Subtraction - Whole Numbers When the Minuend Contains Fewer Units Than the Subtrahend

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SUBTRACTION -- WHOLE NUMBERS WHEN THE MINUEND CONTAINS FEWER UNITS THAN THE SUBTRAHEND

A Thesis
Presented to
the Graduate Faculty
Central Washington State College

In Partial Fulfillment
of the Requirements for the Degree
Master of Education

by
Naida Ruth Pino
August, 1968
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Ellensburg, Washington
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>The Problem</td>
<td>1</td>
</tr>
<tr>
<td>Difficulty in stating the problem</td>
<td>1</td>
</tr>
<tr>
<td>Statement of the problem</td>
<td>1</td>
</tr>
<tr>
<td>Importance of the study</td>
<td>2</td>
</tr>
<tr>
<td>Limitations of the study</td>
<td>3</td>
</tr>
<tr>
<td>Definitions of Terms Used</td>
<td>4</td>
</tr>
<tr>
<td>Subtraction</td>
<td>4</td>
</tr>
<tr>
<td>Minuend</td>
<td>4</td>
</tr>
<tr>
<td>Subtrahend</td>
<td>4</td>
</tr>
<tr>
<td>Difference</td>
<td>4</td>
</tr>
<tr>
<td>Complement</td>
<td>4</td>
</tr>
<tr>
<td>Methods of Subtraction</td>
<td>5</td>
</tr>
<tr>
<td>Compound subtraction</td>
<td>5</td>
</tr>
<tr>
<td>Take-away</td>
<td>5</td>
</tr>
<tr>
<td>Additive</td>
<td>5</td>
</tr>
<tr>
<td>Decomposition</td>
<td>5</td>
</tr>
<tr>
<td>Equal additions</td>
<td>6</td>
</tr>
<tr>
<td>Complementary</td>
<td>6</td>
</tr>
<tr>
<td>Organization and Procedure</td>
<td>6</td>
</tr>
<tr>
<td>Scope and procedures</td>
<td>6</td>
</tr>
<tr>
<td>Organization of the study</td>
<td>7</td>
</tr>
<tr>
<td>CHAPTER</td>
<td>PAGE</td>
</tr>
<tr>
<td>---------</td>
<td>------</td>
</tr>
<tr>
<td>II. REVIEW OF THE LITERATURE</td>
<td>8</td>
</tr>
<tr>
<td>Methods of Teaching Compound Subtraction</td>
<td>8</td>
</tr>
<tr>
<td>The decomposition method</td>
<td>8</td>
</tr>
<tr>
<td>The equal additions method</td>
<td>9</td>
</tr>
<tr>
<td>The Austrian method</td>
<td>10</td>
</tr>
<tr>
<td>The complementary method</td>
<td>11</td>
</tr>
<tr>
<td>The scratch method</td>
<td>12</td>
</tr>
<tr>
<td>The modern scratch method</td>
<td>12</td>
</tr>
<tr>
<td>Present Trends in Teaching Compound Subtraction</td>
<td>13</td>
</tr>
<tr>
<td>Research in Compound Subtraction</td>
<td>16</td>
</tr>
<tr>
<td>Explanation of the Tables</td>
<td>21</td>
</tr>
<tr>
<td>Summary of Chapter II</td>
<td>27</td>
</tr>
<tr>
<td>III. SURVEY OF TEACHER OPINION</td>
<td>28</td>
</tr>
<tr>
<td>IV. CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS</td>
<td>32</td>
</tr>
<tr>
<td>Conclusions</td>
<td>32</td>
</tr>
<tr>
<td>Implications and Recommendations</td>
<td>32</td>
</tr>
<tr>
<td>BIBLIOGRAPHY</td>
<td>35</td>
</tr>
<tr>
<td>APPENDIX A. Letter to Professors</td>
<td>43</td>
</tr>
<tr>
<td>APPENDIX B. A Survey of Teacher Opinion</td>
<td>44</td>
</tr>
</tbody>
</table>
# LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Methods of Compound Subtraction Explained in Teacher Textbooks</td>
<td>22</td>
</tr>
<tr>
<td>II. Curriculum Guides Summary</td>
<td>23</td>
</tr>
<tr>
<td>III. Lack of Uniformity in Terms Used in Subtraction in Children's Books</td>
<td>24</td>
</tr>
<tr>
<td>IV. Survey of Teacher Opinion on Compound Subtraction</td>
<td>29</td>
</tr>
</tbody>
</table>
CHAPTER I

INTRODUCTION

According to Raths, teachers today are concerned with adjusting the arithmetic curriculum to the child's needs. If children are to be encouraged to think, they should be helped to realize, that rather than one method of solving an arithmetic problem, there are several methods. It is the teacher's responsibility to provide for each child the method he can best understand and use. (41)

I. THE PROBLEM

Difficulty in stating the problem. In stating the problem, it was found that there is no definitive word to express the concept or procedure which was studied. The decomposition method of subtraction is generally referred to as borrowing although today such terms as regrouping or renaming are considered more accurate. None of these names apply to such methods as the equal additions or complementary methods.

