1955

Transfer of learning in the study of percentage

Barnes, Earl Donald
Boston University

http://hdl.handle.net/2144/6710
Boston University
Boston University
School of Education

THESIS

TRANSFER OF LEARNING IN THE STUDY
OF PERCENTAGE

Submitted By
Earl Donald Barnes
Bachelor of Science University of New Hampshire
Durham New Hampshire 1950

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

1955
First Reader: J. Fred Weaver
   Associate Prof. of Education

Second Reader: Gilbert M. Wilson
   Assistant Prof. of Education
In preparing this paper the author has enjoyed several types of assistance which he is glad to acknowledge. He is grateful to Dr. J. Fred Weaver for his many helpful suggestions and expert assistance in editing the manuscript, and to Mrs. Caroline Catalfo, Mrs. Helen O'Connell, and Mr. James McShane for helping to carry through the academic program so essential to the success of this study.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. THE PROBLEM</td>
<td>1</td>
</tr>
<tr>
<td>STATEMENT OF THE PROBLEM</td>
<td>1</td>
</tr>
<tr>
<td>JUSTIFICATION FOR THE STUDY</td>
<td>1</td>
</tr>
<tr>
<td>SCOPE AND LIMITATIONS OF THE STUDY</td>
<td>2</td>
</tr>
<tr>
<td>II. REVIEW OF RELATED LITERATURE AND RESEARCH</td>
<td>3</td>
</tr>
<tr>
<td>III. PLAN AND PROCEDURE OF INVESTIGATION</td>
<td>19</td>
</tr>
<tr>
<td>IV. PRESENTATION, ANALYSIS, AND INTERPRETATION OF DATA</td>
<td>24</td>
</tr>
<tr>
<td>V. SUMMARY AND CONCLUSIONS</td>
<td>36</td>
</tr>
<tr>
<td>SUMMARY OF FINDINGS</td>
<td>36</td>
</tr>
<tr>
<td>CONCLUSIONS</td>
<td>36</td>
</tr>
<tr>
<td>LIMITATIONS</td>
<td>37</td>
</tr>
<tr>
<td>SUGGESTIONS FOR FURTHER STUDY</td>
<td>37</td>
</tr>
<tr>
<td>WORKS CITED</td>
<td>38</td>
</tr>
<tr>
<td>APPENDIX</td>
<td>40</td>
</tr>
</tbody>
</table>
CHAPTER I

THE PROBLEM AND ITS JUSTIFICATION

I THE PROBLEM

The purpose of this study was to determine the ability of 7th grade students to work with the three cases of percentage without direct instruction, when emphasis has been given to the comparable types of problems involving fractions and decimals.

II JUSTIFICATION

Relatively little research has been done on transfer of training in the field of arithmetic. No published research was found on transfer in the field of percentage.

Rosskopf tells us:

"There remains much experimental work to be done on transfer...Not only do we need to learn more about what is transferred but we need to experiment to see how transfer can be facilitated. But, and this is important for all teachers, experimental research indicates that transfer is a fact. How to make the percentage of transfer larger is a problem that every teacher recognizes and that every teacher works on in his own classroom."[1]

This study was undertaken to try to find the extent to which transfer of learning can be used effectively in one aspect of the work with percentage.

---

III  SCOPE

This experimental study was conducted with 140 seventh grade students. One class of 35 students was used as the experimental group, while students from three other classes containing a total of 105 students formed the matched control group. The study covered a period of four weeks.
CHAPTER II

LITERATURE AND RESEARCH ON TRANSFER OF TRAINING IN ARITHMETIC

The doctrine of formal discipline guided our schools for many years until the late 1800's. The idea of transfer of training in this philosophy presented very little problem whatsoever. All that man had to do was to train himself in the fundamentals like Latin, Mathematics, and Science, and he "magically" was able to transfer this knowledge to any other field. In these earlier days transfer of training held a seat of honor. It was inevitable that the doctrine of formal discipline was to be challenged as man progressed toward greater understanding of the learning process.

