A Comparison of Three Methods of Teaching Mathematics in Fourth Grade: Cognitive and Affective Dimensions

Daniel Gilbert
Loyola University Chicago

Recommended Citation
http://ecommons.luc.edu/luc_diss/1512

This work is licensed under a Creative Commons Attribution-Noncommercial-No Derivative Works 3.0 License.
Copyright © 1976 Daniel Gilbert
A COMPARISON OF THREE METHODS OF TEACHING
MATHEMATICS IN FOURTH GRADE: COGNITIVE
AND AFFECTIVE DIMENSIONS

by

Daniel Gilbert

A Dissertation Submitted to the Faculty of the Graduate
School of Education of Loyola University in Partial
Fulfillment of the Requirements for the
Degree of Doctor of Education

February
1976
DEDICATION

This dissertation is dedicated to my wife, Helen, my son, David, and my daughter, Jennifer, whose patience made it possible.
ACKNOWLEDGEMENTS

The author acknowledges the support of his doctoral committee, Dr. Barney Berlin, Dr. Lois Lackner, and Dr. John Penick. Their time and effort made this project possible.

A special note of gratitude is given to Dr. John Penick for his assistance in development and interpretation of the statistical data.

The teachers and principals who assisted in the data gathering process deserve credit for their cooperation and encouragement during the study. Not only were they willing to try various teaching methods in an effort to improve instruction, but they welcomed the idea of evaluating their undertakings.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEDICATION</td>
<td>ii</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>iii</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>vi</td>
</tr>
<tr>
<td>Chapter</td>
<td></td>
</tr>
<tr>
<td>I. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>II. REVIEW OF RELATED RESEARCH AND LITERATURE</td>
<td>7</td>
</tr>
<tr>
<td>III. PROCEDURES</td>
<td>18</td>
</tr>
<tr>
<td>IV. FINDINGS OF THE STUDY</td>
<td>32</td>
</tr>
<tr>
<td>Development of Attitudes Toward Mathematics</td>
<td></td>
</tr>
<tr>
<td>Sex Difference as a Factor in Attitude Toward and Achievements in Mathematics</td>
<td></td>
</tr>
<tr>
<td>The Teacher as a Factor in Attitude and Achievements in Mathematics</td>
<td></td>
</tr>
<tr>
<td>Attitude and Achievement</td>
<td></td>
</tr>
<tr>
<td>Teaching Method</td>
<td></td>
</tr>
<tr>
<td>Community Description</td>
<td></td>
</tr>
<tr>
<td>Teacher Sample</td>
<td></td>
</tr>
<tr>
<td>Instructional Strategies</td>
<td></td>
</tr>
<tr>
<td>Data Collection and Analysis</td>
<td></td>
</tr>
<tr>
<td>Stanford Arithmetic Test</td>
<td></td>
</tr>
<tr>
<td>Duncan's New Multiple Range Test</td>
<td></td>
</tr>
<tr>
<td>Analysis of Covariance</td>
<td></td>
</tr>
<tr>
<td>Chapter</td>
<td>page</td>
</tr>
<tr>
<td>---------</td>
<td>------</td>
</tr>
<tr>
<td>V. CONCLUSIONS AND DISCUSSION</td>
<td>42</td>
</tr>
<tr>
<td>Mathematical Computation</td>
<td></td>
</tr>
<tr>
<td>Mathematical Concept Acquisition</td>
<td></td>
</tr>
<tr>
<td>Mathematical Application Skills</td>
<td></td>
</tr>
<tr>
<td>Interactions</td>
<td></td>
</tr>
<tr>
<td>Other Factors</td>
<td></td>
</tr>
<tr>
<td>Recommendations</td>
<td></td>
</tr>
<tr>
<td>Suggestions for Further Research</td>
<td></td>
</tr>
</tbody>
</table>

APPENDICES

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A. DUTTON ATTITUDE SCALE, FORM C, SCALE 5</td>
<td>55</td>
</tr>
<tr>
<td>B. THE PURDUE TEACHER OPINIONAIRE</td>
<td>59</td>
</tr>
</tbody>
</table>

REFERENCES | 71 |

VITA | 76 |
### LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Parameters of the Various Teaching Methods..</td>
<td>3 &amp; 4</td>
</tr>
<tr>
<td>2.</td>
<td>Teacher Data</td>
<td>20</td>
</tr>
<tr>
<td>3.</td>
<td>Mathematics Curriculum</td>
<td>21 - 24</td>
</tr>
<tr>
<td>4.</td>
<td>Purdue Teacher Opinionaire Data</td>
<td>28</td>
</tr>
<tr>
<td>5.</td>
<td>Summary of Stanford Achievement Test Score Analysis Blocked by Student Attitude</td>
<td>34 &amp; 35</td>
</tr>
<tr>
<td>6.</td>
<td>Results of Duncan's New Multiple Range Test Computation</td>
<td>36</td>
</tr>
<tr>
<td>7.</td>
<td>Results of Duncan's New Multiple Range Test Concept Acquisition</td>
<td>37</td>
</tr>
<tr>
<td>8.</td>
<td>Results of Duncan's New Multiple Range Test Application Skills</td>
<td>38</td>
</tr>
</tbody>
</table>
CHAPTER I

INTRODUCTION

Background

The variety of methods and materials available to teach elementary school mathematics seems to be ever-expanding. Publishers and educators seem to be searching for better ways to impart these skills and concepts to students. It often appears as though the process of changing curriculum is becoming more important than the affects of the change. As school personnel search for better methods of teaching, their work frequently does not consider the factor of evaluation, as well as what needs to be evaluated.

Along with the study of the important areas of arithmetic computation, concepts, and applications, the student's attitude towards the subject has also gained attention in recent years.

The study reported herein grew out of the author's interest in both the cognitive and affective aspects of elementary school mathematics instruction and the effect on these of various teaching strategies.

Statement of the Problem

The purpose of this study was to determine the
effect of three different teaching strategies on student performance and attitude toward mathematics in fourth grade. Two of the methods of teaching were individualized and one was traditional. The cognitive factors of computation, concept acquisition, and application skills as well as attitudes were studied under the three methods (Table 1). The following hypotheses were tested.

Hypotheses

Hypothesis 1 There is no significant difference in mean arithmetic computation achievement scores among students taught via the three methods of instruction.

Hypothesis 2 The interaction effect of method of instruction and student attitude towards arithmetic on arithmetic computation is zero.

Hypothesis 3 There is no significant difference in mean mathematical concept acquisition achievement scores among students taught via the three methods of instruction.

Hypothesis 4 The interaction effect of method of
### TABLE 1

**PARAMETERS OF THE VARIOUS TEACHING METHODS**

<table>
<thead>
<tr>
<th>Method</th>
<th>School A</th>
<th>School B</th>
<th>School C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Individualized - Class progresses through the same material at varied rates.</td>
<td>Individualized - Students progress through teacher assigned materials at varied rates.</td>
<td>Traditional - Students in each of three class groups work on different assignments.</td>
</tr>
<tr>
<td>Grouping</td>
<td>Flexible groups are formed by teacher for students with similar difficulties.</td>
<td>Flexible groups are formed by teacher for students with similar difficulties.</td>
<td>Three relatively inflexible groups are determined by student ability.</td>
</tr>
<tr>
<td>Instructional Materials</td>
<td>textbook, workbook, dittoed material for enrichment supplied by the publisher, Addison Wesley</td>
<td>textbook, commercially prepared dittoes</td>
<td>textbook, workbook</td>
</tr>
<tr>
<td>Grading of daily work</td>
<td>teacher graded</td>
<td>student self graded using answer keys</td>
<td>graded by teachers or students as answers are read or put on chalkboard</td>
</tr>
</tbody>
</table>
TABLE 1 - continued
PARAMETERS OF THE VARIOUS TEACHING METHODS

<table>
<thead>
<tr>
<th>Evaluation of student learning</th>
<th>School A</th>
<th>School B</th>
<th>School C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Enrichment</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal -</td>
<td>textbook publisher's chapter tests</td>
<td>pre and post tests for each contract</td>
<td>textbook publisher's chapter tests</td>
</tr>
<tr>
<td>Students who complete chapter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>are given depth materials on the same content.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical -</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students progress to more difficult areas as they are able, i.e. whole class study of measurement, geometry, etc.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Each of the three groups studies enrichment topics as a group.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
instruction and student attitude toward arithmetic on mathematical concept acquisition is zero.

Hypothesis 5 There is no significant difference in mean mathematical application skill scores among students taught via the three methods of instruction.

Hypothesis 6 The interaction effect of method of instruction and student attitude toward arithmetic on mathematical application skills is zero.