Statement of the problem. A study was made on how subtraction is taught to elementary school children using the literature available including teacher texts, children's texts, curriculum guides, and research studies. The study
was confined to examples like 61 - 14, 11 - 7, 741 - 288, when the minuend contains fewer units in a given position than the subtrahend. Some of the methods studied were the decomposition method, the equal additions method, the Austrian method, and the complementary method. The purpose of the study was to answer the question: Which method or methods of teaching subtraction are being used in the elementary school today? An attempt also was made to answer the question: Why?

**Importance of the study.** When subtracting relatively large numbers, if the minuend contains fewer units in a given position than the subtrahend, as in the example 8264 - 3976, children may find it difficult to follow the reasoning applied with small numbers. Therefore, "it becomes necessary to develop an algorithm that will be easy to perform and that is mathematically sound" (40:67).

When discussing four methods of subtraction, Banks states, "The superiority of each method has been the subject of much debate, yielding more heat than light. Experimental evidence concerning their relative merits is inconclusive" (4:169).

The complementary method of subtraction, as explained by Banks, eliminates the use of thirty-six of the 100 basic subtraction facts and therefore was reviewed.
Dutton and Adams state that although the decomposition method of subtraction is the most widely used method at this time, it has alternated in popularity in past years with the equal additions method. They quote Ray's Arithmetic of 1845 as saying that the equal additions method "is the one generally used in practice; it is more convenient, and less liable to error, especially when the upper number contains one or more zeros" (15:62).

In a report on a survey of research in mathematics education in the years 1961-62, it was stated that several studies on the best method of teaching a particular skill or concept were made yielding inconclusive results. The article concludes,

There may be a very effective method for teaching certain pupils. Research has given little information on methods for different types of pupils. Until research gives us more information, no doubt, successful teachers will continue to use many methods in an attempt to clarify a mathematical concept (5:549).

The importance, then, of this study was to show teachers many methods of teaching subtraction.

**Limitations of the study.** Research materials available in the college library and teacher textbooks loaned to the researcher were used.

Only sixteen replies to the teacher opinion survey were received.
II. DEFINITIONS OF TERMS USED

Subtraction. Subtraction is the inverse operation of addition. It has three different interpretations. One is the comparison concept; "a - b" may be interpreted as how many more "a" is than "b". The second interpretation is the take-away concept; how many are left when "b" is taken from "a". The third meaning may be called the missing addend concept; "a" is wanted, we have "b", how many more are needed (4:163-64; 49:120). Subtraction in this paper may mean any or all of the three interpretations.

Minuend. The minuend is the number or quantity from which another is to be subtracted (4:164; 23:96).

Subtrahend. The subtrahend is the number or quantity to be subtracted from another (4:164; 23:96).

Difference. The difference (or remainder) is that which is left after subtraction (4:164; 23:96).

Complement. The complement of a number is the difference between the number and ten. The complement of nine is one, of eight is two, of seven is three, of six is four, of five is five, of four is six, of three is seven, of two is eight, of one is nine, and of zero is ten (4:175-76; 49:122).
III. METHODS OF SUBTRACTION

**Compound subtraction.** Compound subtraction is arbitrarily designated as the term which includes all methods of subtraction when the minuend contains fewer units in a given position than the subtrahend. As was previously explained, there is no generally used term to express this concept. However, this term was used in at least two sources (21:164; 42:63).

**Take-away.** Take-away is the process of eliminating an amount from the minuend. This may be stated as: seven take-away three, three from seven, seven less three, seven minus three (4:166; 25:100-01).

**Additive.** In the additive process one begins with the subtrahend and adds to it until the desired minuend is reached. This may be stated as: three plus _?_ equals seven (4:165, 167; 21:164-65).

**Decomposition.** Decomposition (or regrouping, renaming, or borrowing) is another process used in subtraction. Since a number may be expressed as the sum of its components in a variety of ways, the minuend is changed as is needed to provide enough digits of each order. For example, 837 may be changed to 800 + 20 + 17 or 700 + 120 + 17 (4:171; 21:164-65).
Equal additions. The equal additions process uses the fact that if the minuend and subtrahend are increased by the same amount, the remainder is unchanged. Therefore, ten of a given digit are added to the minuend and one of the next higher place is added to the subtrahend (4:171-72; 49:117).

