the Dalton Plan".
 School and Society, Vol. 30:211-12. Aug. 10, 1929.
- Cook, A. R.
 "Contract Plan, its Working".
 Educational Review, Vol. 73:109-11. Feb. 1927.
- Holzinger, K. J.
 1928. Statistical Methods for Students in Education.
 Ginn and Company, Chicago, Illinois.
- Kelley, T. L.
 1924. Statistical Method.
 The Macmillan Company, New York.
- Parkhurst, Helen
 "Combines Classwork, Group Work, and Individual Work".
 School Life, Vol. 10:168-9. May 1925.
- Twenty-Fourth Yearbook of the National Society for the
 Study of Education.
 "Adopting the School to Individual Differences".
 Part II.
- Walker, Helen M.
 "Concerning the Standard Error of a Difference".
 Journal of Educational Psychology, Vol. 20:53-60.
 Jan. 1929.
- Washburne, Carleton Wolsey
 "Individual System in Winnetka".
 Elementary School Journal, Vol. 21:52-68. Sept. 1930.
- Washburne, Carleton Wolsey
 "Merits of Individual Plan of Instruction".
 School Life, Vol. 9:179. April 1924.
- Washburne, Carleton Wolsey
 "Winnetka".
 School and Society, Vol. 29:37-50. Jan. 12, 1929.

Washburne, Carleton Wolsey

"The Attainments of Gifted Children Under Individual Instruction".

N.E.A. Yearbook 1924. Pp.247-261.

Wilson, L. L. W.

"Dalton Plan: Why and How".

National Educational Association Journal, Vol. 14:
181-3. Jan. 1925.

APPENDIX

In this section are found

1. A copy of the final test in algebra used in this study.
2. Samples of guide sheets and tests used in the class taught by the individual method of instruction.
3. A copy of the exercise in the use of a spelling rule.
4. A copy of the exercise in the use of a short-cut in multiplication.

ALGEBRA

Part I - Translating Words into Symbols

In each blank write the algebraic expression which should be supplied where the corresponding number is found in the incomplete statements below.

- Twice the number represented by N is expressed algebraically as (1)____; and 4 less than twice the number as (2)____ 1. _____
2. _____
- The sum of any two numbers, a and b is expressed as (3)____; twice their sum as (4)____. 3. _____
4. _____
- The quotient of a divided by b is generally expressed as (5)____; and that obtained by dividing the sum of x and 2 by y as (6)____. 5. _____
6. _____
- At 5¢ each 4 articles cost 20¢; at K cents each N articles cost (7)____. 7. _____
- The formula for the cost, C , of N pencils at M cents each is (8)____. 8. _____
- At 4 for 25¢ the cost of N articles is (9) cents____; at X for Q cents it is (10) cents____. 9. _____
10. _____
- At a speed of 25 miles per hour the distance traveled in 3 hours is (11) miles; at M miles per hour for H hours it is (12) miles____. The formula for the distance, D , traveled in T hours at a speed of R miles per hour is (13)____. 11. _____
12. _____
13. _____
- The number 18 is divided into two parts. If N is the larger part, the smaller is expressed as (14)____. 14. _____
- The algebraic equation for the expression twice a number, N , is 8 is (15)____. 15. _____
- Half a number, X , is 7; the algebraic equation for this is (16)____. 16. _____
- If 5 be subtracted from half the number, X , the result is equal to one fourth the number; this expressed algebraically is (17)____. 17. _____
- The rule for calculating postage, P , in cents on a parcel the sixth zone is to add 3 to eight times the weight, W , of the parcel in pounds; a formula for this is (18)____. 18. _____
- A rectangle is L feet long and W feet wide; the formula for its perimeter, P , is (19)____, and for its area, A is (20)____. 19. _____
20. _____
- The speed, S , in feet per minute of a point on the rim of a flywheel is found by taking $1/12$ of the product of π , the diameter of the wheel in inches and the number of revolutions, N , per minute; a formula for this is (21)____. 21. _____

Part II - Translating Symbols into English

In each blank write the word which should be supplied where the corresponding number appears in the incomplete statements below.

- $(ab)^2$ means the (1)____ of the (2)____ of (3)____ and (4)____ 1. _____
2. _____
3. _____
4. _____

$(a + b)^2$ means the (5)___ of the (6)___ of (7)___ and (8)___.

