EVALUATION OF THE FORMAL VERSUS THE INFORMAL METHOD
OF TEACHING ARITHMETIC

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EVALUATION OF THE FORMAL VERSUS THE INFORMAL METHOD OF TEACHING ARITHMETIC

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By

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CHAPTER I

INTRODUCTION

With other discoveries which war brought is the realization that even good students have failed to learn arithmetic so that they can use it. Tests applied by the army, navy, and industries show that high school graduates not only fail in applying advanced mathematics but also fail in using common fractions and decimals, in interpreting scales, drawings, in understanding maps, reading graphs, and telling time.

"If you want to help the Navy fight the war, teach the boys mathematics," Lieutenant William Exton, Training Division of the Bureau of Navigation, United States Navy, told the convention of the Oklahoma Education Association at its 1942 session at Oklahoma City.

During the last few years a great percentage of adults found themselves unable to keep up with the swift movement of economic and social progress because they lacked the proper mathematical background. Society and the war have placed their demands for trained men.

Dr. J. O. Hassler in his report on the placement tests given by the University of Oklahoma to freshmen matriculating there shows that something should be done in regard to
mathematics in the grades and the junior and senior high
schools as well as in college. Dr. Hassler says:

We do not expect to make up in our remedial course,
meeting five hours per week for one semester, what stu-
dents fail to get in twelve years, but the students have
come here and wish to stay so we do the best we can.
The course is taught only by experienced teachers, most
of them being high school teachers who are pursuing
graduate study for a higher degree. We find that a
great number of students cannot even now learn the funda-
mental processes of arithmetic, which is the subject
matter of about one-third of the course. These drop out
early in the first year. If their grade school and high
school teachers had been allowed to grade them justly on
achievement, perhaps they would never have graduated from
high school. An examination of their records in other
courses convinces us that they should never have tried
to enter college.¹

Reading and arithmetic instruction are popular pedagogi-
cal topics these days. Much has been written about them.
Less has been done about them. They creep into the discussion
of almost any group of elementary educators whatever the
purpose of the meeting may be. Teachers are devising intri-
cate apparatus and procedures for dealing with anything and
everything directly or indirectly connected with reading and
arithmetic instruction. One can get attention off-hand by
bringing in the reading or the arithmetic question when
assembled with fellow teachers. Everybody is doing something
about arithmetic and reading, or, at least, is trying to create
the impression of doing something. Tests are given, surveys

¹J. C. Hassler, "Why Came These to College?" The
Oklahoma Teacher, XXIII (March, 1942), 3.
are made, and special teachers are set upon the trail of pupils whose reading and arithmetic are not up to a desired mark. 2

Problem

The problem in this investigation has a three-fold purpose: namely, (1) to determine the results of delaying formal arithmetic until the fourth grade; (2) to ascertain the results reflected in the reading abilities of children when the time ordinarily spent on drill and organized instruction in arithmetic is given to reading, the diverted time being spent in reading arithmetic stories, playing games, and in using other arithmetical processes in connection with school activities; (3) to compare the results of a behavior journal kept for each child in the experimental group and in the control group.

Source of Data

The source of data used in this report is work done by the pupils of the fourth grade in Duncan, Oklahoma, schools, designated as the experimental group, and by the pupils of the fourth grade of Marlow, Oklahoma, schools, designated as the control group. The experiment extended over a period of seven months.

---

The pupils of both groups were given the Kuhlmann-Anderson Intelligence Test in October and were matched according to their I. Q.'s. They were also given the Metropolitan Achievement Tests (Intermediate Battery-Complete), Form B, in October to check ability at the beginning of the year, Form A in April to determine the progress made during the term.

A behavior journal was kept for each child so that the teacher's rating of the experimental group could be compared with the rating of the control group and could be checked against progress made during the term as shown by the achievement tests.

At the conclusion of the seven months' experiment the check booklet contained:

1. The I. Q. of each pupil
2. The occupation of the parents of each pupil
3. Scores for tests I and II in arithmetic problems, arithmetic fundamentals, reading, vocabulary, spelling, literature, and English
4. A behavior journal for each pupil
5. Class schedules for each group.

From the information secured, various tables were arranged. Two sets of measures were obtained, scores on tests and teachers' observations.

The Origin of the Problem

The program of delaying formal arithmetic until the fourth
grade has been in operation in the Duncan schools for four years, and as it has evoked the enthusiastic interest of the writer since its beginning, the problem—Evaluation of the Formal Versus the Informal Method of Teaching Arithmetic—originated from the desire to know the intrinsic worth of such a program.

Procedure

This study reports the procedures utilized and the results attained in an educational method that was set up through the interest of the superintendent in teaching boys and girls, not for the purpose of writing a thesis. This method was started four and one-half years ago and in it formal arithmetic was delayed until the fourth year. Knowing that much thought and planning had to be done before the program could be put into operation the professional group, composed of superintendent, principals, and teachers of the first three grades, met once each month during the last half of the school year of 1937-1938 to discuss and make plans for the new method which was to be started at the beginning of the school year 1938-1939.