The possible combinations of these methods are (1) take-away -- decomposition, (2) take-away -- equal additions, (3) additive -- decomposition, and (4) additive -- equal additions (23:100-02; 4:170).

Complementary. The complementary method is another process of subtraction. It capitalizes on the numeral ten. In order to find the difference in this method, the operator adds the complement of each digit in the subtrahend to the corresponding digit in the minuend and subtracts ten from the resulting sum. For example, when subtracting thirteen minus eight, instead of subtracting eight, add two to the three and subtract ten. (4:175-76; 49:122)

IV. ORGANIZATION AND PROCEDURE

Scope and procedure. Past and present methods of teaching subtraction, when the minuend contains fewer units in a given position than the subtrahend, were analyzed. Curriculum guides, children's texts, and teachers' texts were examined from the point where these methods are introduced to
children to their termination in the elementary grades. A survey of teacher opinion was also conducted. The results of these reviews were analyzed in verbal and numerical form, descriptions, and tables.

Organization of the study. The literature related to subtraction methods will be reviewed in Chapter II. Verbal and quantitative comparisons of the literature with summarizing tables will also be given.

Chapter III will be a discussion of a survey conducted at Central Washington State College among experienced teachers taking education classes during summer session and will include the results of this survey.

Chapter IV contains recommendations and conclusions of the study.
CHAPTER II

REVIEW OF THE LITERATURE

The literature reviewed explained the methods of teaching compound subtraction, surveyed current trends in teaching compound subtraction, and reported research studies in compound subtraction. A tabular review of subtraction methods explained in the literature and of subtraction terms used in the literature was presented at the end of the chapter.

Since there are many procedures by which such examples as 92 - 38 and 460 - 277 may be subtracted, there is some question as to the comparative values of the various methods.

I. METHODS OF TEACHING COMPOUND SUBTRACTION

The decomposition method. The decomposition method usually refers to the take-away decomposition method. Sometimes the additive form of decomposition is also taught with it.

Examples such as 14 - 7 and 17 - 8 are taught as part of the basic subtraction facts. When examples such as 23 - 6 are reached, the subtraction algorism is used. The twenty-three is expanded into 2 tens and 3 ones and then 1 ten is renamed 10 ones and added to the 3 ones making 13 ones. This
leaves 1 ten and 13 ones minus 6 ones. The ones are subtracted first as 13 - 6 = 7. As there are no tens to subtract, the answer is 1 ten and 7 ones or 17. This method is usually written as:

\[ \begin{array}{c}
9 \\
- 6 \\
\hline
17
\end{array} \]

A three digit compound subtraction example is regrouped or renamed in a like manner as in the example 732 - 584. The minuend is decomposed from 7 hundreds, 3 tens 2 ones, to 6 hundreds 12 tens 12 ones in two steps. First one of the 3 tens is changed to 10 ones and added to the 2 ones making 12 ones. Then one of the 7 hundreds is changed to 10 tens and added to the remaining 2 tens making 12 tens and leaving 6 hundreds. The subtraction can then be made as follows:

\[ \begin{array}{c}
732 \\
- 584 \\
\hline
148
\end{array} \]

The equal additions method. The equal additions method is the take-away equal additions method. In an example such as 73 - 27, 10 ones are added to the 3 ones in the minuend and 1 ten is added to the 2 tens in the subtrahend. The subtraction may then proceed as 13 ones minus 7 ones equals 6 ones and 7 tens minus 3 tens equals 4 tens which makes 46. This is usually written as:

\[ \begin{array}{c}
61212 \\
- 584 \\
\hline
148
\end{array} \]
In three digit compound subtraction if 10 tens are added to the minuend then 1 hundred is added to the subtrahend. For example:

\[
\begin{array}{c}
  \phantom{-}73 \\
- \phantom{0}27 \\
\hline
\phantom{-}46
\end{array}
\]

\[
\begin{array}{c}
  \phantom{-}7 \phantom{3} \phantom{5} \phantom{0} \\
- \phantom{0}3 \phantom{7} \phantom{6} \\
\hline
\phantom{-}1 \phantom{6} \phantom{4}
\end{array}
\]

The two mathematical principles involved are:

1. Adding the same number to both numbers of an example in subtraction does not change the value of the difference between the numbers.