Statistical Analysis

An analysis of covariance was used to determine if the independent variable, type of treatment in mathematics, had any affect on the dependent variable of student attitude in mathematics. Duncan's New Multiple Range Test (Kirk, 1968, pp. 93-94) utilizing covaried means was used to determine if the independent variable had any affect on the dependent variable of student achievement in mathematics. Student achievement in arithmetic computation, mathematical concepts, and applications was assessed by the Stanford Arithmetic Test (1964), while attitudes toward mathematics were measured with the Dutton Attitude Scale, Form C, Scale 5 (1962).
Limitations of the Study

The study is limited in that it considers only fourth grade students in three schools of one suburban, middle-class Chicago school district. There are few minority group students enrolled in the schools.

The study was run in classrooms where the research conditions already existed. Thus intact groups were used rather than those of a random sample. This factor affects not only the student population but the population of eight female teachers and one male teacher.

Thus, one must be cautious in applying the findings to other schools and grade levels in different locations with different teachers and student populations.
CHAPTER II

REVIEW OF RELATED RESEARCH AND LITERATURE

Development of Attitudes Toward Mathematics

If attitudes are to be of concern for educators, the many factors in their development need to be considered. Abrego (1966) remarked that, "Home environment, school environment, heredity and good health --- physical and mental --- have played their part in maturation of the student. All of these influences can aid learning, but without the right attitude the child's full potential of growth in knowledge cannot be realized (p. 206)."

Arithmetic has been rated as a favored subject by children in intermediate grades (Mosher, 1951, Rowland and Inskeep, 1963). The studies of Chase (1949) and Sister Josephina (1959) indicated that elementary school children rated arithmetic as their second best liked subject. Capps and Cox (1969) found that 225 children in fourth and fifth grades tended to list arithmetic as either best-liked or least-liked. It is also interesting to note, however, that Sister Josephina (1959) found arithmetic ranked first on a separate list of least-liked subjects.
An early investigator in the area of attitude, as it relates to mathematics, was Wilbur H. Dutton of the University of California at Los Angeles. His work in this field began in 1951. He used a group of 211 students in a methods of teaching elementary school arithmetic class to help "...them discover the importance of attitudes in their own learning experiences and to help them to define their attitudes toward arithmetic and isolate some of the factors causing them (1951, p. 84)."

Dutton (1954) found that the most important times for the development of attitudes in mathematics were in grades three through six and in the junior high school.

In another study Dutton (1956) found that most junior high school pupils (87%) enjoy problems when they know how to work them well, and that they felt mathematics was as important as any other subject (83%). He found that lasting attitudes toward mathematics are developed at each grade level, with grades five and eight pronounced most crucial.

Another study by Dutton (1962) determined the formation of students' attitudes was most crucial in grades four through eight.

Smith (1964) found that "...feelings toward arithmetic
are developed at all stages in our educational system (p. 477)." In his study of 123 college students attitudes he found that, "More than one-half of the students in this study named the elementary school years as the period in which their feelings toward arithmetic developed (p. 477)." In separate studies Stright (1960) and Fedon (1958) found that students have definite attitudes for and against arithmetic as early as the third grade.

The work of Reys and Delon (1968) differs from the above studies regarding when attitudes toward arithmetic are formulated. In their study of 385 students in a teacher training program, they state, "The greatest percentage of students indicated that their present feelings toward arithmetic were developed in the junior high grades (p. 366)." Of those students who felt their attitudes toward arithmetic were developed in elementary school, most felt the intermediate grades were more important than other grades in the formation of their attitudes.

In yet another study of college students White (1963) found that attitudes toward arithmetic were developed in grades two through twelve, but the intermediate
grades four through six were the most influential.

There is conflicting data concerning when lasting attitudes toward mathematics are developed. Although the intermediate grades (4 - 6) are most often mentioned as the place where attitudes develop, there is general agreement that definite measurable attitudes exist at the fourth grade level.

Sex Difference as a Factor in Attitude Toward and Achievement in Mathematics

In their study of attitude toward arithmetic Capps and Cox (1969) found that fourth grade girls' attitudes toward arithmetic were superior to boys' at the .05 level. Yet at the fifth grade level, boys' attitude scores increased while girls' decreased, leaving no significant difference. The authors concluded that some unknown and undetermined factors influence girls more strongly than boys in favorable attitude toward arithmetic at or before fourth grade.

In studying boys' and girls' preferences Mosher (1952) found that subject preferences by sexes grow progressively great in number as children reach different levels of maturity. He also found little difference in subject preferences with respect to urban, rural and mountain communities.
Jarvis (1964), in investigating boy-girl differences of more than 700 sixth grade students, found that boys are generally superior in arithmetic reasoning and girls in arithmetic fundamentals. He concluded, however, that "...the percentage of differences was not of significant magnitude to warrant any serious consideration (p. 659)." Cleveland and Bosworth (1967) studied 282 sixth grade students in three schools in Syracuse, New York and found no significant differences between the sexes in any aspect of arithmetic achievement. Wozencraft (1963) concludes his study of boy-girl differences in arithmetic with the statement:

"If any conclusions are to be drawn from these figures, they might be in respect to the necessity for a very broad program of work which allows pupils to work at their own levels' of ability. These considerations are of more value for the arithmetic program than sex differences (p. 490)."

Differences in sex seem to have no effect on mathematical skills learning. In one study sex has been found to be a significant factor in attitudes toward mathematics at the fourth grade level, although the differences were not significant at the fifth grade level.
The Teacher as a Factor in Attitude and Achievement in Mathematics

Stern (1963) commented that teacher attitudes are assumed to play a significant role in student learning, "...but direct evidence on this point is surprisingly meager (p. 424)."

Smail (1959) found no significant relationship between pupil-mean-gain in arithmetic and teachers' understanding of basic mathematical concepts. He also found that the number of courses completed by a teacher in higher mathematics was not related to pupil-mean-gain. He did, however, find pupil achievement was significantly related to the number of courses in methods of teaching arithmetic each teacher had completed. Cox (1970) agrees with these findings. In his study of 536 third and 469 sixth grade students and their teachers, he found pupil mean achievement in the areas of mathematics computation, concepts, and reasoning were not significantly affected by the teacher's knowledge of mathematics. He did find that a positive relation existed between teacher competence level and mean hours in mathematics methods courses.

Poffenberger and Norton (1959) commented that nearly half of the high school students in their study believed that their mathematics teachers had no effect on their attitudes toward the subject. The lack of
relationship between teacher and student attitude is further evidenced by Peskin (1964). In her study seventh grade students from nine New York City junior high schools and their teachers were tested. Teachers and students were evaluated on the basis of mathematical understanding and attitude. She found no significant relation between the teachers' attitude scores and the students' attitude or achievement scores.

Wess (1969), in his work with 22 teachers and their 535 pupils in grades two through six, found no significant relationships between teachers' attitudes toward mathematics and pupils' mathematics attitude and achievement test scores.

Caezza (1969) found no relationship between teacher attitude and grade level taught, total semester hours earned in mathematics, graduate semester hours earned in mathematics, college degree held and teacher knowledge of mathematical concepts. He further found, in his study of 104 teachers and 2,765 students in grades two through six, that teacher attitude in mathematics was not significantly related to pupil attitude or achievement. In addition, Caezza's correlation of student attitude and achievement was not significant.
Teachers' attitudes toward mathematics have been shown to have no significant effect on pupils' attitudes and achievement in the subject. The teachers' mathematical background, grade level taught, and degree are considered unrelated to student attitude and achievement, but methods courses are.

**Attitude and Achievement**

Fedon (1958) found a positive relationship between pupil attitudes towards and achievement in mathematics in third grade by using a unique method of relating the Dutton Attitude Scale to intensity of colors. He concluded that definite attitudes are expressed by children both for and against arithmetic as early as third grade.

Bassham, Murphy, and Murphy (1964) found that in their study of 159 elementary school students, "...over four times as many pupils with poor attitude toward arithmetic were classified as .65 grade below expected achievement as were classified as .65 grade above expected achievement (p.71)."

Lyda and Morse (1963) noted that it was possible to improve arithmetic achievement and attitude with meaningful teaching. In their study of fourth grade students they drew the following conclusions at the .05
level of confidence.

1. When meaningful methods of teaching arithmetic are used, changes in attitudes toward arithmetic take place. Negative attitudes become positive, and the intensity of positive attitudes becomes enhanced.