The pioneering in this field was led by William James. As early as 1890, William James showed that practice in one mental function had little effect on another mental function. He learned, in the course of eight days, 158 lines of Victor Hugo's SATYR. For the next 38 days, 20 minutes each day, James exercised his memory learning the first book of PARADISE LOST. At the end of his practice period, James came back to another 158 lines of SATYR. Instead of finding his memory working more rapidly, James found that it took him longer to learn the second 158 lines than it did the first.¹

This first break in doctrine of formal discipline was

followed by many others.

In 1901, Thorndike and Woodworth published three papers showing the extent to which the effect of training in estimating areas, lengths, and weights of a certain shape and size, spread to estimating areas, lengths, and weights similar in shape, but different in size, different in shape, but similar in size, and different in both shape and size.2

As a result of experiments such as these, which either showed no transfer or else much less than would have been previously expected, there was a common tendency on the part of psychologists and educators to swing from a belief in general transfer to a denial of any transfer.3

This change in attitude was summarized, as follows, by Knight and Setzafandt in 1924:

"Characteristics of the whole-or-none attitude of American thinking, when once our faith in general transfer was taken from us by competent research, notably the work of Thorndike, we went over, for some time, to the theory that there was no transfer whatever. We learned exactly what we practiced and nothing more. Addition of whole numbers was a skill developed by adding whole numbers; subtraction of whole numbers was a skill derived from subtraction of whole numbers. More specifically, adding 5 and 6 taught how to add 5 and 6, and nothing else." 4

---

2 E. L. Thorndike and R. S. Woodworth, The Influence of Improvement in One Mental Function upon the Efficiency of Other Functions. Psychological Review 8: p. 247-261; 1901

3 James Overman, "An Experimental Study of Certain Factors Affecting Transfer of Training in Arithmetic." Educational Psychological Monograph 29: 1931; p. 4.

With the doctrine of formal discipline destroyed, transfer of training was thus looked upon by many as something that did not exist.

This belief of all-or-none in transfer of training was not, however, shared by all. Thorndike, in 1913 said:

"The real question is not, Does improvement in one function alter others?, but, To what extent and how does it?" 5

"The notions of mental machinery which, being improved for one sort of data, held the improvement equally for all sorts of magic powers which, being trained by exercise of one sort to a high efficiency, held that efficiency whatever they might be exercised upon; and of the mind as a reservoir for potential energy which could be filled by any one activity and drawn on for any other------have now disappeared from expert writing on psychology. A survey of experimental results is now needed perhaps as much to prevent the opposite superstition; for apparently, some careless thinkers have rushed from the belief in totally general training to the belief that training is totally specialized." 6

Until the time of William James, little had been done on transfer. Once he questioned it, however, many followed in his footsteps.

The field of arithmetic was not excluded from the field of research, either to prove or disprove the doctrine of transfer of training. However, the amount of research done on transfer of training in the field of arithmetic is limited.

In 1910, Winch tried to determine whether improvement in accuracy of numerical computation would result in improvement

5 E. L. Thorndike, Educational Psychology II: (New York: Teachers College, Columbia University, 1913) p. 358

6 E. L. Thorndike, Ibid., p. 364-365
in arithmetical reasoning. On the basis of tests, pupils in four schools were divided into two groups. (One of these groups practiced working "rule sums.") The other group continued with their regular classroom work. After a specified time both groups were given a test on a series of problems designed to measure arithmetical reasoning. The test was scored only on the basis of right process. No attention was paid to the numerical answers. It was found that some sections of the control group did better than some sections of the experimental or practice group and vice-versa. The differences were small in all cases. The author concluded that it seemed possible to improve the accuracy of numerical computation without any certainty that we shall thereby improve the accuracy of arithmetical reasoning.\(^7\)

The results of this experiment at that time were, of course, generally accepted. This acceptance was not due to last for long.