2. Adding 10 to a digit on the right is the same as adding 1 to a digit one place to the left (21:165).

The **Austrian** method. The Austrian method is the additive equal additions method. It is like the more commonly used equal additions method except it used a different thought pattern. The thought pattern in the example which was given before, 73 - 27, after making the equal additions, is 7 ones and 6 ones are 13 ones, write 6; and 3 tens and 4 tens are 7 tens, write 4. It is written the same as the equal additions examples (21:164).
The complementary method. The complementary method has several variations depending on the source.

Banks' method uses complements of ten. The process to subtract 1726 minus 259 is as follows:

1. One is the complement of 9. Add 1 to 6, giving 7 in the ones digit. Since this is less than 10 we must subtract a ten from the tens digit.

2. Five is its own complement. Add 5 to 1 (we used 1 of the 2 in step 1.) giving 6 in the tens digit. Again we have less than ten so we must reduce the 7 in the hundreds place to a 6.

3. The complement of 2 is 8. Add 8 + 6 = 14. Here, since the sum is greater than 10, we subtract 10 from the sum, writing 4 in the hundreds place.

4. We can still apply the rule to the last digit. Zero has 10 for its complement. Add 10 to 1 and subtract 10, leaving 1 in thousands place. (4:175)

Banks also gives a variation of the complementary method in which the complement to nine of each digit of the subtrahend is added to the minuend. To subtract 7923 minus 5361, the operation is as follows:

1. 8 (the complement of 1) + 3 = 11. Write 1 and carry 1.

2. 3 (the complement of 6) + 2 + 1 (carried) = 6. Write 6.

3. 6 (the complement of 3) + 9 = 15. Write 5 and carry 1.

4. 4 (the complement of 5) + 7 + 1 (carried) = 12.

Now the highest digit, which must be a 1, is removed and added to the ones digit, giving 2562, the correct remainder (4:176).

Mueller says that the complementary method was once in frequent use in the United States and is still rather widely
used in Europe. To speed up the process he suggests subtracting in the subtrahend the units digit from ten and all the others from nine. The one at the left of the remainder is crossed off. This is the same as Banks' second method except that the ones digit is subtracted from ten instead of being subtracted from nine and then adding one to it at the end. (34:109)

Spitzer explains the complementary method the same as Mueller. He states, "This procedure is based on the fact that every power of ten minus one leaves all 9's. For example, 10 - 1 = 9, 100 - 1 = 99, and 10,000 - 1 = 9,999" (49:122).

**The scratch method.** The scratch method was an early method adapted from computations on the abacus. This method proceeds from left to right as follows:

Subtract 1726 - 259 = 1467.

1. 2 from 7, the 2 and 7 are canceled and 5 placed over the 7.
2. 5 from 52, leaves 47. The 5, the 2 above it, and the 5 in hundreds place are canceled.
3. 9 from 76. The 9, 7, and 6 are canceled, leaving 6 over the canceled 7 and 7 over the canceled 6.
4. Everything is now canceled except the remainder 1467 (4:175).

**The modern scratch method.** Neureiter advocates a "modern scratch method" which uses take-away decomposition but proceeds from left to right. He says the subtraction operation should be left to right as the inverse of addition
just as division is left to right as the inverse of multipli-
cation. In this method also the child may first use a crutch:

\[
\begin{array}{c}
73 \\
- 28 \\
45 \\
\end{array}
\]

The child thinks '7 minus 2, 5.' He writes down 5, but glancing to the next column on the right, he observes the upper digit is smaller than the lower, so he corrects 5 to 4. '13 minus 8, 5.' He has decomposed 5 tens into 4 tens plus 10 units and then added these units to 3 (36:278).

\[
\begin{array}{c}
13 \\
7\beta \\
- 28 \\
\ \ 45 \\
\ \ 4 \\
\end{array}
\]

With practice, the child gets into the habit of looking at the next column before writing anything down.

Another example is:

\[
\begin{array}{c}
5432 \\
- 1876 \\
3556 \\
\end{array}
\]

5 minus 1, 4; but in the next column the upper digit is smaller than the lower, therefore put down 3; 14 minus 8, 6; but 3 is smaller than 7, put down 5; 13 minus 7, 6; but 2 is smaller than 6, put down 5; 12 minus 6, 6 (36:279).

II. PRESENT TRENDS IN TEACHING COMPOUND SUBTRACTION

Which of these methods are being taught in the schools today? All of the children's text books surveyed use the decomposition method. It is called renaming, regrouping, borrowing, changing, or exchanging. Place value and expanded notation are stressed in teaching for meaning.