2. Associated with meaningful methods of teaching arithmetic and changes in attitude are significant gains in arithmetic achievement, that is, in arithmetical computation and reasoning. (p. 138)

Data on the relationship between attitude and achievement is inconclusive. While one large study shows no relationship, another utilizing only third grade students reports a positive relationship. Meaningful teaching has been proven to improve attitudes toward and achievement in mathematics.

**Teaching Method**

Wiebe (1966) found that a combination of teacher, programmed materials, and immediate reinforcement produced students superior in achievement compared to both programmed materials only and a combination of teacher, programmed materials, and delayed reinforcement significant at the .05 level. His work with low-achieving ninth grade students in a general mathematics class also showed no significant difference between the three groups in retention.

In Fisher's (1966) study of sixth grade mathematics he found that permitting students to work and progress
independently did not contribute significantly to their achievement. He also found no evidence that permitting students to evaluate their own work or a pupil's sex had a significant relationship to mathematics learning.

In a study with two fourth grade classes Bartel (1965) found students in an individualized mathematics program, who selected their own materials and topics for study, did not differ significantly in achievement from those in a traditional approach. She also found that children in the self selecting materials and topic class scored consistently higher than pupils in the traditional class on the concept test. This finding was significant beyond the .01 level.

In his comparison of individually prescribed instruction, programmed learning instruction, and standard classroom instruction Fisher (1967) found no significant differences among student arithmetic achievement as measured by standardized tests.

In their survey of current research pertaining to methods of teaching elementary school mathematics Glennon and Callahan (1968) maintain,

*There is very little valid and dependable evidence from studies with experimental
designs. Very few studies have been done and very few of those stand up under close scrutiny using the criterion of common sense (p. 9).

Several studies concerning individualized instruction have shown no significant differences in achievement as compared to traditional approaches (Wiebe, 1966; Fisher, 1966; Bartel, 1965; Fisher, 1967). In one instance self selection of materials and topic produced significant differences in concept knowledge (Bartel, 1965).

Immediate reinforcement, programmed materials, and teacher help proved superior to other methods in working with low-achieving ninth grade students.
CHAPTER III.

PROCEDURES

Community Description

In its most recent census the U.S. Department of Commerce (1970) described the village where this study took place as having a population of 68,543, with a mean family income of $19,108.00 and a median family income of $16,423.00. The median value of homes was listed as $36,713.00. In its Suburban Factbook (1973), The Northeastern Illinois Planning Commission listed 12,288 of the village's 15,831 private homes as valued at more than $25,000.00.

Student Sample

The sample in this study consisted of seventy-two fourth grade students in each of three public elementary schools.

The three schools were chosen for the following reasons:

1. similarity in size, socio-economic background, teachers' and administrators' experience;

2. willingness of administration and staff to participate in the study and learn from its results;
3. sufficient numbers of students and teachers in fourth grade (80 - 90 students and three teachers) to facilitate comparisons and meaningful statistical analyses.

**Teacher Sample**

Each of the nine teachers cooperating in the study had taught in his respective school and grade level for at least three years. The mean years of total teaching experience for the three School A teachers was 7.33, for the three School B teachers 7.66 and for the three School C teachers 6.33. More complete data on teachers is listed in Table 2.

**Instructional Strategies** (See Table 1)

Each of the schools included in the study had developed its own method of teaching the district's prescribed arithmetic curriculum. Each taught the content of *Elementary School Mathematics, Book 4* (Addison Wesley, 1964) in fourth grade (Table 3). The topics were studied in order of their appearance in Table 3. There was no specific time schedule for work on each concept throughout the district.

School A used the textbook in a semi-individualized method. All class members began their work in each textbook chapter at the same time. Major concepts were
<table>
<thead>
<tr>
<th>School A</th>
<th>Age</th>
<th>Years in Teaching</th>
<th>Years in Current Position</th>
<th>Highest Degree Held</th>
<th>Sex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher 1</td>
<td>40</td>
<td>14</td>
<td>7</td>
<td>M.S.</td>
<td>F</td>
</tr>
<tr>
<td>Teacher 2</td>
<td>31</td>
<td>4</td>
<td>4</td>
<td>B.A.</td>
<td>M</td>
</tr>
<tr>
<td>Teacher 3</td>
<td>25</td>
<td>4</td>
<td>4</td>
<td>M.A.</td>
<td>F</td>
</tr>
<tr>
<td>School B</td>
<td>Age</td>
<td>Years in Teaching</td>
<td>Years in Current Position</td>
<td>Highest Degree Held</td>
<td>Sex</td>
</tr>
<tr>
<td>Teacher 1</td>
<td>40</td>
<td>7</td>
<td>7</td>
<td>M.A.</td>
<td>F</td>
</tr>
<tr>
<td>Teacher 2</td>
<td>27</td>
<td>6</td>
<td>5</td>
<td>B.A.</td>
<td>F</td>
</tr>
<tr>
<td>Teacher 3</td>
<td>38</td>
<td>10</td>
<td>7</td>
<td>M.A.</td>
<td>F</td>
</tr>
<tr>
<td>School C</td>
<td>Age</td>
<td>Years in Teaching</td>
<td>Years in Current Position</td>
<td>Highest Degree Held</td>
<td>Sex</td>
</tr>
<tr>
<td>Teacher 1</td>
<td>26</td>
<td>5</td>
<td>5</td>
<td>M.A.</td>
<td>F</td>
</tr>
<tr>
<td>Teacher 2</td>
<td>31</td>
<td>6</td>
<td>4</td>
<td>B.A.</td>
<td>F</td>
</tr>
<tr>
<td>Teacher 3</td>
<td>29</td>
<td>8</td>
<td>3</td>
<td>B.A.</td>
<td>F</td>
</tr>
</tbody>
</table>
### TABLE 3
MATHEMATICS CURRICULUM

<table>
<thead>
<tr>
<th>1. Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Length</strong></td>
</tr>
<tr>
<td>arbitrary units</td>
</tr>
<tr>
<td>inches and centimeters to the nearest half-unit</td>
</tr>
<tr>
<td><strong>Area</strong></td>
</tr>
<tr>
<td>counting squares</td>
</tr>
<tr>
<td>approximation</td>
</tr>
<tr>
<td><strong>Volume</strong></td>
</tr>
<tr>
<td>counting cubes</td>
</tr>
<tr>
<td>liquid</td>
</tr>
<tr>
<td><strong>Perimeter</strong></td>
</tr>
<tr>
<td>of polygons</td>
</tr>
<tr>
<td>comparison with area</td>
</tr>
<tr>
<td><strong>Surface area</strong></td>
</tr>
<tr>
<td>of space figures</td>
</tr>
<tr>
<td>comparison with volume</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Place Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>General concept of</td>
</tr>
<tr>
<td>Reading of numbers through millions</td>
</tr>
<tr>
<td>Introduction of billions and trillions</td>
</tr>
<tr>
<td>Inequalities</td>
</tr>
<tr>
<td>Work problems</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3. Addition and Subtraction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sets</strong></td>
</tr>
<tr>
<td>Addition and subtraction concepts</td>
</tr>
<tr>
<td>Equations and solutions</td>
</tr>
<tr>
<td>Inverse relation</td>
</tr>
<tr>
<td>Number line</td>
</tr>
<tr>
<td>Basic principles</td>
</tr>
<tr>
<td>Facts through 18</td>
</tr>
<tr>
<td>Word problems</td>
</tr>
<tr>
<td>Use of the basic principles</td>
</tr>
<tr>
<td>Reasoning</td>
</tr>
<tr>
<td>Addition with carrying</td>
</tr>
<tr>
<td>Subtraction with borrowing</td>
</tr>
<tr>
<td>Work with dollar and decimal-point notation</td>
</tr>
</tbody>
</table>
TABLE 3 CONTINUED

MATHEMATICS CURRICULUM

4. Multiplication and Division

Multiplication and division concept
Number line
Repeated addition and repeated subtraction
Skip counting
Product sets
Facts through 81
Multiplication table
Basic principles
Inverse relation
Number of equivalent sets
Number in a set
Word Problems

5. Special Products and Quotients

Products that are multiples of 10, 100, and 1000
Related quotients
Use of the basic principles
Special attention to the multiplication-addition principle
A summary of the basic principles

6. Estimation

Estimating sums
Estimating differences
Estimating products
Estimating missing factors
Estimating quotients
Special attention to estimates leading to development of the division algorithm
Estimation in work problems

7. Multiplying

Use of the multiplication-addition principle
Estimation
Inequalities
Products involving factors with two, three, and four digits
Word problems
8. Dividing

Estimation
Inverse relation
Repeated subtraction
Inequalities
Reasoning
Long-division process (two-digit divisors)
Word problems
Averages