At these meetings it was planned that all formal instruction and drill in arithmetic would be delayed until the fourth year, that the time ordinarily spent on drill and formal arithmetic would be spent in teaching informal arithmetic and reading, that this time would be utilized in reading arithmetic
stories and keeping scores in games and plays, that much time
would be spent in measuring, reading and writing numbers,
telling time, and doing other such arithmetical processes as
are connected with child play, that all formal drill in con-
nection with addition, subtraction, multiplication, and
division be delayed until the fourth year. The following
outlines indicate the plans that were discussed and decided
upon by the professional group for the first four grades.
Each outline was worked out by the teachers of the respective
grades under the supervision of the principals and the super-
intendent.

PRIMARY AND FIRST GRADE OUTLINE

Reading.--Use one book supplemental to reading.
The minimum number of books to be read is
ten, four pre-primers, four primers, and
two first readers.
The pupils should read as many books as
possible, but they should not be driven.

Writing.--Place no stress on writing the first semester.
Use two space letters for the last semester.

Spelling.--Do not use any time on this subject

Music.--Is to be taught but procedure is to be left
to the individual teacher.

Seatwork.--Procedure is to be left to the individual
teacher.

Arithmetic.--Is to consist of number concepts only; use no
drill on counting or any of the simple fundamentals. Teach arithmetic in connection with reading—finding page numbers, games, and plays.

SECOND GRADE OUTLINE

Reading.—The minimum number of books to be read is ten. The pupils should read as many books as possible without being forced.

Music, Art, Seatwork.—Are to be taught but procedure is to be left to individual teacher.

Health and Safety.—Are to be taught but correlated with reading.

Arithmetic.—Spend no time on drill in fundamentals. Use the time in reading number stories or numbers, measuring, and telling time. Correlate as much as possible with reading.

THIRD GRADE OUTLINE

Reading.—The minimum number of books to be read is ten. Encourage pupils to read as many as they can.

Geography, English, and Health.—Are to be correlated with reading.

Music and Art.—Are to be correlated with other subjects according to the judgment of the teacher.

Arithmetic.—Give no formal drill on fundamental processes. Continue as in Grade II.
In Grade IV formal drill becomes a part of the teaching just as it is taught in ordinary school programs throughout the country. Reading is to be stressed, and subjects are to be correlated with it through the elementary grades.

The following means were devised to encourage the reading of library books:

1. Presenting reading certificates furnished by the State when twenty-five books were read the first year,
2. Giving reading certificates furnished by the school when twenty-five or more books were read in any of the other elementary grades,
3. Encouraging the reading of books from the public as well as the school library.

This educational program was set up with the following convictions:

1. That the child should learn to read during his first three years in school,
2. That if the child can read, he can get arithmetic when he sees the value of it,
3. That if the child can read, he will do better not only in reading but in all subjects.

Thus the half-year of planning ended, and all of the teachers looked forward to the opening of school in the fall of 1938.

When that time came, the professional group felt that they needed a book or drill pad. The superintendent called a meeting of the group to discuss the work-books. The whole
foundation of the new method was contradicted if the books were used because they were composed of basic drills on the fundamentals of arithmetic. There were no games, and few exercises were devoted to thought or reading problems. The work-pads were returned by decision of the group, and the teachers set out to teach reading and informal arithmetic in grades one, two, and three.

Up to this time no means of comparison, nor tests of any kind, had been given to determine the value of this method. During these four years many of the following questions had been asked:

1. How did the pupils rank at the beginning of the fourth year?

2. How did the idea of having no arithmetic fundamentals and formal drill in the first three grades meet the approval of the public?

3. How did the method of delayed formal arithmetic instruction affect pupils who moved to schools using the usual methods of instruction?

4. How does the method of delayed arithmetic instruction affect the progress of fourth-grade pupils when they are given their first formal arithmetic?

5. What is the value of delaying formal arithmetic until the fourth year to the following subjects: reading, vocabulary, arithmetic fundamentals, arithmetic problems, literature, spelling, and English?

6. Now that the program has been in progress for four
years, that tests and comparisons have been made, what are the conclusions and suggestions?

The discussions that follow will attempt to answer the above questions. It is hoped that this method will help pupils and teachers of grades one, two, and three now, and add to the efficiency of these students during high school and college.
CHAPTER II

EVALUATION OF PUPIL PROGRESS

The Experimental and Control Groups

This study was conducted with the fourth-grade pupils in the schools of Duncan and Marlow, Oklahoma. These towns are located in the southern part of the state in Stephens County. They are ten miles apart, so that the children who make up these groups are living in practically the same environment. Both localities are maintained by agriculture and the oil industry.

During the course of the experiment, and for convenience of later discussion, the fourth-grade pupils of the Duncan system will be referred to as the experimental group, and the fourth grade of Marlow will be mentioned as the control group.

The entire fourth grade of both the experimental and the control schools were involved in this experiment. There were two classes of approximately thirty-five pupils in each—the experimental and the control group. The numbers varied through the year, and, although there were seventy-five to take the first test in October, 1941, only forty-seven of the control group took the test in April, 1942. Only forty-three of the experimental group could be paired with the control group. The many families removing to defense areas and new
families coming into town accounted for the discrepancies.

The children who make up these groups are from families whose fathers are salesmen, laborers, carpenters, truck-drivers—the usual or average cross-section of American occupations.