The curriculum guides surveyed also all advocate using the decomposition method. Only one mentioned any other method, the equal additions method, but stated the decomposition method is better understood by children (52:45).
How do individual teachers approach compound subtraction? To learn the harder subtraction facts, Mrs. Lane's second grade class at Wrights Mill School in Auburn, Alabama, is taught the commutative and associative properties of integers. This knowledge is applied in explaining the new subtraction facts using facts the children already know as is shown by this example:

$$14 - 5 = \boxed{9} = (10 + 4) - 5 = \boxed{9} = (4 + 10) - 5 = \boxed{9}$$

Another second grade teacher suggests deducting tens and then ones to find the answer in two digit compound subtraction. For example, to subtract 83 - 47, subtract four tens from 83 ones, 73--63--53--43; then from 43 ones subtract 7 ones, 42--41--40--39--38--37--36. Practice in deducting tens and ones is given before relating it to compound subtraction (44:611).

Using the decomposition method, in two digit subtraction the student must choose whether regrouping from tens to ones or no regrouping is necessary. However, three digit subtraction can call for no regrouping, regrouping from tens to ones, regrouping from hundreds to tens, or both regrouping from hundreds to tens and from tens to ones.
To give the students practice in deciding which regrouping is needed one teacher uses a game called the "Witch's Best" game. The teacher writes a three digit number on the board and then writes four ways the number is most often renamed. Such a number might be 352 with the four choices:

1. \(300 + 50 + 2\), 2. \(300 + 40 + 12\), 3. \(200 + 150 + 2\), 4. \(200 + 140 + 12\). Then the teacher writes a subtrahend below the number. Each student chooses the best renaming and indicates his choice by raising one, two, three or four fingers. Other subtrahends are used. Then a new number is chosen. This method brings immediate reinforcement and those having difficulty may be easily spotted (48:683).

Another teacher suggests three types of exercises to give practice in renaming numbers. These are:

1. expanded notation with blanks: \(524 = 500 + 20 + \_\_\_\_\_ \) or \(500 + 10 + \_\_\_\_\_ \) or \(400 + \_\_\_\_\_ + 14\);

2. choose the best way to rename as in the "Witch's Best" game previously explained;

3. which expanded form shows the way 500 has been renamed:

\[
\begin{array}{cccc}
4 & 9 & 10 \\
\_ & \_ & \_ & \_ \\
- & 2 & 3 & 4 \\
\end{array}
\]

400 + 10
400 + 9 + 10
400 + 90 + 10 (12:142)

One writer advocates using negative numbers for compound subtraction in the upper elementary grades after negative numbers have been introduced. A negative number would be written as a partial remainder wherever necessary. Then
the partial remainders are added according to the laws of negative numbers. Two examples are given:

\[
\begin{array}{cccc}
4 & 1 & 5 & 3 \\
- & 2 & 8 & 6 \\
\hline
2 & -7 & -1 & 2 = 2000 + (-700) + (-10) + 2 = 1292
\end{array}
\]

\[
\begin{array}{cccc}
8 & 0 & 3 & 0 \\
- & 2 & 5 & 0 \\
\hline
6 & 5 & 3 & 1 = 6000 + (-500) + 30 + (-1) = 5529
\end{array}
\]

III. RESEARCH IN COMPOUND SUBTRACTION

Why is the decomposition method so widely taught in the United States? Most research on subtraction in the early part of this century showed the equal additions and Austrian methods to be superior in both rate and accuracy when compared with the decomposition method (43).

Johnson published studies on subtraction in 1924, in 1931, and 1938. He used the differential testing technique rather than experiment-control groups. His subjects in the 1938 study ranged from grade three through grade eight plus a few adults. He concluded; on the basis of accuracy and rate of work, that the Austrian method is to be preferred, equal additions is as accurate but slower, and decomposition is the poorest (28).

Murray, like Johnson, made use of differential testing but reported separately data for children who were in the early stages of learning subtraction and those who were two years further along. In both groups decomposition was found
to be inferior in accuracy and rate. Equal additions was found to be the most accurate and was recommended for use throughout Scotland although the Austrian method was somewhat superior in speed (35).

In 1949 a study entitled Meaningful vs. Mechanical Learning: A Study in Grade III Subtraction by William Brownell and Harold E. Moser was published (9). This study tried to test understanding as well as speed and accuracy. Their study was considered to have been well done and the results were widely accepted and quoted as having proven the decomposition method is the best if one is concerned with teaching meaning (21:166; 15:63; 40:60).