In 1911, Starch conducted an experiment to obtain data on the transfer of training in the field of mental activities. The training consisted of mental multiplication with 3 digit multiplicands, and one digit multipliers. The experimental period covered fourteen days. Fifteen cases were used in the experiment. Of the fifteen original subjects, eight were chosen and given fourteen days of special training. Finally,

---

the whole group was given final tests. These tests consisted of many areas not included in the training. In the final testing, all calculations were done mentally. Eight tests were given to both groups and scores were compared. The tests consisted of:

1. Eight problems in adding fractions.
2. Eight problems in adding 2-place numbers.
3. Memory span of numbers.
4. Eight problems of subtracting 3-place numbers.
5. Eight problems of multiplying a 4-place number by one digit.
6. Memory span for words, using monosyllabic nouns of objects.
7. Eight problems of multiplying a 2-place number by one digit.
8. Eight problems of dividing a 3-place number by one digit.

From this, the percentages of gains were computed. The eight people taking special training showed from 20% to 40% more improvement than the unpracticed in ability to do other fundamental arithmetical operations. 8

These two studies seem to represent the major contributions in regard to transfer done in the early 1900's. Of course, the results of Starch's experiment were directly in

---

opposition to those of Winch.

In 1924 Knight and Setzafandt reported a study showing transfer of training within the narrow mental function of the addition of fractions. Two groups of pupils as nearly equated as possible, and just beginning the addition of fractions, were used. Both groups were given the same amount of practice in the addition of fractions; however, the practice material given to the two groups differed. The material given to Group A was so constructed that there was an even and thorough spread in the integers used as denominators. The numbers 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 15, 16, 18, 21, 24, 28, and 30, were present in the drill as denominators. Group B was given similar drill material with the exception that the numbers 3, 5, 7, 9, 14, 15, 18, 21, 28, and 30, did not appear at all in the drill material. The problem now was: How much does training in the addition of fractions involving the denominators 2, 4, 6, 8, 10, 12, 16, and 24, transfer to the ability of handling the addition of fractions in which 3, 5, 7, 9, 14, 15, 18, 21, 28, and 30 were used as denominators? The drill material consisted of ten exercises in addition, two exercises in the reduction of fractions, and one exercise in adding mixed numbers.

Following the period of instruction, both groups were tested. The test was made up of two parts. Part I was restricted to addition of fractions involving the denominators practiced by both groups; Part II included the denominators
practiced by Group A, but not by Group B. Test results showed that pupils work with unfamiliar denominators about as well as with familiar denominators. The following reason is apparently sound. The common denominator idea transfers from one group to another with great ease. The function is so narrow that transfer is automatic and practically complete. 9

Herbert T. Olander experimented on transfer in simple addition and subtraction, and brought out more pertinent information on the subject. The purpose of this investigation was two-fold.... (1) Does mastery of certain taught number combinations give mastery, likewise, over other untaught combinations?.... (2) Is a method employing a few minutes of generalization daily, more or less effective in promoting transfer, than a method which gives the same amount of time to drill?..... The problem of transfer from taught to untaught combinations was attacked in two ways:

1. Comparison of the scores of the children who were taught 200 combinations, with the children who were taught 100 combinations.

2. A comparison of scores of all children, on combinations that were taught, with the scores of the same children on combinations which were untaught.

The following conclusions were reached:

(1) A group of children who were taught 100 simple number combinations in addition and 100 simple number combinations in subtraction achieved no higher scores on all of the two hundred combinations than did a group of pupils who were taught only fifty-five combinations in each of the two processes.

(2) The ability gained by children on the fifty-five simple number combinations in addition and on the fifty-five simple combinations in subtraction, transferred almost completely to the forty-five remaining simple number combinations in each of the two processes.

(3) Between addition and subtraction little significant difference was found.

This work in transfer confirmed the fact that transfer was a field that required a great deal of further study. Most of this work, however, did nothing to help explain how transfer could be accomplished.

In 1930, Overman made one of the initial experiments to attempt an explanation of how transfer could be increased to a greater degree. The purpose of his investigation was to measure the effect of instruction given in three types of examples in 2-place addition upon the pupils' ability to handle closely related types in two and three place addition and subtraction. He also wanted to determine whether the amount of transfer is a function or method of teaching.

Teaching methods used consisted of:

(1) Helping the pupils generalize consciously, and formulate a general method of procedure applicable to related types,

(2) Rationalizing or considering the underlying principle, and,

(3) Combining generalization and rationalization.