The teachers of the experimental and control groups have about equal qualifications and experience. A check of personnel records showed that all teachers have a Bachelor of Arts Degree, that most of them have from eight to sixteen hours on a Master's Degree, and have had five years or more of teaching experience. Most of the teachers have been in their respective school systems for two or more years.

Procedures Used by Each Group

The procedure used by the experimental group for the last four years has been to stress reading and delay formal instruction in arithmetic until the fourth year as has been outlined in the introduction. No drill was given on the simple combinations or any of the four fundamental processes. Up to the fourth grade arithmetic was taught in connection with the activities of reading and play. The children have access to objects that deal with numbers such as the tape measure, yardstick, clock face; and they keep scores for games which they play.

Since the teaching of reading is stressed, a plan has been worked out to encourage reading in all grades. The state furnished one reading certificate for a child when he
read his first twenty-five or more books during a school year. This plan has been extended so that the child receives another certificate from the school when he reads twenty-five or more books the second, or any successive year. It is believed that this method has caused the children to have a greater interest in reading.

A record is kept in the files of the school for each pupil showing the number of books he has read. This makes it easy to determine whether the child has received a certificate for reading twenty-five or more books for the first, second, third, or fourth year. It is not compulsory that the child read the twenty-five or more books. Teachers check with the children to see that they have really read the book as they reported.

Table 1 shows the number of children in the experimental

<table>
<thead>
<tr>
<th>Number of Years That Each Child Read Twenty-five or More Books</th>
<th>Number of Children</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did not read twenty-five or more books</td>
<td>5</td>
</tr>
<tr>
<td>One year</td>
<td>20</td>
</tr>
<tr>
<td>Two years</td>
<td>11</td>
</tr>
<tr>
<td>Three years</td>
<td>7</td>
</tr>
</tbody>
</table>
group who read twenty-five or more books during the first, second, third, and fourth years of school. There were five in the group who had not read twenty-five books. There were twenty who had read twenty-five or more books for only one year. There were eleven who had read twenty-five or more books for two years. There were seven who had read twenty-five or more books for three years.

The class schedule below shows the school work of grades one, two, three, and four of the experimental group for the last four years.

FIRST GRADE DAILY PROGRAM

9:00... Opening, Flag salute, Songs, Bible story, Conversation
9:20... Busy Bees read Others read library books, play with
9:40... Bluebirds read blocks, do free-hand art work.

Recess

10:30... Redbirds read
10:50... Yellowbirds read
11:10... Busy Bees read

Noon

1:00... Reports
1:10... Rhythm Band, Monday, Wednesday, Friday
Vocal music, Tuesday, Thursday
1:40... Pass out seatwork and explain
1:50... Bluebirds read; others continue seatwork

Recess

2:30... Redbirds read; others continue seatwork
2:50....Yellowbirds read
3:10....Check papers
3:20....Stories, poems, dramatization

SECOND GRADE DAILY PROGRAM

9:00....Opening exercises and explanation of seatwork
9:15....Willing Workers read; others do seatwork
9:35....Busy Bees read

Recess

10:15...Canaries read Others continue seatwork and
10:40...Robins read read library books

11:05...Language and Spelling correlated

Noon

1:00....Reports
1:10....Busy Bees read
1:30....Penmanship, Music, Rhythm Band alternated with Art

2:00....Willing Workers read

Recess

2:30....Canaries read Others do clay modeling, creative
2:55....Robins read art, or library reading

3:20....Story Hour

THIRD GRADE SCHEDULE

9:00....Opening
9:10....First Reading Group
9:30....Second Reading Group
9:50....Third Reading Group
Recess

10:30...Music
10:50...Health and Social Science
11:10...Penmanship
11:30...Art

Noon

1:00....Reports
1:05....English
1:30....First Reading Group
1:50....Second Reading Group

Recess

2:30....Third Reading Group
2:50....Spelling
3:05....Library and Activity

FOURTH GRADE SCHEDULE

9:00....Opening
9:10....Mathematics
10:00....Spelling

Recess

10:30...Health
11:00...Social Science
11:30...Study

Noon

1:00....Reports
1:05....English
1:30....Music
2:00....Study

Recess

2:45....First Reading Group
3:05....Second Reading Group
3:25....Third Reading Group
3:45....Activity

The practice of teaching arithmetic used by the control group has been the formal method that is used in most schools throughout the country today. Counting and the simple combinations of addition and subtraction were taught in the first grade, while in the second and third grades drill pads and text books were used. Drill was given in addition, subtraction, multiplication, and the more simple form of division.

Reading was stressed in the school of the control group by having a library or free period. The children were encouraged to read public library books as well as books of the school library. No record was kept of the number of books read by the pupils. No certificates were given.

The class schedules below show the program of school work for grades one, two, three, and four of the control group.