Brownell and Moser state that most research up to their study in 1942 tested children and adults a long time after the learning period. Because of this, there was little known on the ease or difficulty of learning the various subtraction procedures. Also, this research was concerned only with rate and accuracy, and variations in methods of instruction as factors in learning were not controlled (9:22).

The Brownell and Moser study was done in the year 1942-43 and published in 1949. Its purpose was to compare the equal additions and the decomposition methods of subtraction. Approximately 1400 third-grade children were divided into four experimental sections: decomposition taught mechanically, decomposition taught rationally, equal
additions taught mechanically, and equal additions taught rationally. Accuracy, rate, smoothness of performance, and degree of understanding were measured.

The results indicated that the decomposition method is better when subtraction is taught meaningfully, while the equal additions method is better when subtraction is taught mechanically.

It was felt that the equal additions method is difficult to rationalize to third grade children because they have not had any experience with the principle that the difference between two numbers remains unchanged if the same amount is added to the subtrahend and the minuend (9:153).

An article by Rheins and Rheins quotes two London, England, authors who advocate teaching the equal additions method. They say the equal additions method "(a) produces fewer errors; (b) takes less time; (c) is less awkward to work with when the minuend has one or more zeros in it" (29).

The article reports on a study of compound subtraction comparing the decomposition and equal additions methods which the two Rheinses conducted with thirteen year old students. There was no significant difference between the two methods with the more intelligent groups, and with the less intelligent groups the decomposition method was superior. They recommend teaching the decomposition method (42:69).
Weaver criticizes the small sample used and the conclusions which were drawn in the study by Rheins and Rheins. He also describes and praises the research done by Brownell and Moser and urges that there be more research (55:17-20).

These two articles resulted in another reply by J. T. Johnson, whose earlier studies have been described. He disagrees with the conclusions reached in the Brownell and Moser study, and those reached in the two articles.

Johnson states that the equal additions method has been proven the best and that meaning is just as important in this method as in the decomposition method. He feels the reason teachers think the decomposition method is easier to explain meaningfully is because most of them were first taught this method (27:39-42).

One teacher suggests the equal additions method should be taught to upper elementary students "to shorten the time required for subtraction, to increase understanding of the process, and to give the student an appreciation of more than one way to accomplish the operation" (16:65).

Which should be stressed—understanding or speed and accuracy? Can meaning be overstressed?

A study was made in five junior high schools in Los Angeles to compare the "rule" method and the "meaning" method in all phases of arithmetic. The "meaning" method tested out favorably in most factors. It was suggested that more research is needed (32:45-49).
William Brownell, of the Brownell and Moser study, wrote an article urging that there should be a balance between understanding and computational competence. He lists four reasons to explain the lack of such balance in today's stress on meaningful teaching.

1. The possible failure of advocates of meaningful arithmetic to emphasize sufficiently the importance of practice in acquiring arithmetical skills;

2. Misinterpretations of psychological theories of learning which have had the effect of minimizing the place of practice;

3. The unwillingness of some teachers, who believe completely that arithmetic must be made intelligible to children, to provide the practice necessary for computational proficiency;

4. We may not as yet be doing a very good job in teaching arithmetical meanings as they should be taught (6:131).

He suggests the following remedy:

1. Accord to competence in computation its rightful place among the outcomes to be achieved through arithmetic;

2. Continue to teach essential arithmetical meanings, but make sure that these meanings are just that and that they contribute as they should to greater computational skill;

3. Base instruction on as complete data as are reasonably possible as they progress toward meaningful habituation;

4. Hold repetitive practice to a minimum until this ultimate stage has been achieved; then provide it in sufficient amount to assure real mastery of skills, real competence in computing accurately, quickly, and confidently (6:136).
IV. EXPLANATION OF THE TABLES

In order to give a concise picture of the review of the literature, the following results were tabled.

The methods of compound subtraction which are explained in the teacher textbooks are presented in Table I. Of ten teacher textbooks reviewed, all ten explained the decomposition method of compound subtraction. Nine of these books explained the equal additions method, three explained the complementary method, two the Austrian method, and one the scratch method. Only Learning and Teaching Arithmetic by Banks (4) explained all five of these methods.

The curriculum guides summary, Table II, shows that of the seven guides surveyed, 100 per cent used the decomposition method while just one, or 14 per cent, explained the equal additions method. The decomposition method was called borrowing in three, or 43 per cent, of the curriculum guides; changing in two, or 29 per cent, of the guides; and regrouping in one, or 14 per cent, of the guides reviewed.