5. _____
6. _____
7. _____
8. _____

$a^2 + b^2$ means the (9) of the (10) of (11) and (12)

9. _____
10. _____
11. _____
12. _____

The expression $\sqrt{a^2 + b^2}$ means the (13)___ root of the (14)___ of the (15)___ of (16)___ and (17)___

13. _____
14. _____
15. _____
16. _____
17. _____

The formula $C = \pi D$ shows that the (18)___ of a (19)___ is (approximately $3 \frac{1}{7}$) times the (20)___.

18. _____
19. _____
20. _____

The equation $2x - 3 = 9$, represents the statement that when 3 is (21)___ from (22)___ the number, (23)___ the result is (24)___.

21. _____
22. _____
23. _____
24. _____

The equation, $N + \frac{1}{2}N = 24$, represents the statement that the result of (25)___ the number (26)___ to (27)___ of (28)___ is equal to (29)___.

25. _____
26. _____
27. _____
28. _____
29. _____

Part III - Problems

In each blank write the result which should be supplied where the corresponding number is found in the algebraic statements below. Use scratch paper for computations.

When $a=2$ and $b=3$; $a + b = (1)$ ___, $ab = (2)$ ___, and $\frac{a}{b} = (3)$ ___.

1. _____
2. _____
3. _____

When $x=8$ and $y=2$; $x-y = (4)$ ___, $y-x = (5)$ ___, and $xy = (6)$ ___.

4. _____
5. _____
6. _____

When $n = -4$; $2n = (7)$ ___, $3n = (8)$ ___, $n^2 = (9)$ ___, $n^3 = (10)$ ___, and $-2n^3 = (11)$ ___.

7. _____
8. _____
9. _____
10. _____
11. _____

When $a=2$ and $b=3$; $a^b = (12)$ ___, $b^a = (13)$ ___, $a^2b^2 = (14)$ ___, $-a^b = (15)$ ___, and $2a^b = (16)$ ___.

12. _____
13. _____
14. _____
15. _____
16. _____

Given the formula $T = \frac{D}{B}$, if B increases while D remains the same, $T = (17)$ ___.

17. _____

If we double the edge of a cube, we multiply the volume ($v = e^3$) by (18)___.

18. _____

If the diameter of a circle is doubled we multiply the circumference ($c = \pi d$, by (19)___). If we double the radius we multiply the area ($A = \pi r^2$) by (20)___.

19. _____
20. _____

In the blank provided write the proper answer to each of the following problems.

21. Collect similar terms:

$$4n^2 + 6ab - b^2 + 7a^2 + 6ab - 3b^2 =$$

22. $-8a^2 + 5ab - 7b^2$ subtracted from

$$7a^2 + 3ab - 6b^2 =$$

23. $(2b^2 - b + 3)(3b - 4) =$

24. $(t + 6w)(5 - 7w) =$

25. Expand: $(3A + 2b)^2 =$

26. Factor: $x^2 - 4x - 12 =$

27. Factor: $a^2 + 4a - 21 =$

28. Solve for y by factoring and check your results:

$$y^2 - 10y - 24 = 0$$

y =

29. If $v = 1$ w h, solve for w.

w =

30. If $s = \frac{a}{1-4}$ find s when $a = 6$ and

$$r = \frac{1}{2}$$

s =

31. From $\frac{1}{p} + \frac{1}{q} = \frac{2}{R}$ find q if $p = 60$ and $R = 30$.

q =

32. Solve for X: $\frac{2x + 5}{5} - \frac{x - 3}{3} = 2$

x =

33. Simplify: $\frac{4x}{x^2 - y^2} - \frac{2}{x + y}$

34. Solve for y: $\frac{2}{y + 1} = 1 - \frac{1}{y - 1}$

y =

35. Solve for x and y. $3x + 2y = 13$
& $5x - 3y = 9$

x =

36.

y =

37. Find the value of the following:

$$23 - 4 \times 3 - 4 + 2 + 16 =$$

In the blank after each of the following equations write a T if it is true and an F if it is false:

38. $\frac{-4a^2}{12} = \frac{a^2}{3}$

39. $\frac{a^2 + 1}{a^2} = 1$

40. $\frac{a^2 - 2ac + c^2}{a - c} = a - c$

Test V.

Time--5 minutes

Using positive and negative numbers complete each of the following statements:

1. If the temperature in Chicago was -5° at 8 o'clock, it would have to rise $\underline{\hspace{1cm}}$ to be $+5^{\circ}$.

2. In a game John has a score of 100 points. If he loses 125 points his score may be represented by $\underline{\hspace{1cm}}$.