FIRST GRADE DAILY PROGRAM

9:00....Opening
9:10....Penmanship
9:30....Music
9:45....Phonics and word drill
10:00...Phonics and word drill
10:15...Phonics and word drill  
Recess

10:45...Arithmetic
11:00...Arithmetic
11:15...Arithmetic  
Noon

1:00....Study Optional
1:15....Reading
1:35....Reading
1:55....Reading
2:15....Story Hour  
Recess

3:00....Art or Nature Study

SECOND GRADE DAILY PROGRAM

9:00....Arithmetic
   Busy Bees Reading
   Bright Eyes Reading
   Busy Workers Reading  
Recess

10:45...Spelling
   Penmanship  
Noon

1:00....Phonics
   Busy Bees Reading
   Bright Eyes Reading
Busy Workers Reading
Language
Recess
2:45...Art
Review Work

THIRD GRADE DAILY PROGRAM

9:00....Opening Exercises
9:10....English
10:00...Art--Monday and Friday
       Music--Wednesday
       Penmanship--Tuesday and Thursday
       Recess

10:45...Arithmetic
       Noon
1:00....Reading
2:00....Spelling
       Recess

2:45....Geography and Health
3:30....Study

FOURTH GRADE DAILY PROGRAM

9:00....Art or Penmanship
9:45....Arithmetic
       Recess

10:45...English
11:20...Geography
Noon
1:00....Study or Library
1:45....Reading

Recess
2:45....Spelling
3:15....Study

Pupils Paired According to Intelligence Quotient

The first step in the research procedure was pairing the pupils of the experimental and the control groups in regard to intelligence quotients. For this purpose the Kuhlmann-Anderson Intelligence Test, Fifth Edition, Grade IV, was given to all pupils in both the experimental and control groups. The actual pairing of pupils was made on the basis of the intelligence quotients. The two groups were equated by matching each pupil of the experimental group with a pupil of like intelligence quotient of the control group. In order that valid pairing should be obtained, only those pupils were selected whose intelligence quotients could be matched within five points. Table 2 shows the pairing according to intelligence quotients. Actually, the pairing was quite close. Thirteen pairs were matched with identical scores; seven pairs within one point; nine pairs within two points; two pairs within three points; seven pairs within four points; and five pairs within five points. On this basis forty-three pairs of pupils were formed.
TABLE 2

THE RELATIONSHIP OF THE SCORES MADE ON THE INTELLIGENCE TEST BY VARIOUS PAIRS OF PUPILS INCLUDED IN THE EXPERIMENT

<table>
<thead>
<tr>
<th>Relationship of Scores</th>
<th>Number of Pairs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identical scores</td>
<td>13</td>
</tr>
<tr>
<td>Within one point</td>
<td>7</td>
</tr>
<tr>
<td>Within two points</td>
<td>9</td>
</tr>
<tr>
<td>Within three points</td>
<td>2</td>
</tr>
<tr>
<td>Within four points</td>
<td>7</td>
</tr>
<tr>
<td>Within five points</td>
<td>5</td>
</tr>
</tbody>
</table>

Appraisal of Pupils According to the Results of Metropolitan Achievement Tests

The second step in the project consisted in giving a battery achievement test to learn the position of each group. For this purpose Form B of the Metropolitan Achievement Tests, Intermediate Battery-Complete, was given to one hundred fifty pupils who enrolled in Grade IV in both schools when the experiment began. The achievement test consists of nine parts designated as follows: (1) Reading, (2) Vocabulary, (3) Arithmetic fundamentals, (4) Arithmetic problems, (5) English, (6) Literature, (7) History and Civics, (8) Geography, (9) Spelling.

The following samples show the types of tests the Metropolitan Achievement Tests are:
Reading.
"Sample." Dick, Tom, and Fred are brothers. The names of Dick's brothers are
(a) ..................(b) ............... 

Vocabulary.
"Sample." Big means the same as (1) bad........ (2) pretty........ (3) large........ (4) tiny........

Arithmetic Fundamentals.
"Sample." 9 - 3 = 

English.
"Sample." Jack says he (don't) (doesn't) like to lose his marbles.

Arithmetic Problems.
"Sample." Our room has 3 erasers on the front board and 4 on the back board. How many are there in the room?

Literature.
"Sample." Sleeping Beauty was awakened by (a) a king..........(b) a fairy.......... (c) a bear..........(d) a prince.......... 

Spelling. Start with simple words and proceed to the more difficult.\(^1\)

\(^1\)Richard D. Allen and others, Metropolitan Achievement Tests, Intermediate Battery-Complete, Form B.
One day was used to administer the tests in each school. Each section of the test was given at the same time of day to each group. Special precautions were taken to see that each division of the test received the proper time. The children of each group were allowed a rest period or recess period during the morning and afternoon.

Table 3 shows the position of the two groups of pupils in each of the subjects in October, 1941. Analysis of the tabular data reveals a number of important findings.

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Higher</th>
<th>Same</th>
<th>Lower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading</td>
<td>36</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Vocabulary</td>
<td>30</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>Arithmetic fundamentals.</td>
<td>14</td>
<td>4</td>
<td>25</td>
</tr>
<tr>
<td>Arithmetic problems.</td>
<td>17</td>
<td>8</td>
<td>18</td>
</tr>
<tr>
<td>English and Grammar.</td>
<td>31</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>Literature</td>
<td>22</td>
<td>2</td>
<td>19</td>
</tr>
<tr>
<td>Spelling</td>
<td>29</td>
<td>2</td>
<td>12</td>
</tr>
</tbody>
</table>
The most outstanding of these is that the pupils in the experimental group rank higher in all of the subjects except arithmetic fundamentals and arithmetic problems. Table 2 shows the total number of pairs to be forty-three. Column one of Table 3 shows the number of pupils of the experimental group who made higher scores than their partners of the control group. Column two shows the number of pupils of both groups who made identical scores. Column three shows the number of pupils of the experimental group who made lower scores than their partners of the control group.