The data with regard to terms used in subtraction in children's textbooks is presented in Table III. The fifteen children's textbooks surveyed all used only the decomposition method. However, this term appeared in none of the children's textbooks and in only one of the teacher edition books. Five other terms were used. Renaming was used in six, or
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**KEY:** Ch = Children's Textbook; T = Teacher Edition
40 per cent, of the children's books and in nine, or 60 per cent, of the teacher editions. Regrouping appeared in seven, or 47 per cent, of the children's books and in the corresponding teacher editions. Changing was the term used in five, or 33 per cent, of the children's books and in six, or 40 per cent, of the teacher editions. In one series the term exchanging was used while borrowing appeared in three, or 20 per cent, of the children's books and in six, or 40 per cent, of the teacher editions.

There was disagreement on other terms used in subtraction. The terms sum, addend, and addend were often used instead of minuend, subtrahend, and difference or remainder to show that subtraction is the inverse operation of addition.

Table III, page 24, indicates that the term sum was used in this respect in four, or 27 per cent, of the children's textbooks surveyed and in five, or 33 per cent, of the teacher editions. The term minuend was used in three, or 20 per cent, of the children's books and in four, or 27 per cent, of the teacher editions.

When referring to the number or quantity to be subtracted from another, addend was used in four, or 27 per cent, of the children's books and in five, or 33 per cent, of the teacher editions. Subtrahend appeared in three, or 20 per cent of both the children's and teacher edition books.
The amount remaining after the subtraction operation has taken place was called the addend in four, or 27 per cent, of the children's books and in five, or 33 per cent, of the teacher editions. Difference was used in eight, or 53 per cent, of the children's books and in seven, or 47 per cent, of the teacher editions. The term remainder appeared in one series.

Summary of Chapter II. Therefore, it is clear that a particular meaning in subtraction may be indicated by varying terms depending on the source.

While there are several methods by which compound subtraction may be taught and research studies do not agree on which method is best, the literature indicates most teachers are using the decomposition method.
CHAPTER III

SURVEY OF TEACHER OPINION

In order to discover which methods presented in the review of the literature teachers were practicing, a survey of elementary school teachers attending Central Washington State College was conducted. Only teachers who wanted to participate were selected.

A cover letter to professors of methods courses at Central Washington State College was distributed with the survey form. These forms then in turn were distributed to teachers. (See Appendix A.)

The form was kept simple. Questions included were: What subtraction method did you learn originally, regrouping, equal additions, other? Then an open ended question was added to determine their feelings about the effectiveness of the methods employed. (See Appendix B.)

Sixteen forms were returned to the researcher by the professors.

These teachers attended Central Washington State College during the summer session of 1968. The results of these forms were reported in Table IV.

The opinions of third grade teachers were wanted because compound subtraction is usually introduced in the third
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<th>Total Experience</th>
<th>Third Grade</th>
<th>Regrouping Learned</th>
<th>Equal Additions Learned</th>
<th>Other Method Learned</th>
<th>Originally</th>
<th>Prefer Regrouping Method</th>
<th>Regrouping Best For Fast Children</th>
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grade. Teaching experience of those responding to the survey varied from one to thirty years. Three teachers had never taught third grade. Six, or 38 per cent, of the teachers had taught third grade two-thirds year or one year. Seven teachers, or 44 per cent, had taught third grade from two to seven years.

All but one teacher had learned the regrouping method originally although three thought borrowing was another method. One teacher had learned the equal additions method originally.

Ten, or 63 per cent, of those responding indicated they prefer the regrouping method although two said it was the only method they knew. Seven, or 44 per cent, said the regrouping method was best for fast children; five, or 31 per cent, said it was best for average children; and two, or 13 per cent, said it was best for slow children.

The last was a minority opinion as six teachers, or 38 per cent, indicated the regrouping method is difficult for slow children to learn.

Two teachers said that children may make mistakes using the regrouping method if they forget they have regrouped.

Teachers suggested emphasizing place value, using expanded notation, checking work by addition, and proceeding slowly step by step in teaching regrouping.
One teacher stated that the teachers and principal in her school were dissatisfied with regrouping and while it is presented, borrowing is emphasized. Since these methods are the same, perhaps she meant the mechanical operation is stressed rather than an understanding of the operation.

One teacher said the reason for using regrouping was that there were less changes and fewer numbers to cross out than in equal additions. This seemed to indicate a lack of understanding of the equal additions process.

Another teacher had observed the abacus being used to subtract in Oriental schools and reported Oriental children subtracted with the abacus much more rapidly than children here could subtract with the regrouping process.