9. Number Theory

Even and odd numbers
Multiples and factors
Common factors and greatest common factors
Prime numbers
Clock (Modular) arithmetic

10. Fractions

Fractions and number pairs
Fractions and measurement
Fractions and segments
Fractions and sets
Fractions and parts of an object
Equivalent fractions
Sets of equivalent fractions
A check (definition) for equivalent fractions
Lower, higher, and lowest terms
Improper fractions
Mixed numerals
Word problems

11. Rational Numbers

Fractions and numbers
On the number line
Names for rational numbers
Equality of rational numbers
Inequalities for rational numbers
Rational numbers greater than one
TABLE 3 CONTINUED

MATHEMATICS CURRICULUM

<table>
<thead>
<tr>
<th>Mathematics Curriculum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Addition of rational numbers (intuitive)</td>
</tr>
<tr>
<td>Whole numbers and rational numbers</td>
</tr>
<tr>
<td>Use in linear measurement</td>
</tr>
<tr>
<td>Word problems</td>
</tr>
</tbody>
</table>

12. Geometry

<table>
<thead>
<tr>
<th>Geometry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sets of points</td>
</tr>
<tr>
<td>Parallel lines</td>
</tr>
<tr>
<td>Parallelograms</td>
</tr>
<tr>
<td>Right triangles</td>
</tr>
<tr>
<td>Polygons and diagonals</td>
</tr>
<tr>
<td>Cubes</td>
</tr>
<tr>
<td>Triangular pyramids</td>
</tr>
<tr>
<td>Central and inscribed angles</td>
</tr>
<tr>
<td>Triangles and circles</td>
</tr>
</tbody>
</table>
taught to the entire class. Students progressed through assigned pages in the text at their own rate.

Completed work was handed in and corrected by the teacher. Individual difficulties were resolved as the teacher met with the student whose work showed he needed added instruction. Whenever possible, small groups of students having similar problems were organized to work with the teacher.

When a student completed the assigned work before the majority of the class, he was given horizontal enrichment work. Tests were given each Friday on all concepts already studied by the entire class.

School B used a contract method of teaching resembling the Individually Prescribed Instruction System (Fisher, 1967) developed at the University of Pittsburgh. The various contracts, based upon sections of the textbook, included a variety of materials to master the prescribed content.

A diagnostic test was administered at the beginning of the school year to determine the student's placement in the various contracts. Each contract had an objective and a number of assignments, which may have included textbook, worksheets or audio-visual materials. There were optional assignments which were used at teacher
discretion. Movement from contract to contract was allowed by 90% mastery of the objective of the completed work. Student work was done individually, by a teacher lecture, in a small group, or on a one to one basis with the teachers.

School C was relatively traditional in its approach to teaching mathematics. Within each of the three heterogenous classes, children of similar ability were assigned to one of the three groups. Each group progressed through the text materials at a rate commensurate with the generalized abilities of its members. Work was checked by teachers, or by the students' exchanging or self-correcting papers as the answers are read or put on the chalkboard. While the teacher worked with one group, the other students worked independently on other classwork. Progress was assessed by the publisher's chapter tests. In future discussion the words school, group, or treatment may be used interchangably in describing the various programs.

All three groups had a daily 45 minute mathematics period between 10:30 and 11:15 A.M. during the 1973-1974 school year.

Data Collection and Analysis

Teachers were given the Purdue Teacher Opinionaire
(1964) to substantiate their similarities or differences. The opinionaire was completed by the participating teachers during the week of October 1, 1973. The opinionaire form was identified by school only. Results of the survey were determined by the investigators hand scoring of the answer sheets. Data were then graphed by the various factors (Table 4). The median scores of each treatment's teachers were compared to the national norms. From these data it was assumed the teachers were equal in teaching ability.

A series of t tests were made on the Stanford Arithmetic Test (1964) scores of the participating teachers' classes from the previous year to substantiate equality of student learning in the three classes within each individual building's program. The t tests for the previous year's achievement test scores yielded no significant difference, at the .05 level, between classes in the three buildings.

Pre and posttests of arithmetic achievement were administered during the weeks of October 8, 1973 and April 15, 1974, using Forms X and W respectively of the Stanford Arithmetic Test, Intermediate I (1964). The Stanford Test provided a set of three scores for each student in the areas of arithmetic computation,
# Table 4

## Purdue Teacher Opinionnaire Data

<table>
<thead>
<tr>
<th>NO.</th>
<th>Factors</th>
<th>Responses and Weights</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Teacher Rapport with Principal</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Satisfaction with Teaching</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Rapport Among Teachers</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Teacher Salary</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Teacher Load</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Curriculum Issues</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Teacher Status</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Community Support of Education</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>School Facilities and Services</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Community Pressures</td>
<td></td>
</tr>
</tbody>
</table>

### Keys: Item Median Profiles
- **A** = Agree
- **PA** = Probably Agree
- **D** = Disagree
- **PD** = Probably Disagree

1. **Norm Profiles**
   - 10th Percentile
   - 50th Percentile
   - 90th Percentile

2. **School A**

3. **School B**

4. **School C**
mathematics concepts, and mathematics applications. The Stanford Arithmetic Tests (1964) were given by homeroom teachers in accordance with the publisher's instructions listed in the test manual.

Student pretest responses were recorded on I.B.M. 805 answer sheets which were hand scored by the investigator using a stencil key. Posttest scores were those of the district wide achievement testing held the week of April 15, 1974.

Student I.Q. scores, as measured by the Lorge-Thorndike Intelligence Tests, Level 2 (1959), were determined on December 5th and 6th, 1973. Testing was done in homerooms by homeroom teachers in accordance with the publisher's instructions listed in the test manual.

Pre and posttests of attitude toward arithmetic using the Dutton Attitude Scale, Form C, Scale 5 were administered by homeroom teachers on October 16, 1973 and April 22, 1974. Individual mean pupil scores were then calculated by the researcher using an adding machine and an electronic calculator.

The student scores for each of the three areas tested by the Stanford Arithmetic Tests, Intermediate I (1964) were analyzed using an analysis of covariance,
covarying on pretest scores and I.Q. This procedure offsets the effects of initial student differences.

In addition, during analysis, student scores were blocked on two levels of attitude. Attitude scores were classified high or low on the basis of their position above or below the median score of 7.765 on the Dutton Attitude Scale, Form C, Scale 5.

Data were analyzed using the I.B.M. 360 Model 65 computer located at the Loyola University of Chicago's Medical Center campus by the General Linear Hypothesis Program (BMD05V) (1973). Adjusted means were compared using Duncan's New Multiple Range Test (Kirk, 1968, pp. 93-94).

The cognitive and affective areas, as measured by the Stanford Arithmetic Tests - Intermediate I (1964) and Dutton Attitude Scale, Form C, Scale 5 (1962) respectively, constituted the dependent variables.

The independent variables were the three treatments: Treatment A where the students progressed through each unit of study at their own rate, Treatment B where students worked individually on various concepts with differentiate assignments, and Treatment C where each class was taught in three groups determined by student ability. Sex had not been listed as a variable,
as each group contained 12 male and 12 female students.
CHAPTER IV.

FINDINGS OF THE STUDY

The results of the Stanford Arithmetic Tests, Intermediate I (1964) were used as the dependent variables to test Hypotheses 1, 3, and 5.

Hypothesis 1  There is no significant difference in mean arithmetic computation achievement scores among students taught via the three methods of instruction.

Hypothesis 3  There is no significant difference in mean mathematical concept acquisition achievement scores among students taught via the three methods of instruction.

Hypothesis 5  There is no significant difference in mean mathematical application skill scores among students taught via the three methods of instruction.

A summary of the Stanford Arithmetic Tests (1964) scores analysis is shown in Table 5. This table is made up of four sections. The first section depicts the arrangement of student cells. The data were blocked
by student attitude toward arithmetic as determined by the Dutton Attitude Scale, Form C, Scale 5 (1962). This blocking was necessary in order to compare pupil attitude as well as achievement.

The following three sections of the table summarize the analysis of the data generated in the areas of arithmetic computation, concept acquisition, and application skills. These sections of the table show various contrasts between the student groups.