The experiment was carried out in fifty-two second grade classes in Toledo, Findley, and Bowling Green, Ohio, during

the years, 1927-28, and 1928-29. Students were divided into four equal groups based on chronological age, IQ's and pretests. Four groups were created of 112 pupils each. Measurement of transfer was done on the basis of percentage of correct examples in the first and last test for two of the untaught types of examples and for all of the untaught types combined. The percentage of maximum possible transfer was used as the measure of transfer. This was obtained by dividing the number of examples to which the effects of the specific training spread, by the number to which it might have spread, had the transfer been complete. The most important results of this investigation may be summarized as follows:

(1) The effect of the instruction and practice given in certain specific types of examples was not confined to those types, but spread to related types. In the group taught by the more favorable method, the mean transfer was 72.4% of complete transfer, and the range of transfer was from 50.6-92.9%, on different types of examples.

(2) On the examples which involved the placing of addends having different number digits, Method B (generalization) increased the transfer by 45.1%, Method C (rationalization) by 15.5%, and Method D (generalization, and rationalization) by 36.9%.

This work done by Overman opened a new field for investigation, namely, how instruction could be so designed as to allow for the greatest possible transfer.

About this time Beito and Brueckner performed an experimental study to determine to what extent the teaching of the fundamental number combinations, in the direct order, transfers to the reverse order of that combination. This work was done with 93 second grade students and covered a period of three weeks. During this time, all number combinations were taught by the direct method, that is, to have the larger addend first and the smaller addend below it. Pretests were given on the reverse order every Monday, then all drill during the week was on direct order. On Friday, a two part test was given containing the direct order and reverse order of the combinations. Conclusions based on the data found in this experiment were as follows:

(1) When pupils of any mental level are taught only the direct form of an addition, combinations such as 7 plus 4, as nearly as can be, the reverse form, 4 plus 7, is learned concomitantly, at least as completely as the direct form.

(2) The bond formed in learning the direct form of an addition combination carries over almost completely to the reverse form.\(^{12}\)

McConnell's investigation in 1934 was carried on along similar lines to the experiment done by Overman. His investigation was a controlled experiment in the learning of the 100 basic addition facts and the 100 basic subtraction facts. This experiment was carried on in the second grade of selected

schools in Toledo, Ohio. It was particularly designed to reveal the relative effectiveness of two procedures of learning of these 200 facts. These two procedures are referred to as, "Method A", and "Method B." These methods were based on two different theories of learning. Method A was based primarily on repetitions or stimulus-response connections, authoritatively identified with no attempt to investing them with meaning; Method B, however, used the discovery or meaningful approach.

The experiment was carried on in Grade 2, with 1270 students taking part. Method A was used in teaching 653 of the students, while Method B was used in teaching 617 students. The two groups were equated, which left 441 cases in Group A and 428 cases in Group B. During the experiment, seven tests were given. Three were of the transfer type. All three tests on transfer favored the meaningful method of teaching (Group B). However, on only one of the tests was the difference enough to be statistically significant. Item analysis on the transfer tests revealed a large amount of transfer to the untaught processes for both groups.\(^\text{13}\)

Grossnickle's study in 1936, however, came up with quite some different conclusion as to transfer in certain arithmetical operations. This study was made to see if the ability to give the correct product to the multiplication facts would

transfer to the use of these facts in long division, when
the divisor is one digit number. No specific instruction was
given to the subjects. They were simply tested and the data
was used to see if transfer had taken place. Two separate
tests were given to 1075 students in grades 5 through 15.
The first test consisted of fifty multiplication facts which
were used in the division test. The second test was a divi-
sion test. In order to measure transfer, the relationship
between errors in multiplication in the multiplication test,
and errors in multiplication in the division test, were the
basis of comparison. From the results of this research,
Grossnickle found that:

(1) There were over twice as many incorrect
products given to the significant facts in the
division test as were given to the same facts in
the multiplication tests.

(2) There is only partial transfer of multipli-
cation facts to their usage in long division.