The experimental group was nearer the control group in arithmetic problems than in arithmetic fundamentals. This was to be expected as arithmetic problems are more closely related to reading, and reading had been stressed for three years. The experimental group scored higher in reading, vocabulary, English, literature, and spelling. The control group scored higher in arithmetic fundamentals and arithmetic problems, which might be expected since the experimental group had had no formal drill in arithmetic.

The final step in the project consisted in measuring the amount of improvement made by the pupils in the experimental and control groups during the course of the experiment which was seven months. For this purpose the Metropolitan Achievement Test, Intermediate Battery-Complete, Form A, was used. This test is the equivalent of the preliminary test in content and difficulty. Table 4 shows the location of the pairs in April, 1942.
<table>
<thead>
<tr>
<th>Subjects</th>
<th>Higher</th>
<th>Same</th>
<th>Lower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading</td>
<td>28</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>Vocabulary</td>
<td>28</td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>Arithmetic fundamentals</td>
<td>31</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Arithmetic problems</td>
<td>34</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>English and Grammar</td>
<td>33</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Literature</td>
<td>29</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>Spelling</td>
<td>29</td>
<td>1</td>
<td>13</td>
</tr>
</tbody>
</table>

A fact revealed by the scores used for comparing the improvement made by the two groups in arithmetic fundamentals and arithmetic problems was that the progress made by the experimental group, as a whole, was not only consistently but also conspicuously greater than that made by the control pupils. This gain was probably due to the fact that drill on the fundamental processes was begun this year and the children were mature enough to see the value of the drill. Another revelation of the scores is that the control group gained in reading and vocabulary from October to April over the experimental group who had had reading stressed for
three years. A possible explanation of this is that the new subject, formal arithmetic, was more fascinating to members of the experimental group and their interest was diverted from reading. The learner was attempting to react in terms of the more complicated higher-order methods which had been acquired; consequently, it takes time for the individual to gain facility in reacting in terms of his behavior.

In order to evaluate more accurately the two methods of teaching arithmetic, a further analysis of the tests was made which shows the average improvement of the experimental and control groups at different levels of achievement. The Tables 5, 6, 7, and 8 show the quartiles calculated on the basis of intelligence quotient.

Table 5 indicates the average improvement made by pupils of the experimental and control groups at different levels of ability in reading comprehension. On the initial tests the first quartile, the second quartile, and the third quartile of the experimental group show a decided superiority over the control group. This is probably due to the fact that more time was devoted to reading in the first three grades of the experimental group. On the final test the first quartile of the experimental group held their own with a one point gain, while the second quartile of the control group surpasses the experimental group with a two point gain. The third quartile of the control group shows a one point gain. A possible explanation is that formal arithmetic was
such a stimulator for the experimental group that reading did not receive the usual amount of attention. The experiment of seven months duration showed very little difference in the two groups. Seemingly, the two methods involved had little effect on reading comprehension.

Table 5 shows the average improvement of the first, second, and third quartile in reading vocabulary. Again on the initial test the pupils of the experimental group rated higher than the pupils of the control group. On the final test the first and second quartiles of the control group showed a two point gain. The third quartile of the experimental group maintained its status with a one point gain. The differences are not great enough to warrant a definite conclusion, however, the superiority of the experimental
Table 6

AVERAGE IMPROVEMENT OF THE FIRST, SECOND, AND THIRD QUARTILES* OF THE EXPERIMENTAL AND CONTROL GROUPS IN READING VOCABULARY

<table>
<thead>
<tr>
<th>Groups</th>
<th>Average of Experimental Group</th>
<th>Average of Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First Test</td>
<td>Final Test</td>
</tr>
<tr>
<td>First quartile</td>
<td>34</td>
<td>41</td>
</tr>
<tr>
<td>Second quartile</td>
<td>29</td>
<td>35</td>
</tr>
<tr>
<td>Third quartile</td>
<td>23</td>
<td>28</td>
</tr>
</tbody>
</table>

*Quartiles are calculated on basis of I. Q.

Group on the initial tests in reading comprehension and reading vocabulary favor the informal method.

Table 7 indicates the relative abilities of the pupils in the two groups in arithmetic fundamentals. Even though the control group had had formal drill in arithmetic for three years, the first and second quartiles were only two points superior on the initial test. The third quartile of the control group was only one point ahead. This evidence points to the superiority of the informal method for all three quartiles. On the final test the first quartile of the experimental group surpassed the first quartile of the control group by two points to show a gain of four points. The second quartile of the experimental group surpassed the second quartile of the control group by two points to show a
## TABLE 7

AVERAGE IMPROVEMENT OF THE FIRST, SECOND, AND THIRD QUARTILES* OF THE EXPERIMENTAL AND CONTROL GROUPS IN ARITHMETIC FUNDAMENTALS

<table>
<thead>
<tr>
<th>Groups</th>
<th>Average of Experimental Group</th>
<th>Average of Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First Test</td>
<td>Final Test</td>
</tr>
<tr>
<td>First quartile</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>Second quartile</td>
<td>19</td>
<td>29</td>
</tr>
<tr>
<td>Third quartile</td>
<td>18</td>
<td>25</td>
</tr>
</tbody>
</table>

*Quartiles are calculated on basis of I. Q.