All of the comparisons needed for the study were not generated by the computer analyses. The researcher found it necessary to utilize Duncan's New Multiple Range Test (Kirk, 1968, pp. 93-94) in some analyses. Results of these analyses are depicted in Tables 6 through 8.
TABLE 5
SUMMARY OF STANFORD ACHIEVEMENT TEST
SCORE ANALYSIS BLOCKED BY STUDENT ATTITUDE

<table>
<thead>
<tr>
<th>Arrangement of Student Cells</th>
<th>A&lt;sup&gt;a&lt;/sup&gt;</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Attitude</td>
<td>µ&lt;sub&gt;1&lt;/sub&gt;</td>
<td>µ&lt;sub&gt;2&lt;/sub&gt;</td>
<td>µ&lt;sub&gt;3&lt;/sub&gt;</td>
</tr>
<tr>
<td>Low Attitude</td>
<td>µ&lt;sub&gt;4&lt;/sub&gt;</td>
<td>µ&lt;sub&gt;5&lt;/sub&gt;</td>
<td>µ&lt;sub&gt;6&lt;/sub&gt;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Computation</th>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Contrast 1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1</td>
<td>212.44</td>
<td>212.44</td>
<td>7.37*</td>
</tr>
<tr>
<td></td>
<td>Contrast 2&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1</td>
<td>171.56</td>
<td>171.56</td>
<td>5.95*</td>
</tr>
<tr>
<td></td>
<td>Attitude</td>
<td>1</td>
<td>185.88</td>
<td>185.88</td>
<td>6.45*</td>
</tr>
<tr>
<td></td>
<td>Interaction</td>
<td>2</td>
<td>152.12</td>
<td>76.06</td>
<td>2.64</td>
</tr>
<tr>
<td></td>
<td>Error</td>
<td>208</td>
<td>5998.19</td>
<td>28.8</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> A = Treatment A; B = Treatment B; C = Treatment C

<sup>b</sup> Contrast 1 = µ<sub>A</sub> - µ<sub>B</sub> = 0

<sup>c</sup> Contrast 2 = \( \frac{µ<sub>A</sub> + µ<sub>B</sub>}{2} - µ<sub>C</sub> = 0 \)

*Value listed is significant at the .05 level.
### TABLE 5 - continued

SUMMARY OF STANFORD ACHIEVEMENT TEST
SCORE ANALYSIS BLOCKED BY STUDENT ATTITUDE

<table>
<thead>
<tr>
<th>Concepts</th>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Contrast 1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1</td>
<td>676.75</td>
<td>676.75</td>
<td>42.57*</td>
</tr>
<tr>
<td></td>
<td>Contrast 2&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1</td>
<td>2.0</td>
<td>2.0</td>
<td>.13</td>
</tr>
<tr>
<td></td>
<td>Attitude</td>
<td>1</td>
<td>29.12</td>
<td>29.12</td>
<td>1.83</td>
</tr>
<tr>
<td></td>
<td>Interaction</td>
<td>2</td>
<td>6.50</td>
<td>3.25</td>
<td>.20</td>
</tr>
<tr>
<td></td>
<td>Error</td>
<td>208</td>
<td>3306.69</td>
<td>15.90</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Application</th>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Contrast 1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1</td>
<td>93.19</td>
<td>93.19</td>
<td>5.70*</td>
</tr>
<tr>
<td></td>
<td>Contrast 2&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1</td>
<td>164.37</td>
<td>164.37</td>
<td>10.05*</td>
</tr>
<tr>
<td></td>
<td>Attitude</td>
<td>1</td>
<td>.44</td>
<td>.44</td>
<td>.03</td>
</tr>
<tr>
<td></td>
<td>Interaction</td>
<td>2</td>
<td>113.86</td>
<td>113.86</td>
<td>6.96*</td>
</tr>
<tr>
<td></td>
<td>Error</td>
<td>208</td>
<td>3401.56</td>
<td>16.35</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>A = Treatment A;  B = Treatment B;  C = Treatment C

<sup>b</sup>Contrast 1 = $\mu_A - \mu_B = 0$

<sup>c</sup>Contrast 2 = $\frac{\mu_A + \mu_B - \mu_C}{2} = 0$

*Value listed is significant at the .05 level.*
TABLE 6
RESULTS OF DUNCAN'S NEW MULTIPLE RANGE TEST - COMPUTATION

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Adjusted Mean Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>28.60</td>
</tr>
<tr>
<td>B</td>
<td>25.20</td>
</tr>
<tr>
<td>C</td>
<td>22.57</td>
</tr>
</tbody>
</table>

A > B at .05 level
B > C at .05 level
A > C at .05 level

*Ranges greater than 1.85 are significant at the .05 level.
### TABLE 7
RESULTS OF DUNCAN'S NEW MULTIPLE RANGE TEST - CONCEPT ACQUISITION

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Adjusted Mean Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>24.50</td>
</tr>
<tr>
<td>C</td>
<td>19.67</td>
</tr>
<tr>
<td>B</td>
<td>17.53</td>
</tr>
</tbody>
</table>

\[ A > C \text{ at .05 level} \]
\[ C > B \text{ at .05 level} \]
\[ A > B \text{ at .05 level} \]

*Ranges greater than 1.37 are significant at the .05 level.*
TABLE 8
RESULTS OF DUNCAN'S NEW MULTIPLE RANGE TEST - APPLICATION SKILLS

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Adjusted Mean Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>22.28</td>
</tr>
<tr>
<td>B</td>
<td>18.56</td>
</tr>
<tr>
<td>C</td>
<td>17.13</td>
</tr>
</tbody>
</table>

A > B at the .05 level
B > C at the .05 level
A > C at the .05 level

*Ranges greater than 1.39 are significant at the .05 level.
Arithmetic computation data using Duncan's New Multiple Range Test (Kirk, 1968, pp. 93-94) is depicted by Table 6. Treatment A, where students progressed through the same materials at varied rates, was significantly better, at the .05 level, than Treatment B, in which students progressed through teacher assigned materials at various rates. Treatment B was significantly better at the .05 level, than Treatment C, in which students were grouped by ability. This data rejects Hypothesis 1, as it shows significant differences among the three treatments.

In the area of mathematical concept acquisition, as shown in Table 7, Treatment A was once again found superior at the .05 level. Treatment C, however, was found superior to Treatment B at the same .05 level. These data reject Hypothesis 3 as they show significant differences between the three treatments.

The data in mathematical application skills, as illustrated in Table 8, continued to show Treatment A superior to the other methods at the .05 level of significance. Here Treatment B was found more successful than Treatment C at the .05 level (Table 7). These data reject Hypothesis 5, as they show significant differences among the three treatments.
F scores generated by the computer program (BMV05D) (1973), as depicted in Table 5, were used to test Hypotheses 2, 4, and 6.

**Hypothesis 2** The interaction effect of method of instruction and student attitude towards arithmetic on arithmetic computation is zero.

**Hypothesis 4** The interaction effect of method of instruction and student attitude toward arithmetic on mathematical concept acquisition is zero.

**Hypothesis 6** The interaction effect of method of instruction and student attitude toward arithmetic on mathematical application skills is zero.

Students whose attitude towards arithmetic were above the median on the posttest scores as shown in Table 5, scored significantly better at the .05 level in the area of mathematical computation. Thus, Hypothesis 2 must be rejected.

When students who were above the median in attitude towards arithmetic were compared to those below the median, there was no significant difference in the area of mathematical concept acquisition. Thus the data as
shown in Table 4 leaves no ground for the rejection of Hypothesis 4.

In the areas of mathematical application skills whether the students' attitude was above or below the median was not shown to be a significant factor. These data as depicted in Table 5 do not allow for the rejection of Hypothesis 6.

In all, Treatment A was shown to be significantly better than Treatments B and C in all of the areas tested by Hypotheses 1, 3, and 5. Treatment B was proved better at the .05 level than Treatment C in the areas of mathematical computation and application skills. In the area of mathematical concept acquisition Treatment C was found superior to Treatment B at the .05 level.

There was a significant interaction between attitude and application skills for Treatment B. This was the only significant interaction found in the study.
CHAPTER V.

CONCLUSIONS AND DISCUSSION

This research was designed to investigate the effects of three different methods of teaching mathematics in fourth grade. Students in each of three schools were evaluated in arithmetic computation, mathematical concept acquisition, and application skills. In addition, students were classified as either high or low in their attitude towards arithmetic. High and low attitude groups were then compared on the basis of the three skills areas tested.

Discussion of the effects of the method of instruction on these three cognitive areas and the relationship of attitude to achievement will focus on the original six hypotheses (pp. 2 and 5) and the limitations of this study (pp. 5 and 6). Tables 4 through 7 summarize the results of the statistical tests involving these hypotheses.

Mathematical Computation

Analysis of the mathematical computation data detected significant differences among all three of the groups involved in the study. The rejection of Hypothesis 1 might have been caused by several factors. Group A,
where students progressed at their own rate through assigned textbook work, scored significantly better than Groups B or C, had a review of computation skills at the end of each week. In addition, because of the teaching pattern, no children in Group A were held back in their progress by the remainder of a group such as was possible in the ability grouping of Group C. Students in Group B worked at their own pace through varied materials and it is possible that many members of the group were not exposed to some types of problems that Group A worked on as a group.