3. Using a signed number, a gain of \$15.00 may be represented by $\underline{\hspace{1cm}}$.

4. Using a signed number, a loss of \$20.00 may be represented by $\underline{\hspace{1cm}}$.

5. William can row his canoe 5 miles an hour in still water. If he rows up a stream having a current of two miles per hour, he can row $\underline{\hspace{1cm}}$ miles per hour up stream.

6. Henry has a total of \$15.00 and owes \$21.00. Using a signed number, his financial standing may be represented by $\underline{\hspace{1cm}}$.

7. If the temperature is -17° at 6 a.m. and rises 23° by 12 o'clock, the temperature at noon is $\underline{\hspace{1cm}}$.

8. If we think of 10 miles east as -10, we can express 12 miles west as $\underline{\hspace{1cm}}$.

9. If a certain stock sold yesterday for 102 and sold

today for 99, this change would be shown in the market report by__.

10. Using a signed number, the altitude of a city which is 1150 feet above sea level may be expressed as__.

11. Using a signed number, the altitude of a point 259 feet below sea level may be expressed by__.

12. The sum of +10, -30, +16, -8, and +31 is__.

13. The average of +32, -8, +6, +3, -20, and -1 is__.

14. A footballs team's gains and losses in yards during a certain period of a game are indicated below:

+7, -15, +10, +2, +8, -15, +7, +1

Using a signed number, the total gain may be represented by__.

Test X.

Part IV. (No time limit)

The values given below are either true or false. If true, place a plus sign after the number, if false, a minus.

1. $a \cdot a^2 = a^3$

7. $5a(-3a^2) = -15a^3$

2. $3a \cdot 4 = 12a^2$

8. $-x(-3x) = 3x^2$

3. $3x \cdot 5y = 15xy$

9. $3a(4a) = 12a$

4. $4a \cdot 3a = 12a^3$

10. $a^a \cdot a \cdot a^3 = a^6$

5. $x^2 \cdot x^3 = x^5$

11. $3x \cdot 2x \cdot 3x = -6a^3$

6. $-3x(5x^2) = 15x^3$

12. $2a(-3a^2) = -6a^3$

- | | |
|---|--|
| 13. $-x \cdot -x \cdot -x = -x^3$ | 27. $\frac{-x^4}{x^2} = -x$ |
| 14. $-4 \cdot x \cdot -3 = 12x$ | 28. $\frac{-20x}{4x} = -5$ |
| 15. $a \cdot -a \cdot 2a = -2a^3$ | 29. $\frac{20a^2b^2}{5ab} = 4ab$ |
| 16. $5x \cdot 3x \cdot -x = 15x^3$ | 30. $\frac{6x^4y^2}{3xy} = 2x^3y$ |
| 17. $a^3 \cdot a^2 \cdot a^4 = a^9$ | 31. $\frac{-7x^2y^2}{7xy} = -xy$ |
| 18. $-2a \cdot 3a \cdot a^2 = 6a^4$ | 32. $\frac{-8x^3y^2}{-2xy} = 4x^2y$ |
| 19. $2a \cdot \frac{1}{2} a^2 = a^3$ | 33. $\frac{18a^2b^3}{-3ab} = -6ab^2$ |
| 20. $(2x)(-3)(3x) = -18x^2$ | 34. $\frac{-36a^4b^5}{4a^3b^4} = -9ab$ |
| 21. $3(a-b) = 3a - 3b$ | 35. $\frac{20x^3y^5}{4xy^4} = 5x^2y$ |
| 22. $a(a-b) = a^2 - ab$ | 36. $\frac{3x + 9}{x + 3} = 3$ |
| 23. $b(1-a) = b - ab$ | |
| 24. $2a(-3a)(-a^2) = 6a^4$ | |
| 25. $a^2 \cdot a^3 \cdot b^2 \cdot 5 = 5a^5b^2$ | |
| 26. $\frac{a^3}{a} = a^2$ | |

Guide Sheet 3

Unit 3--Simple Equations

(2½ weeks)

Lesson 1. Changing formulae into other forms.

Text - Pp.27-29, Ex. 1-7.

Lesson 2. "The Meaning of an Equation".

Text - Pp.29-32. Study page 29, Ex. 1-19,

Pp.30-32.

Lesson 3. "The Keys to an Equation".

Text - Pp.33. Learn 4 laws. Ex. 1-8.

Lesson 4. Fundamental Types of Equations.