Gain of five points. The third quartile of the experimental group surpassed the third quartile of the control group by one point to show a five point gain. Definitely, the experimental group was ready for formal arithmetic so they accomplished more in the one year in arithmetic fundamentals than the control group accomplished in three years of formal drill. The differences were consistently on the side of the informal method and they are practically large enough to establish its superiority with certainty.

Table 8 presents the most extraordinary findings of all the study, and gives conclusive proof that the informal method is better than the formal method. It must be kept in mind that the experimental group had had reading stressed for three years, and that arithmetic had been taught informally.
TABLE 8

AVERAGE IMPROVEMENT OF THE FIRST, SECOND, AND THIRD QUARTILES* OF THE EXPERIMENTAL AND CONTROL GROUPS IN ARITHMETIC PROBLEMS

<table>
<thead>
<tr>
<th>Groups</th>
<th>Average of Experimental Group</th>
<th>Average of Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First Test</td>
<td>Final Test</td>
</tr>
<tr>
<td>First quartile</td>
<td>19</td>
<td>31</td>
</tr>
<tr>
<td>Second quartile</td>
<td>19</td>
<td>29</td>
</tr>
<tr>
<td>Third quartile</td>
<td>18</td>
<td>26</td>
</tr>
</tbody>
</table>

*Quartiles are calculated on basis of I. Q.

for three years. The control group had had formal drill in arithmetic and had had the usual reading instruction as given in the regular school systems throughout the United States. On the initial test the control group of the first and second quartiles were only one point in advance of the experimental group in arithmetic problems. In the third quartile both groups scored the same. On the final test all three quartiles of the experimental group surpassed the three quartiles of the control group. The first quartile of the experimental group showed a gain of twelve while the first quartile of the control group showed a gain of only four points. The second quartile of the experimental group showed a gain of ten points while the second quartile of the control group showed a gain of two points. The third quartile of the
experimental group gained eight points and the third quartile of the control gained two points. The ability to read and understand the arithmetic problems was a determining factor that favored the experimental group. These data on arithmetic problems thus increase the degree of certainty attached to the conclusion that the informal method is superior to the formal.

Appraisal of Pupils According to the Behavior Journal

To supplement the purely scientific approach and as a second and more individual arrangement, a behavior journal in arithmetic was kept for each pupil in the experimental and the control groups. Each child was rated by his teacher and an anecdote for each rating was written in the journal.

Table 9 shows the number of pupils in the same experimental group of forty-three making superior, good, average,

<p>| TABLE 9 |
|------------------|--------|------|------|-----|------|</p>
<table>
<thead>
<tr>
<th>Group</th>
<th>Superior</th>
<th>Good</th>
<th>Average</th>
<th>Poor</th>
<th>Not-at-all</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>3</td>
<td>15</td>
<td>17</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>Control</td>
<td>3</td>
<td>19</td>
<td>17</td>
<td>4</td>
<td>0</td>
</tr>
</tbody>
</table>

poor, and not-at-all rating as compared with the corresponding paired pupil of the control group of the forty-three in
the behavior journal. It will be observed that the teachers of the control group rated the pupils higher than the teachers of the experimental group rated their pupils, although the tests made in achievement showed that the pupils of the experimental group rated higher. The teachers of the control group placed a higher rating than was justified by the test results; whereas the teachers of the experimental group more nearly approached the findings of the tests. In this simple statement might be found support for a contention that the experiment reduces the element of personalities and contributes to absolute fairness of judgment.

Great care was exercised to keep uniform the conditions under which the initial and the final tests were given, and to secure control over non-experimental factors while the experiment was in progress. Since these precautions were taken, it seems fair to assume that the difference in improvement made by pupils in the experimental group over those in the control group constitutes an objective measure of the effectiveness of delaying formal instruction in arithmetic. The findings are recorded in Tables 3, 4, 5, 6, 7, 8, and 9.
CHAPTER III

OBSERVATIONS AND FINDINGS ON THE INFORMAL METHOD
OF TEACHING ARITHMETIC

Observed Influences of the Experimental Group

Observations of the writer reveal that informality in the arithmetic program is (1) vitality of the total school program; (2) emphasis on those functions of arithmetic which are used most in everyday life; (3) recognition of the needs, the potentialities, and the limitation of the group of children in any given situation; (4) recognition of stages of growth and the evolving nature of child development.

Children who are so situated that they are learning and growing in all their life and school activities are, in general, those who are learning and growing in their uses of arithmetic. The informal school program recognizes that arithmetic functions throughout the day, that it is part of everything that takes place, that it cannot be learned in isolation.