As children progressed through their work in Group B they moved from topic to topic without constant drill. Yet children in Group C, who were grouped by ability and given more drill work, did significantly poorer on the test, probably because of the areas tested that they never had an opportunity to study.

**Mathematical Computation and Attitude**

When the students of all three groups were blocked by attitude there was a significant difference between computation test scores of those students of high and low attitude towards mathematics. This rejection of Hypothesis 2 is possibly one caused by motivation. Students who enjoy doing arithmetic computation would
probably work with more care and not be in as great a hurry to complete their work.

**Mathematical Concept Acquisition**

Analysis of the mathematical concept acquisition data detected differences among all of the groups involved in the study. In Group A, which scored significantly better than the other two groups, mathematical concepts were taught to the whole class as it began each topic. Thus, all students were exposed to each of the concepts covered in their curriculum.

Group C scored significantly better than Group B. This might also be the result of group work. Because of the ability groups, each student was not exposed to every concept, but there was a great deal of group work on concepts. Group B, because of its individualized nature, did not provide for group work on concepts. It is possible, however, that some members of Group B learned concepts far in excess of those in the other groups.

**Mathematical Concept Acquisition and Attitude**

When the three groups were blocked by attitude there was no significant difference between students of high and low attitude towards arithmetic and
mathematical concept acquisition scores. Thus, Hypothesis 4 was not rejected. It appears that there is no relationship between how students feel about arithmetic and how well they learn mathematical concepts.

In Groups A and C, mathematical concepts were taught to groups of children. This procedure eliminated the need for students individual motivation for learning as all were taught at the same time. Mastery of the concepts was tested by the classroom teachers following the unit. In the third situation (Group B) the concepts were not stressed or taught in a group. Even those students who progressed at a rapid rate through the mathematics program had little opportunity to learn concepts.

In either situation the classification of high or low attitude towards arithmetic had no effect on how well the student learned mathematical concepts.

### Mathematical Application Skills

Analysis of the mathematical application skill data detected significant differences among all three of the groups involved in the study. This rejection of Hypothesis 5 might have been caused by the nature of the test itself. The computational skills the students were asked to use in applications are the same as were
measured by the computation test. In this case the student must compute as well as decide what skill is needed. In this test, Group A once again scored significantly better than Groups B or C. In similar fashion, Group B scored significantly better than Group C on computation.

In addition Group A worked on problems involving application skills in whole class groups, as part of its weekly reviews. Although Group B did no group work on application skills, contracts which dealt with applying acquired skills were a part of the basic curriculum. Group B did work on application skills in its ability groups, but some groups never studied all of the skills tested.

Mathematical Application Skills and Attitude

When the three groups were blocked by attitude there was no significant difference between students of high and low attitude towards arithmetic and mathematical application skills. Thus Hypothesis 6 was not rejected. It appears that there is no relationship between how students feel about arithmetic and how well they can apply mathematical skills.

The Dutton Attitude Scale, Form C, Scale 5 (1962), which was used to measure attitude towards arithmetic
measures only attitude towards computation. It is not sensitive to student attitude towards applying mathematic skills in solving problems. Perhaps another test more sensitive to applications would yield different results.

**Interactions**

The only significant interaction found in the study was found between attitude and application skills for Treatment B. The low attitude group scored higher than the high attitude group for Treatment B. It is also possible that because of the nature of Treatment B students with a high attitude towards arithmetic do not have good application skills because of a lack of group work in this area.

Group work could have given the students in Treatment B the opportunity to learn and practice the application skills as measured by the Stanford Arithmetic Tests (1964).

**Other Factors**

It also appears that other factors not previously mentioned might have had some effect on the outcomes of this study. Although all teachers involved in the study agreed to control the amount of time they taught mathematics, and the investigator met with them monthly
during the course of the project, each day it is possible there could have been variance in time allotments. The achievement test used is a commercially prepared one; it is also possible it did not measure all that was learned by students or that some teachers did not vary or rearrange their curriculums to have their students better prepared for the achievement tests.

This limited study looked at students' attitude toward and achievement in fourth grade mathematics. It did not attempt to concern itself with larger questions such as: How should we prepare teachers? How should we teach elementary school mathematics? Should mastery learning be emphasized? Should all children be exposed to important concepts? The researcher considers the preceding questions in what follows.

The question of teacher preparation is an interesting one. The two treatments which were most often found to be significantly better than the other one were treatments developed by the teachers who used them. Treatment A's varied pace textbook approach was found superior to the other two treatment in every cognitive test given. It was developed by a team of teachers in search of a better way to meet students' individual needs while covering the prescribed grade level mathematics.
curriculum.

Treatment B's approach, which dealt with individual students in assignments and concepts covered was also developed by the teachers who utilized it. This treatment was found better, at the .05 level, than the more traditional Treatment C in the areas of mathematical computation and application skills.

The ability grouping in Treatment C, which was found better than Treatment B in the area of mathematical concept acquisition, was the method which has been used by most of the teacher sample since they began teaching. They continued to use the system which had existed in the district prior to their employment.

This information clearly shows that in this study teacher interest in trying new methods has improved what the children in their classes learned. Although other factors could have altered some of the results, the less traditional approaches proved superior in all but one instance.

Teacher preparation institutions need to look at these kinds of data as they prepared their students to teach. The issue is not which method is better. Rather it is that various teaching methods do work and that students need the opportunity to see several approaches.
In this study, one treatment was shown to be superior to the others in the areas tested. The question of what teaching method is the best has not been answered. There are many areas, including teacher comfort with how they are teaching, which need to be considered. Another type test might also have given a different set of results. What seems important is a realization by educators that the one perfect method has not been found.

Treatment B's individualized approach did not allow a student to begin work on a new area of study until he earned a score of 90% or better on a test dealing with his current topic. This necessity for every student to have mastered each area he studied seems to have had an effect on the results of this study. This stress on mastery learning likely did not allow students to work on other concepts. They were kept from studying areas they might have easily grasped or been interested in.

**Recommendations**

As a result of this study certain recommendations were made to the participating teachers and administrators. Group B's individualized approach should be altered so that small discussion groups could be scheduled. The
small group sessions would give students working on the same mathematical processes the opportunity to discuss the basic concepts under teacher direction. It was hoped this action would increase student achievement in the area of mathematical concept acquisition achievement.

It was further recommended that Group C's ability grouping plan be looked at in light of the finding of this study. As this treatment produced student scores significantly inferior to the other two treatments, in two of the areas tested, it was suggested that an exchange of ideas with teachers who organized their instruction in another manner could prove fruitful.

Suggestions for Further Research

As a result of this study the following future studied might prove fruitful:

1. As this dissertation was limited to comparing high and low attitude across groups, a future study might consider attitude as it is affected by treatment in each group, or correlate attitude with achievement.

2. Another study could repeat this project using randomly selected groups of students and/or teachers.
3. A similar investigation might be undertaken to see whether more recently developed achievement tests yield similar results.

4. Some research could be done in comparing student self-concept (rather than attitude towards arithmetic) and teaching method.

5. A similar study might be run in a multi-age group to see if one method of instruction is superior in that organizational pattern.

6. Although this study attempted to equate teacher qualifications and proficiencies other studies might look at the effects of varying and controlling teacher abilities, attitudes, and classroom behavior.
APPENDIX A

THE DUTTON ATTITUDE SCALE, FORM C, SCALE 5
THE DUTTON ATTITUDE SCALE, FORM C, SCALE 2

The Dutton Attitude Scale was designed to measure an individual's feelings towards arithmetic. In preparation of the scale Dr. Dutton used the steps outlined by Thurstone (1959). Thurstone summarized the steps in the construction of an attitude scale as follows:

1. Specification of the attitude variable to be measured.
2. Collection of a wide variety of opinions relating to the specified attitude variable.
3. Editing this material for a list of about one hundred brief statements of opinion.
4. Sorting the statements into an imaginary scale representing the attitude variable. This should be done by about three hundred readers.
5. Calculation of the scale value of each statement.
6. Elimination of some statements by the criterion of ambiguity.
7. Elimination of some statements by the criterion of irrelevance.
8. Selection of a shorter list of about twenty statements evenly graduated along the scale (232).

Thurstone contended that, "The score for each person is the average scale value of all the statements he has endorsed (1959, p. 232).