(3) There were over twice as many errors of
multiplication in division as there were, when
the multiplication facts were isolated.14

This study by Grossnickle indicated that very little
transfer took place in that particular experiment. Ethel
Kortage has what may be a partial explanation for the results
of that experiment. She said:

"To me, transfer is not automatic, but depends
upon a deliberate attempt to interpret new

14 F. E. Grossnickle, "Transfer of Knowledge of Multiplica-
tion Facts to their use in Long Division." Journal of
Educational Research, No. 29, pp. 677-685 (May, 1936)
situations in the light of past experiences; one might say that if there is to be transfer, there must be teaching for transfer." 15

Brownell, Moser, and others conducted an experiment on the effect of mechanical versus meaningful learning, using approximately 1400 third graders. These 1400 children were divided among three instructional centers called A, B, and C. Half of the classes in each center learned borrowing in subtraction by decomposition (D), and half by equal addends (EA). Each of these groups was divided into meaningful or rational (R) learning, and mechanical (M) learning. Thus were developed four groups: DM (decomposition mechanically), DR (decomposition rationally), EAR (Equal addends rationally), and EAM (equal addends mechanically). Students were taught "borrowing" in subtraction using these four methods. Some of the tests given during this experiment were on material that had not been taught during the instructional period. This was done to measure transfer. Tabulation of these results revealed the vast superiority of DR Group making transfer to untaught material. The mean of the DR group was superior to the three other sections means by highly significant amounts.16

In 1949, Swenson carried on an investigation to study learning transfer of training and retroactive inhibition as

they appeared in the learning of 100 addition facts. Three hundred thirty-two second grade students were involved in the experiment. Three different methods of teaching were used and are described:

(1) The generalization method.
(2) The drill method.
(3) The drill plus method.

Following an experimental period of 20 weeks a series of tests were given. Three of these tests were on untaught material: Test (1), on 100 untaught subtraction facts; test (2), on 100 decade facts where one addend was a 2 digit number and the other addend a one digit number; and test (3), a variety of addition situations, such as those with and without carrying and bridging. The following conclusions were arrived at through this experiment. Most transfer to untaught addition facts occurred from groups taught to organize addition facts around number generalizations. The intermediate position in amount of transfer was held by groups who learned addition facts organized by size of sum, and the least transfer occurred in the drill groups.\(^{17}\)

As recently as last year, Vlass conducted an investigation in which transfer was again demonstrated. Her study was to determine whether a significant amount of transfer takes place when students are given specific instruction in

certain aspects of work with common fractions. (Instruction was given in halves, thirds, and fourths, and then the students were tested on the fractions, fifths, sixths, and eighths.) Significant gains were found on the basis of pre-test and end test results.\(^{18}\)

Through the reported research, it is revealed that the point of view regarding transfer of training has almost made a complete cycle. Transfer of training has gone through two complete stages....the first being that of its magical era when it served as a basis of formal discipline....secondly, the era of total obscurity, when transfer was thought to be a thing that existed not at all. Where it stands now, is well expressed in the words of J. R. Overman:

"At the present time we are entering upon the third stage, that of critical evaluation. Later experiments, together with a more careful interpretation of the results obtained by the early workers in the field have shown that belief in the total absence of all transfer is just as false as the earlier belief in complete and magical spread." \(^{19}\)

The "critical evaluation" stage has made some progress, but it is far from complete. P. T. Orata, a leading student of transfer of training, following a recent study of results of experimental research, writes:

"First, transfer is a fact, as revealed by


nearly eighty percent of the studies, second, transfer is not an automatic process that can be taken for granted, but it is to be worked for, and third, the amount of transfer is conditioned by many factors, among which are: age, mental ability; (possibly) time interval between learning and transfer; degree of stability attained by the learned pattern; knowledge of directions; favorable attitude toward the learning situation and efficient use of past experience; accuracy of learning; conscious acceptance by the learner of methods, procedures, principles, sentiments, and ideals; meaningfulness of the learning situation; the personality of the subject—greater transfer in extroverts than introverts; methods of study; suitable organization of subject matter presentation; and provision for continuous reconstruction of experiences.

CHAPTER III

PLAN AND PROCEDURE OF INVESTIGATION

The purpose of this investigation was to determine the extent to which students were able to apply their ability to work with the three types of problems involving common fractions and decimal fractions, to these same types of problems involving percentage.