Arithmetic must be the outgrowth of experience. With a given class of children it is desirable that many of these experiences be common to the whole group, particularly those experiences which form arithmetical concepts, and understandings, which many children lack on coming to school. The
informal school program gives that preliminary common experience. Materials are touched and manipulated. New impressions come to the child. He is getting, moreover, experiences with other children, who are also reacting to their environment. These reactions bring into being new situations, which, in turn, create specific problems. If the child’s time is spent in isolated drill the child is not getting the real experiences. He is becoming an automaton.

It is of the greatest importance that children gain the right attitude toward the subject if they are to get the most out of their study of mathematics. Teachers need to develop certain skills and impart certain knowledge to their pupils, but while they are doing these things they need to help them to appreciate the wonders of their subject. Observations show that this attitude is developed more in the informal program than in the formal program.

In spite of the changing ideas about "mental discipline," mathematics is still recognized as an important means of training people in clear thinking. "Logic" is the same wherever it may be found. Students can be helped to "think straighter" by the right kind of teaching of mathematics.

Learning to read is, in itself, a discipline for the primary-school pupil. The same can be said, with additional certainty, of beginning arithmetic. Why should the school, by confronting the child with marked vocabulary difficulties, continue to make beginning arithmetic even more formidable
than it is? Three types of reading are involved in arithmetic problems: the reading of numbers, the reading of words, and the reading of both numbers and words. When the child learns to read, the systematic study of arithmetic is not made unduly difficult by confusion resulting from an inadequate vocabulary.

Readiness is a concept designed to tie together the overt behavior (symptoms) of the learner with the inner dynamics of maturation. Figuratively speaking, it is the bridge connecting the observable behavior of the learner with the organized overt behavior operating on his level of maturation. With these concepts teachers are ever led to look deeper into the learner's behavior than into his overt, desultory behavior. They assay the level of meaning and the pupil's understanding of the materials that he is trying to learn.

Children develop at different rates in accordance with their mental ability and physical condition, the high or low stimulus value of their home and community environment, and the differences in their educational opportunities.

Arithmetic growth in the informal school is not considered as a matter of single skills, but as a matter of total development, with its roots in the child's general background, his personality, his environment, his emotional balance, and his intelligence. The program keeps these conditioning factors as well as the arithmetic aims in mind, and provides for recognition of stages of growth and levels of achievement.
each child proceeds from where he is to the next desirable stage regardless of his grade placement and regardless of any goals and standards traditionally attached to his grade or his age.

During the first year of regular formal arithmetic certain tendencies which resulted from informal teaching in the first three years were observed in the child's behavior. These tendencies are substantiated by the data in Tables 5, 6, 7, and 8.

(a) When the child has been given isolated drill during the first three years in school, he has a passive attitude toward arithmetic. The child who studies formal arithmetic for the first time at the beginning of the fourth year finds a new interest which leads him into the realization of life values. He has a zeal for it because he is old enough to see value in it.

(b) Good work habits are inculcated; procrastination finds poor soil for its roots; boredom and impatience are infrequent; and a much better classroom morale and general attitude are maintained.

(c) The child who has had reading stressed for the first three years is able to read the problems and understand them.

(d) The child is willing to proceed without assistance on definite tasks assigned.
(e) The child has the ability and background to attack problems.
(f) He gains increased confidence in himself.
(g) He takes more part in group discussion, showing some measure of sustained interest.
(h) He gets along with other children.
(i) He raises interesting and stimulating questions.
(j) The child's greater control of experience is reflected in:
   1. Increase of vocabulary
   2. Clearer expression of ideas
(k) He is more apt to stick to a task until it is finished.

The following observations, made by teachers of the experimental group, are illustrations of children who enter the fourth grade with a lack of formal drill.

Patsy has good study habits in arithmetic. She likes to know just what the assignment means and then she is ready for work. She expresses herself clearly, is accurate in her work. She does not hesitate to attack problems and does not give up until they are worked. She is destined to be a teacher. She sees to it that the children near her get their work.

John has a good attitude toward arithmetic. He has good study habits. He has the ability to attack problems without assistance. He expresses himself clearly and is accurate.

Dale's attitude toward arithmetic is excellent. His first statement to me was, "Mother wants you to teach me the multiplication table." He learned it. His work is accurate and he has the ability to attack problems. He gets along with other children.
Findings of Other Studies

Other studies of the problem of arithmetic placement have reached conclusions which correspond with these observations. The answer to this question, "When shall systematic instruction of arithmetic begin?" depends upon the circumstances. After surveying all the evidence, Clifford Woody has concluded that instruction should be postponed as long as possible. Instruction should be given in connection with the needs of the children.¹

Another investigation by Harap and Mapes recommends the postponement of formal instruction in arithmetic because such postponement offers opportunity for the development of meaningful number experiences and allows the use of the time ordinarily devoted to the formal teaching of arithmetic for reading and language. When the knowledge of arithmetic is essential in meeting a given purpose, the child learns the needed arithmetic.²

In summarizing reports made on the studies of arithmetic, and this report, "Evaluation of the Formal Versus the Informal Method of Teaching Arithmetic," the writer is convinced that arithmetic is difficult for many children, that


it is so difficult that more pupils above the fourth grade fail in it than in any other subject, and that something should be done about it. Carlton Washburne, in his report of "When Should We Teach Arithmetic?" announced that it is conceivable that during their first and second years in school the pupils whose formal arithmetic was not begun until the third grade were gaining other types of experiences which were of sufficient value to justify any loss of arithmetic efficiency through delayed drill in it.\(^3\) The Washburne report was valid in that it was based upon tests given to about five thousand sixth-grade pupils in fifteen Middle Western cities in schools of various sizes.