Supplementary Sheet 7.

Report for Test 3:

Lesson 5. Supplementary Sheet 8. Meaning of an Equation.

Lesson 6. Supplementary Sheet 9. Writing Word Statements
in Algebraic Form.

Lesson 7. Problems to be solved by equations.

Text - Pp.36-37. C--Ex. 1-6
 B--Ex. 1-8
 A--Ex. 1-11

Lesson 8. Solving formulae.

Text - Pp.38-39. P.38-Ex.1-8. P.29-Ex.1-3.

Report for Test 4:

A. Solution of more difficult equations.

Supplementary Sheet 10.

B. Solution of Formulae - Text - P.40-Ex.1-10.

C. Using What You Have Learned. Text - Pp.42-43-
Ex.1-16.

Guide Sheet 7

Unit 7--Four Fundamental Operations

(2 weeks)

Lesson 1. Rule for addition of like terms.

Text - P.100, Ex. 1-21.

Lesson 2. Addition of polynomials.

Text - Pp.101-102. Study Pp.101-102.

C--Ex. 1-8, No checks.

B--Ex. 1-12, Check 1-5.

A--Ex. 1-12, Check 1-5,
1, 10, 12.

Lesson 3. Practice in addition.

Text - P.103.

C--Ex. 1 (Keep record of
time).

B--Ex. 1-6.

A--Ex. 1-14.

Report for Test 14:

Lesson 4. Subtraction of signed numbers.

Text - Pp.104-105, Ex. 1-21.

Report for Test 15:

Lesson 5. Multiplication. (Monomial times polynomial)

Text - Pp.106-107.

C--Ex. 1-15.

B--Ex. 1-25.

A--Ex. 1-35.

Report for Test 16:

Lesson 6. Multiplication. (Polynomials)

Text - Pp.108-109. Study Pp.108-109.

C--Ex. 1-18.
 B--Ex. 1-11 Check.
 2
 A--Ex. 1-12 Check.
 2

Report for Test 17:

Lesson 7. Division of polynomial by a monomial.

Text - P.110.

C--Ex. 1-6.
 B--Ex. 1-7.
 A--Ex. 1-7.

Report for Test 18:

Lesson 8. Division of polynomials.

Text - P.111, Ex. 1-3. Text - P.112.

C--Ex. 1-15.
 B--Ex. 1-19.
 A--Ex. 1-19 and Ex.1-2
 P.113.

Report for Test 19:

A. Business Problems Solved by Equations.

Text - P.116, Ex. 1-5.

B. Using What Has Been Learned.

Text - P.117, Ex. 1-9.

C. Cumulative Review.

Text - P.118, Ex. 1-4.

A Spelling Rule

(Time--12 minutes)

Instructions:

Study carefully Exercises 263-264 concerning the formation of participles found in Junior English by Rose Buhlig on page 250 and 251. Notice Rule 5 especially. Write out exercises A and B, page 251.

Copy of material found in Junior English by Rose Buhlig. Pp.250-251.

Exercise 263--Formation of Participles.

Hop, hopping, hopped Heap, heaping, heaped

Hop is a monosyllable ending in a single consonant preceded by a single vowel. The final consonant in such words is doubled before a suffix beginning with a vowel is added.

In heap the final consonant is not doubled because it is preceded by two vowels.

Make the participles of the following verbs:

chat	rap	suit	step
cheat	reap	sit	steep
rot	train	tap	trot
root	trim	trip	treat

Trap, trapping, trapped Track, tracking, tracked

Why is the final consonant doubled in trap before

--ing is added?

The final consonant in track is not doubled because the word ends in two consonants.

Pin, pinning

Pine, pining

Pine drops the silent e because the tendency in English is to drop endings that are not needed for pronunciation before adding a suffix beginning with a vowel.

Form the participles of the following verbs:

knot	rob	flop
note	robe	elope
deal	swim	quit (u is not here a vowel)
clap	strike	crawl (w is here a vowel)
stop	oil	wax (x equals cks)
peal	rush	bow (w is here a vowel)

Exercise 264--Doubled Consonants.

Exercise 263 applies also to words of more than one syllable accented on the last syllable, if the accent is retained on the same syllable after the suffix is added. Therefore,

Rule 5.-- Monosyllables or words accented on the last syllable, ending in a single consonant preceded by a single vowel, double the final consonant before adding a suffix beginning with a vowel.