The reliability of the Dutton Attitude Scale measured by the test-retest method was .94 (Dutton, 1962). The test has been validated through the concept of content validity. As Shaw and Wright (1967) contend, Content validity is specified by the procedure used in constructing Thurstone-type scales. Items are
selected on the basis of agreement among the judges regarding their content validity (p. 562).

The scale consists of 15 statements ranging in value from 1.0 (extreme dislike) to 10.5 (extreme liking). The students place a check mark in front of the statement on the scale that seems to best express their feelings toward arithmetic.

Following student testing the checked responses are assigned their appropriate numerical values and a mean score is calculated for each pupil.
A STUDY OF ATTITUDE TOWARD ARITHMETIC

W. H. Duttong
University of California, Los Angeles
Form C, Scale 5, 1962

Name ___________________________ Male____ Female____ Age____
Grade in school _________________ School________________

Read the statements below. Choose statements which show your feelings toward arithmetic. Let your experiences with this subject in the elementary school determine the marking of items.

Place a check ( ) before those statements which tell how you feel about arithmetic. Select only the items which express your true feelings --- probably not more than five items.

Scoring
Scale

3.2 _____ 1. I avoid arithmetic because I am not very good with figures.
8.1 _____ 2. Arithmetic is very interesting.
2.0 _____ 3. I am afraid of doing word problems.
2.5 _____ 4. I have always been afraid of arithmetic.
8.7 _____ 5. Working with numbers is fun.
1.0 _____ 6. I would rather do anything else than do arithmetic.
7.7 _____ 7. I like arithmetic because it is practical.
1.5 _____ 8. I have never liked arithmetic.
3.7 _____ 9. I don't feel sure of myself in arithmetic.
7.0 ____ 10. Sometimes I enjoy the challenge presented by an arithmetic problem.
5.2 ____ 11. I am completely indifferent to arithmetic.
9.5 ____ 12. I think about arithmetic problems outside of school and like to work them out.
10.5 ___ 13. Arithmetic thrills me and I like it better than any other subject.
5.6 ____ 14. I like arithmetic but I like other subjects just as well.
9.8 ____ 15. I never get tired to working with numbers.
APPENDIX B

THE PURDUE TEACHER OPINIONAIRE
THE PURDUE TEACHER OPINIONAIRE

Bentley and Rempel (1970) conceive morale..."as an effect related to the successful interaction among individual needs and incentive and organizational goals (p. 2)."

The Purdue Teacher Opinionaire was designed to provide a measure of teacher morale. It yields an overall score indicating teacher as well as individual scores in the ten areas of: (1) Teacher Rapport with Principal; (2) Satisfaction with Teaching; (3) Rapport Among Teachers; (4) Teacher Salary; (5) Teacher Load; (6) Curriculum Issues; (7) Teacher Status; (8) Community Support of Education; (9) School Facilities and Services; and (10) Community Pressures.

Preliminary Form of the Purdue Teacher Opinionaire

The first form of the opinionaire was developed in 1961 and contained 145 items which were grouped into the eight categories of teaching as an occupation, relationships with students, relationships with other teachers, administrative policies and procedures, relationships with community, curriculum factors, working conditions, and economic factors.

The instrument was administered to a large representative sample of high school teachers. The items
chosen for use in the opinionnaire were based on internal consistency item analysis techniques. The Kuder-Richardson internal consistency reliability coefficients for the eight categories ranged from .79 to .98, with an overall reliability coefficient of .96.

Peer judgments made by fellow teachers were used in validating the 145 item instrument. On the basis of these judgments, "high", "middle", and "low" teacher morale groups were defined. The instruments validity was calculated against the peer judgment criterion. Differences among the three groups were significant in the expected direction beyond the .05 level.

Revised Form of the Purdue Teacher Opinionaire

The revised form of the Purdue Teacher Opinionaire includes ten factors as described by Bentley and Remple (1970) as follows:

Factor 1 - "Teacher Rapport with Principal" deals with the teacher's feelings about the principal -- his professional competency, his interest in teachers and their work, his ability to communicate, and his skill in human relations.

Factor 2 - "Satisfaction with Teaching" pertains to teacher relationships with students and feelings of satisfaction with teaching. According to this factor, the high morale teacher loves to teach, feels competent in his job, enjoys his students, and believes in the future of teaching as an occupation.

Factor 3 - "Rapport Among Teachers" focuses on a teacher's relationships with other teachers. The items here solicit the teacher's opinion regarding the
cooperation, preparation, ethics, influence, interests, and competency of his peers.

Factor 4 - "Teacher Salary" pertains primarily to the teacher's feelings about salaries and salary policies. Are salaries based on teacher competency? Do they compare favorably with salaries in other school systems? Are salary policies administered fairly and justly, and do teachers participate in the development of these policies?

Factor 5 - "Teacher Load" deals with such matters as record-keeping, clerical work, "red tape", community demands on teacher time, extra-curricular load, and keeping up to date professionally.

Factor 6 - "Curriculum Issues" solicits teacher reactions to the adequacy of the school program in meeting student needs, in providing for individual differences, and in preparing students for effective citizenship.

Factor 7 - "Teacher Status" samples feelings about the prestige, security, and benefits afforded by teaching. Several of the items refer to the extent to which the teacher feels he is an accepted member of the community.

Factor 8 - "Community Support of Education" deals with the extent to which the community understands and is willing to support a sound educational program.

Factor 9 - "School Facilities and Services" has to do with the adequacy of facilities, supplies and equipment, and the efficiency of the procedures for obtaining materials and services.

Factor 10 - "Community Pressures" gives special attention to community expectations with respect to the teacher's personal standards, his participation in outside-school activities, and his freedom to discuss controversial issues in the classroom (p. 4).

The reliability of the revised form was established through administration to high school faculties with 20 or more teachers in Indiana and Oregon. Four weeks later the instrument was readministered in each of the 60 Indiana schools and 16 Oregon schools. The test-retest
data that were obtained for 3023 teachers were charted as follows (Bentley and Remple, 1970):

<table>
<thead>
<tr>
<th>Factor</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Teacher Rapport with Principal</td>
<td>.88</td>
</tr>
<tr>
<td>2. Satisfaction with Teaching</td>
<td>.84</td>
</tr>
<tr>
<td>3. Rapport Among Teachers</td>
<td>.80</td>
</tr>
<tr>
<td>4. Teacher Salary</td>
<td>.81</td>
</tr>
<tr>
<td>5. Teacher Load</td>
<td>.77</td>
</tr>
<tr>
<td>6. Curriculum Issues</td>
<td>.76</td>
</tr>
<tr>
<td>7. Teacher Status</td>
<td>.81</td>
</tr>
<tr>
<td>8. Community Support of Education</td>
<td>.78</td>
</tr>
<tr>
<td>9. School Facilities and Services</td>
<td>.80</td>
</tr>
<tr>
<td>10. Community Pressures</td>
<td>.62</td>
</tr>
<tr>
<td>Total Score</td>
<td>.87 (p.5)</td>
</tr>
</tbody>
</table>

**Administration**

The Purdue Teacher Opinionnaire is completed by the individual teachers at their leisure. No time limit is imposed although the authors assume the instrument can be completed in 20 to 30 minutes. In order to obtain valid and reliable data the instrument must remain strictly confidential.

Two options exist for responding to the Purdue Teacher Opinionnaire. When Form A is used the questions are answered directly on the test booklet by the teacher completing the task. The test booklets are then hand scored. When Form B is used the responses are recorded on specially prepared mark-sense IBM cards. Because of the limited size of the sample in this case Form A was used.
In both cases the teacher reads the questions and responds indicating whether she agrees, probably agrees, probably disagrees, or disagrees with each statement.

**Scoring**

When "A" agree is the keyed response, the weights for the items are A-4, PA-3, PD-2, D-1. When "D" disagree is the keyed response the weights for the items are: A-1, PA-2, PD-3, D-4.

The faculty morale of one school may be compared to that of another or of faculties in general by comparing the percentile distribution of item medians.
THE PURDUE TEACHER OPINIONAIRE

Prepared by Ralph R. Bentley and Averno M. Rempel

This instrument is designed to provide you the opportunity to express your opinions about your work as a teacher and various school problems in your particular school situation. There are no right or wrong responses, so do not hesitate to mark the statements frankly.

A separate answer sheet is furnished for your responses. Fill in the information requested on the answer sheet. You will notice that there is no place for your name. Please do not record your name. All responses will be strictly confidential and results will be reported by groups only. DO NOT OMIT ANY ITEMS.