Several teachers mentioned regrouping could be taught with understanding. One teacher felt children should not be taught regrouping until they are ready which may not be in the third grade.
CHAPTER IV

CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

I. CONCLUSIONS

From the results of this study the following conclusions are drawn:

1. In the United States compound subtraction is being taught by the decomposition method.
2. Some authorities, such as J. T. Johnson, state that the equal additions method is better.
3. Teacher texts explain the equal additions method but recommend that the decomposition method be taught.
4. All but one of the teachers who responded to the opinion survey had learned the decomposition method originally.
5. There is a lack of uniformity of terms used in subtraction.

II. IMPLICATIONS AND RECOMMENDATIONS

It would seem that the reason compound subtraction is being taught by the decomposition method may be because of research, particularly that by Brownell and Moser (9), which indicated that the decomposition method is better for teaching
understanding of the process, and that most of the current
children's texts use the decomposition method.

Other authorities, such as Johnson (27; 28), disagree. They feel the equal additions method is better for speed and accuracy and may be taught with understanding as well. Some European countries, mainly England and Scotland, favor the equal additions method.

Brownell, in a later article (6), warns against over-emphasizing understanding without teaching computational competence.

It would also seem that many teachers in the United States learned the decomposition method originally and may only know this method. Perhaps this is another reason why they teach the decomposition method.

Teacher textbooks explain the equal additions method but add that the decomposition method is the preferred one to teach. Few of these books explain the other methods.

Curriculum guides and children's textbooks seem to mainly ignore other methods while stating the decomposition method should be used.

The survey of teacher opinion supports these conclusions. All but one of the teachers surveyed had learned the decomposition method originally, although three thought that borrowing was another method. Two stated it was the only method they knew.
There is a lack of uniformity in terms used in subtraction. While the term decomposition was generally used in the teacher textbooks, other terms are used in the curriculum guides and children's textbooks. These include regrouping, renaming, changing, exchanging, and borrowing.

As is indicated by Table III, page 24, there is also disagreement on other terms used in subtraction. Those who wished to emphasize that subtraction is the inverse of addition used the terms sum, addend, and addend. Others still use the terms subtrahend, minuend, and difference or remainder.

As was pointed out before, there is not a commonly used term for what has been called compound subtraction in this paper.

It is suggested that teachers should become aware of the various methods of performing the compound subtraction operation. Because of the differences in children, perhaps one method is not the best for all children. Those having difficulty with the decomposition method may be able to understand and work accurately another method.

Learning other methods may also be profitable for fast children who are bored with having to repeat the same operation frequently.
As several authors suggested, more research needs to be undertaken to find out if one method of teaching subtraction is superior to others. This presents many difficulties.

Nevertheless, it is felt that the question, "Which method is best?" should be kept open. Individual teachers, using more than one method for children where it seems advisable, may do much to add to the information now available.

Also, further study might perhaps be conducted to learn what methods of subtraction are being employed by college teachers who teach elementary arithmetic methods courses. This statement is made in light of what was found in the review of literature on college texts on teaching subtraction, mainly that some texts employ methods other than decomposition which was taught so prevalently in the children's materials.
BIBLIOGRAPHY


APPENDICES
APPENDIX A

LETTER TO PROFESSORS

Will you please take a few minutes Monday or Tuesday to give this survey to your class. Will you put the answered surveys in Mr. John Schwenker's mailbox by Tuesday evening. These will be used in a thesis I am writing comparing the various methods of teaching compound subtraction.

Thank you.

Naida Pino
APPENDIX B

A SURVEY OF TEACHER OPINION

COMPOUND SUBTRACTION

Examples:

Regrouping, renaming
borrowing, or decomposition method--

Equal additions
method--

\[
\begin{array}{ccc}
7 & 14 & 2 \times 10 \\
\hline
8 & \times & 3 \times 3 \\
- & 2 & 6 \\
\hline
5 & 8 & 1 \times 7 \\
\end{array}
\]

\[
\begin{array}{ccc}
14 & 10 & 10 \\
\hline
8 & \times & 3 \times 3 \\
- & 3 & 2 \times 6 \\
\hline
7 & 6 & 1 \times 3 \\
\hline
5 & 8 & 1 \times 7 \\
\end{array}
\]

What subtraction method did you learn originally?

Regrouping ____ Equal Addition ____ Other ____

Total years teaching experience _____

Total years teaching third grade _____

How do you feel about the regrouping method for teaching compound subtraction to third grade children? What are the positive and negative features of this method? Is there any difference in its effectiveness when teaching fast, average, and slow children? (Write on the back if necessary.)