Four seventh grade classes, commencing the study of percentage, were used in this experiment. The experimental period covered a period of four weeks. The four classes were divided into two groups, one an experimental group and one a control group.

The following was the procedure used:

I. The Control Group

The control group was made up of pupils from three classes with approximately 105 students. The teachers of these three classes were most cooperative in using the prescribed procedure.

A. First Week

An understanding of what is meant by percentage and its relationship to common and decimal fractions.

B. Second Week

Finding the percent of a number. Eg: $10\%$ of 50.

C. Third Week

Finding what percent one number is of another.
Eg: 4 is what % of 8.

D. Fourth Week

Finding a whole when a percent is given. Eg: 4 is 50% of what number.

No directions were given as to method of instruction or amount of drill. The only restriction was that the allotted time of one week be spent on each of the above phases of instruction.

II. The Experimental Group

The experimental group consisted of one class of 38 pupils. This group was given a specific type of instruction during the four week experimental period.

A. First Week

Finding decimal fractional and common fractional parts of numbers. The week was quite evenly divided into work with common and decimal fractions. Worksheets prepared by the investigator were used each week of the experiment. Worksheets for the first week consisted of finding fractional parts of numbers, such as \( \frac{1}{4} \) of 24. It also included determining the decimal parts of numbers, such as .25 of 24. Worksheets consisting of the following material of a semi-concrete nature were used.

1. Shade as nearly as possible,

1/5 of this 2/3 of this 1/4 of this
2. Shade:

\[
\begin{array}{ccc}
0000000000 & 0000000000 & 0000000000 \\
1/5 of these & 1/4 of these & 3/4 of these \\
00000000 & 00000000 & 0000 \\
00000000 & 00 & \\
.25 of these & .2 of these & .75 of these
\end{array}
\]

3. Show by diagram that the following examples are true:

\[
1/4 of 12 = 3 \\
.20 of 20 = 4
\]

All work sheets were corrected in class and students were encouraged to try to prove all answers by diagraming and rationalization.

B. Second Week

Finding what fractional and decimal part one number is of another. Worksheets were used, and consisted of examples and semi-concrete problems. Examples were patterned as follows:

4 is what fractional part of 40
2 is how many tenths of 4
9 is how many hundredths of 12

Semi-concrete material consisted of the following types:
1. What fractional part of the whole are the shaded pieces?

\[ \begin{align*}
&\cdot000 \\
&\cdot\cdot000 \\
&\cdot\cdot\cdot000
\end{align*} \]

2. What decimal part of the whole are the shaded pieces?

\[ \begin{align*}
&\cdot0000 \\
&\cdot\cdot00 \\
&\cdot\cdot\cdot00 \\
&\cdot\cdot\cdot\cdot00
\end{align*} \]

C. Third Week

Finding the whole, when a decimal or fractional part is known. Worksheets for this week contained the work types as follows:

Examples:

- 17 is \(\frac{1}{4}\) of what number
- .25 of what number is 20
- .7 of what number is 21

Semi-concrete material:

1. Show by diagram the following:

- 3 is \(\frac{1}{4}\) of what number

- .5 of what number is 51

2. Complete the following by drawing in the proper
number of circles:

000 = 1/4 of a group of __________
0 = 1/2 of a group of __________
0000 = 2/3 of a group of __________
0000 = .4 of a group of __________
00000 = .50 of a group of __________

D. Fourth Week

This week was the same as the first week of the control group. The meaning of percentage, and its relationship to decimal fractions, and common fractions was taught. Worksheets contained material concerning only the relationship of percentage to decimal fractions and common fractions, and no work was done with the uses of percentage in the example or semi-concrete form.

III. At the end of this four week period, all groups were given a test made by the investigator covering the relationship of common fractions, decimal fractions and percents, and the three types of problems found in percentage. This test can be found in the appendix on pages 40 and 41.
CHAPTER IV

PRESENTATION, ANALYSIS, AND INTERPRETATION OF DATA

In order to determine the effect of the type of instruction given, a test was constructed in percentage. The test consisted of three parts: Section I, 16 items on the inter-relationships of fractions, decimals, and percents; Section II, 20 examples in each of the three cases involving percent; Section III, 6 problems involving the three cases of percents. The total possible score on the test was 42 points. The test was administered to all four classes, three classes in the control group and one class designated as the experimental group.