A. Form participles from the following verbs accented on the last syllable:

prefer	intervene	escape	expel
refer	reveal	acquire	contain
occur	repeal	secure	forbid
permit	pursue	conceal	incur

interfere	erase	arrange	forget
retain	control	acquit	repel

B. Form participles from the following verbs not accented on the last syllable:

benefit	travel	marvel	shelter
revel	answer	exhibit	render
quarrel	profit	shovel	limit

A Short Cut in Multiplication

(Time --20 minutes)

Instructions:

Study carefully the short cut in multiplication explained in the text on page 351 and 352.

After you are sure you understand the method, use it to solve the problems found in exercise 2 at the bottom of page 352. Omit exercise 1.

Copy of material found in Modern Algebra by Schorling--Clark. P.351-352.

"A short cut in multiplication. If it is possible for you to form the habit, you can save time in multiplying by not recording the parts that prove meaningless in the answer. Let us compare the ordinary method of multiplication with the short method.

$$\begin{array}{r}
 3482 \\
 4596 \\
 \hline
 20892 \\
 31338 \\
 17410 \\
 13928 \\
 \hline
 16003272
 \end{array}$$

At the left is shown the ordinary method of multiplying 3482 by 4596 and at the right is shown the short method. The steps taken

$$\begin{array}{r}
 3482 \\
 4596 \\
 \hline
 18000 \\
 31500 \\
 17400 \\
 13928 \\
 \hline
 16001000
 \end{array}$$

in the short method are as follows:

Step 1. Instead of multiplying 3482 by 6, multiply the nearest whole number of thousands (3000) by 6. The product is 18000.

Step 2. Multiply the nearest whole number of hundreds (3500) by 9. The product is 31500.

Step 3. Multiply the nearest whole number of tens (3480) by 5. The product is 17400.

Step 4. Multiply 3482 by 4. The product is 13928.

Step 5. Find the sum of the partial products as usual.

When multiplying by the short method, the position of the decimal point is determined in the same manner as in ordinary multiplication. Thus, if we had been multiplying 34.82 by 45.96, we would have to point off four decimal places, so that our answer would be 1600.1000.

Note that by the short method we have saved six multiplications--we have saved multiplying 482 by 6, 82 by 9, and 2 by 5.

Note that our answer by the short method is correct to four places, and for most purposes four significant figures

are ample.

Of course it is not necessary to write down the six zeros shown in the short method if these will not appear in the answer. In such a case we may, if we wish, abbreviate the multiplication as shown at the right. The position of the decimal point is found by counting to the left from a position directly below the right hand figure in the multiplier, in other words, in the same manner as if the three zeros had been written in the answer before pointing off the decimal places.

$$\begin{array}{r}
 34.82 \\
 45.96 \\
 \hline
 18 \\
 315 \\
 1740 \\
 13928 \\
 \hline
 1600.1
 \end{array}$$

Note that when this method is used each partial product is so placed that the right-hand figure is directly below the left-hand figure in the multiplicand.

This short method can be used for multiplying any two numbers of any number of figures with any number of decimal places in each. Always begin by multiplying the left-hand figure in the multiplicand by the right-hand figure in the multiplier and write the partial product so that the right-hand figure will be directly below the left-hand figure of the multiplicand. In each succeeding multiplication include one more figure of the multiplicand.

Exercises

1. Assume that the dimensions of a garden are carefully

measured and recorded as 48.56 feet by 34.27 feet. Show that the difference between the smallest and the largest possible area of the garden is actually over four fifths of a square foot. Find the area of the garden by using abbreviated multiplication.

2. Use abbreviated multiplication to find the product of (a) 47.58×36.24 ; (b) 8.643 and 7.649; (c) 2.348 and 46.84; (d) .824 and 468.5; (e) 452.3 and 5.261; (f) 34.93 and 2.123; (g) 5.625 and 23.45; (h) 5.623 and .341; (i) 89.62 and 4.52.

ACKNOWLEDGMENT

I wish to express my sincere appreciation of the kind and helpful supervision which I have received from Dr. V. L. Strickland throughout the two years spent in this study.

I also am greatly indebted to Dr. W. H. Andrews for the training in the use of statistics I have received in his courses and particularly for the suggestions he has given in regard to the statistical treatment of this data.

I wish to express my appreciation also to Mr. Rees Hughes, Superintendent of Schools, Parsons, Kansas, and to Mr. L. M. Eddy, Principal of West Junior High School, Parsons, Kansas, who made it possible for me to conduct this experiment in that school.