The report on "The Grade Placement of Arithmetic Topics" is significant in that it shows how to determine, in a scientific way, the grade placement for the arithmetic topics.\(^4\) This study emphasizes the importance of mental age as a criterion for determining the placement of arithmetic topics in the grades. The report stresses the futility of allowing pupils to take certain topics until they are mentally old enough to study them. The results of these experiments agree with the philosophy of deferring certain arithmetic

\(^3\)Carlton Washburne, "When Should We Teach Arithmetic?" \textit{Elementary School Journal}, XXVIII (May, 1928), 659-665.

topics at least one year. The study was made in 1930. The number of cases was large. This gives scientific significance to the results of the study.

Interest in the problem of teaching arithmetic and a desire to apply it as it might benefit the pupils of the school rather than as a basis of experiment led to this trial in the Duncan schools. The statement reproduced below gives the reaction to it of the principal, T. P. Witt, of Emerson School of Duncan, Oklahoma.

In Emerson School the plan of emphasizing reading and withholding arithmetic until the fourth year has been met with favor after a few trials and adjustments. The first criticism worthy of mention was the lack of work done by the child. This weakness, or supposed weakness, was overcome by a concentrated library program. Library cards to the public library were secured for every child. Comparison with friends and relatives in other schools brought a wave of criticism because the children were learning no arithmetic. Patience and constant testing overcame this problem. Children entering the fourth year and getting the first taste of arithmetic, as such, were found to advance rapidly and to like arithmetic. This, of course, merely showed an application of the theory of readiness.

Progress by small steps rather than by grades, allowing for a maximum development of the individual, is the feature of the program which sells it to the patrons.5

5A statement by T. P. Witt, Principal of Emerson School, Duncan, Oklahoma. The writer requested the reaction of the Principal to the informal method.
CHAPTER IV

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

On the basis of the data presented, the following conclusions may be drawn:

1. In comparison with the formal method, the informal method of teaching arithmetic was found in general to yield better results in arithmetic problems and arithmetic fundamentals and as good or better results in the other subjects.

2. Much of the arithmetic material included in the formal arithmetic for the first three grades is too far removed from the life of the child to be of maximum value to the child's development.

3. Due to the stressing of reading in the informal method, the background of the child was more highly developed.

4. Children who have had no formal arithmetic in the first three grades approach the fourth grade formal arithmetic with confidence because they can read and understand what they are to do.

5. The teachers reported that the pupils who were introduced in the fourth grade to the subject as arithmetic displayed an eagerness not manifested by those who had had formal arithmetic in earlier grades.
6. Much of the drill in formal arithmetic is unnecessary because the children of the first three grades are not mature enough to see value in it.

7. Results concede that mere play on drill with meaningless repetition is the practice of much of the formal arithmetic methods for the first three grades.

8. The pupils at the beginning of the formal arithmetic, who have had reading stressed the first three years, and had been taught informal arithmetic, have a distinct advantage in solving arithmetic problems.

9. Pupils can be introduced to the formal method of arithmetic at the proper time without detracting from, or neglecting, the one essential phase of the instructional program which is teaching pupils to read.

10. The informal course made possible savings in time, in teaching-effort, and in pupil-energy.

11. The introduction of information from actual situations was instrumental in developing an interest for the study of arithmetic not found in the formal classes.

The informal method which seeks reality develops arithmetic as part of the whole school program; emphasizes those functions of arithmetic that children use and will use in daily life; recognizes individual differences in abilities, achievements, and interests; recognizes the different levels of the elementary-school child and develops the program in terms of these levels.
Recommendations

This study suffers from the small number of pupils involved. However, the results are probably indicative and may be taken as suggestive of the need for further, more leisurely, and more scientific investigation.

On such a limited basis, then, the writer would like to propose to school systems that they experiment with the informal method in the first three grades.

The writer also recommends that more research be done to determine with certainty the stage of the child's development at which each mathematical process may be introduced and the stage when mastery of that process should be attained.
APPENDIX
A BEHAVIOR JOURNAL

School ____________________ Pupil ____________________

Rated by ____________________ Grade _____ Age _____ Date _____

What is the child's attitude toward Arithmetic?
Has he developed good study habits?
Can he read the problems?
Is he willing to proceed without assistance on definite tasks assigned?
Does he have the ability to attack problems?
Is he accurate in his work?
Does he work well with a group?
Does he get along with other children?
Does he raise interesting and stimulating questions?
Can he express his ideas clearly?
Does he see value in arithmetic?
Does he stick to a task until it is finished?

Rating_____________________

Key

4----Superior
3----Good
2----Average
1----Poor
0----Not at all

Anecdote
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Reports


Tests