DIRECTIONS FOR RECORDING RESPONSES ON ANSWER SHEET

Read each statement carefully. Then indicate whether you agree, probably agree, probably disagree, or disagree with each statement. Mark your answers on the separate answer sheet in the following manner:

If you agree with the statement, blacken the space................................. A PA PD D
If you are somewhat uncertain, but probably agree with the statement, blacken the space................................. A PA PD D
If you are somewhat uncertain, but probably disagree with the statement, blacken the space................................. A PA PD D
If you disagree with the statement, blacken the space................................. A PA PD D

All marks should be heavy and completely fill the answer space. If you change a response, erase the first mark completely. Make no stray marks on the answer sheet. Please do not mark this booklet.
1. Details, "red tape," and required reports absorb too much of my time. A PA PD D

2. The work of individual faculty members is appreciated and commended by our principal A PA PD D

3. Teachers feel free to criticize administrative policy at faculty meetings called by our principal A PA PD D

4. The faculty feels that their suggestions pertaining to salaries are adequately transmitted by the administration to the board of education. A PA PD D

5. Our principal shows favoritism in his relations with the teachers in our school A PA PD D

6. Teachers in this school are expected to do an unreasonable amount of record-keeping and clerical work. A PA PD D

7. My principal makes a real effort to maintain close contact with the faculty. A PA PD D

8. Community demands upon the teacher's time are unreasonable. A PA PD D

9. I am satisfied with the policies under which pay raises are granted. A PA PD D

10. My teaching load is greater than that of most of the other teachers in our school. A PA PD D

11. The extra-curricular load of the teachers in our school is unreasonable A PA PD D

12. Our principal's leadership in faculty meetings challenges and stimulates our professional growth A PA PD D

13. My teaching position gives me the social status in the community that I desire. A PA PD D

14. The number of hours a teacher must work is unreasonable A PA PD D

15. Teaching enables me to enjoy many of the material and cultural things I like A PA PD D

16. My school provides me with adequate classroom supplies and equipment. A PA PD D

17. Our school has a well-balanced curriculum A PA PD D

18. There is a great deal of griping, arguing, taking sides, and feuding among our teachers A PA PD D

19. Teaching gives me a great deal of personal satisfaction A PA PD D

20. The curriculum of our school makes reasonable provision for student individual differences A PA PD D

21. The procedures for obtaining materials and services are well defined and efficient A PA PD D

22. Generally, teachers in our school do not take advantage of one another A PA PD D

23. The teachers in our school cooperate with each other to achieve common, personal, and professional objectives A PA PD D

Continue with item 24 on next page
24. Teaching enables me to make my greatest contribution to society

25. The curriculum of our school is in need of major revisions

26. I love to teach

27. If I could plan my career again, I would choose teaching

28. Experienced faculty members accept new and younger members as colleagues

29. I would recommend teaching as an occupation to students of high scholastic ability

30. If I could earn as much money in another occupation, I would stop teaching

31. The school schedule places my classes at a disadvantage

32. Within the limits of financial resources, the school tries to follow a generous policy regarding fringe benefits, professional travel, professional study, etc.

33. My principal makes my work easier and more pleasant

34. Keeping up professionally is too much of a burden

35. Our community makes its teachers feel as though they are a real part of the community

36. Salary policies are administered with fairness and justice

37. Teaching affords me the security I want in an occupation

38. My school principal understands and recognizes good teaching procedures

39. Teachers clearly understand the policies governing salary increases

40. My classes are used as a "dumping ground" for problem students

41. The lines and methods of communication between teachers and the principal in our school are well developed and maintained

42. My teaching load in this school is unreasonable

43. My principal shows a real interest in my department

44. Our principal promotes a sense of belonging among the teachers in our school

45. My heavy teaching load unduly restricts my nonprofessional activities

46. I find my contacts with students, for the most part, highly satisfying and rewarding

47. I feel that I am an important part of this school system

48. The competency of the teachers in our school compares favorably with that of teachers in other schools with which I am familiar
49. My school provides the teachers with adequate audio-visual aids and projection equipment

50. I feel successful and competent in my present position

51. I enjoy working with student organizations, clubs, and societies

52. Our teaching staff is congenial to work with

53. My teaching associates are well prepared for their jobs

54. Our school faculty has a tendency to form into cliques

55. The teachers in our school work well together

56. I am at a disadvantage professionally because other teachers are better prepared to teach than I am

57. Our school provides adequate clerical services for the teachers

58. As far as I know, the other teachers think I am a good teacher

59. Library facilities and resources are adequate for the grade or subject area which I teach

60. The “stress and strain” resulting from teaching makes teaching undesirable for me

61. My principal is concerned with the problems of the faculty and handles these problems sympathetically

62. I do not hesitate to discuss any school problem with my principal

63. Teaching gives me the prestige I desire

64. My teaching job enables me to provide a satisfactory standard of living for my family

65. The salary schedule in our school adequately recognizes teacher competency

66. Most of the people in this community understand and appreciate good education

67. In my judgment, this community is a good place to raise a family

68. This community respects its teachers and treats them like professional persons

69. My principal acts as though he is interested in me and my problems

70. My school principal supervises rather than “snoopervises” the teachers in our school

71. It is difficult for teachers to gain acceptance by the people in this community

72. Teachers’ meetings as now conducted by our principal waste the time and energy of the staff

Continue with item 73 on next page
73. My principal has a reasonable understanding of the problems connected with my teaching assignment

74. I feel that my work is judged fairly by my principal.

75. Salaries paid in this school system compare favorably with salaries in other systems with which I am familiar.

76. Most of the actions of students irritate me.

77. The cooperativeness of teachers in our school helps make my work more enjoyable.

78. My students regard me with respect and seem to have confidence in my professional ability.

79. The purposes and objectives of the school cannot be achieved by the present curriculum.

80. The teachers in our school have a desirable influence on the values and attitudes of their students.

81. This community expects its teachers to meet unreasonable personal standards.

82. My students appreciate the help I give them with their school work.

83. To me there is no more challenging work than teaching.

84. Other teachers in our school are appreciative of my work.

85. As a teacher in this community, my nonprofessional activities outside of school are unduly restricted.

86. As a teacher, I think I am as competent as most other teachers.

87. The teachers with whom I work have high professional ethics.

88. Our school curriculum does a good job of preparing students to become enlightened and competent citizens.

89. I really enjoy working with my students.

90. The teachers in our school show a great deal of initiative and creativity in their teaching assignments.

91. Teachers in our community feel free to discuss controversial issues in their classes.

92. My principal tries to make me feel comfortable when he visits my classes.

93. My principal makes effective use of the individual teacher’s capacity and talent.

94. The people in this community, generally, have a sincere and wholehearted interest in the school system.
95. Teachers feel free to go to the principal about problems of personal and group welfare

96. This community supports ethical procedures regarding the appointment and reappointment of members of the teaching staff

97. This community is willing to support a good program of education

98. Our community expects the teachers to participate in too many social activities

99. Community pressures prevent me from doing my best as a teacher

100. I am well satisfied with my present teaching position
REFERENCES


Bassham, H., & Murphy, M., & Murphy, K. Attitude and achievement in arithmetic. The Arithmetic Teacher, 1964, 11, 66-72.


Caetza, J.F. A study of teacher experience, knowledge of and attitude toward mathematics and the relationship of these variables to elementary school pupils' attitudes toward and achievement in mathematics. (Doctoral dissertation, Syracuse University) Ann Arbor, Mich.: University Microfilms, 1969, No. 70-15, 228.

Capps, L.R., & Cox, L.S. Attitude toward arithmetic at the fourth and fifth-grade levels. The Arithmetic Teacher, 1969, 16, 215-220.

Chase, L.W. Subject preferences of fifth grade children. Elementary School Journal, 1949, 50, 204-211.


Wozencraft, M. Are boys better than girls in arithmetic. The Arithmetic Teacher, 1963, 10, 486-490.
Daniel Gilbert, born June 4, 1943 in Chicago, Illinois, received his elementary and secondary education in the public school system of Chicago. He received the Bachelor of Arts Degree from Northeastern Illinois University in 1965 and the Master of Arts Degree in Administration and Supervision from Roosevelt University in 1967.

He taught in the Chicago Public School System during the school year of 1965-66 and has for the last nine years been a teacher and team leader in the Jane Stenson School in Skokie, Illinois.
APPROVAL SHEET

The dissertation submitted by Daniel Gilbert has been read and approved by three members of the Department of Education.

The final copies have been examined by the director of the dissertation and the signature which appears below verifies the fact that any necessary changes have been incorporated, and that the dissertation is now given final approval with reference to content, form, and mechanical accuracy.

The dissertation is therefore accepted in partial fulfillment of the requirements for the Degree of Doctor of Education.

[Signature]

Date: Jan 10, 1975

Signature of Adviser