Of the original 35 students in the experimental groups, only 28 test scores were used. Because of prolonged absenteeism, four students missed more than half of the instruction and three students were doing special work. These 28 students from the experimental group were matched, as nearly as possible, with 28 students taken from the other 3 control groups. The basis for the matched pairs was on IQ's and Arithmetic Grade Placement, as obtained from the California Test of Mental Maturity and the California Achievement Test.

Table I shows the 28 matched pairs with their IQ's and Grade Placements. On all Tables E stands for the experimental group and C stands for the control group.
Table I

Table of Pairs

<table>
<thead>
<tr>
<th>Pairs</th>
<th>IQ $^1$</th>
<th>IQ $^2$</th>
<th>E</th>
<th>C</th>
<th>AGP $^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>137</td>
<td>133</td>
<td>8.8</td>
<td>8.7</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>137</td>
<td>130</td>
<td>9.5</td>
<td>9.0</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>125</td>
<td>124</td>
<td>8.3</td>
<td>8.6</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>120</td>
<td>125</td>
<td>8.2</td>
<td>8.1</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>122</td>
<td>122</td>
<td>8.2</td>
<td>8.0</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>118</td>
<td>118</td>
<td>6.3</td>
<td>6.3</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>117</td>
<td>116</td>
<td>7.6</td>
<td>7.7</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>116</td>
<td>114</td>
<td>8.0</td>
<td>8.0</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>116</td>
<td>115</td>
<td>7.0</td>
<td>6.8</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>116</td>
<td>115</td>
<td>7.6</td>
<td>7.5</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>115</td>
<td>113</td>
<td>7.0</td>
<td>6.9</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>112</td>
<td>113</td>
<td>8.0</td>
<td>8.0</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>111</td>
<td>114</td>
<td>6.4</td>
<td>6.7</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>110</td>
<td>110</td>
<td>8.1</td>
<td>7.9</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>106</td>
<td>105</td>
<td>7.5</td>
<td>7.5</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>106</td>
<td>107</td>
<td>7.6</td>
<td>7.5</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>105</td>
<td>105</td>
<td>5.4</td>
<td>5.4</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>105</td>
<td>103</td>
<td>8.0</td>
<td>8.2</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>105</td>
<td>107</td>
<td>5.6</td>
<td>5.8</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>101</td>
<td>102</td>
<td>5.9</td>
<td>6.0</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>101</td>
<td>102</td>
<td>6.3</td>
<td>6.3</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>101</td>
<td>101</td>
<td>7.0</td>
<td>7.0</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>98</td>
<td>97</td>
<td>5.9</td>
<td>5.9</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>95</td>
<td>97</td>
<td>6.9</td>
<td>6.7</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>94</td>
<td>93</td>
<td>6.9</td>
<td>6.8</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>93</td>
<td>95</td>
<td>6.5</td>
<td>6.5</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>82</td>
<td>83</td>
<td>5.6</td>
<td>5.6</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>75</td>
<td>77</td>
<td>5.9</td>
<td>5.9</td>
<td></td>
</tr>
</tbody>
</table>

IQ $^1$  | 108.54  | 108.47  | M = 7.11 | M = 7.14 |
S.D. $^1$ | 13.88   | 12.85   | S.D. = 1.1 | S.D. = 1.1 |

1 = Experimental Group
2 = Control Group
3 = Arithmetic Grade Placement
Table II shows the total test scores received by each pupil in both groups, and the difference in total test score for each of the 28 matched pairs. The total score in each case is equal to the number of questions answered correctly, the maximum possible score being 42.

The mean test score for the E-group equals 28.71, while the mean score for the C-group equals 27.42.

For differences between the means to be significant when \( df = N-1 = 27 \), \( t \) must equal 2.05 at the 5% level or \( t \) must equal 2.77 at the 1% level. The t-ratio of .76 based on the difference between the means of the total test scores for the two groups was not significant statistically.

The relationship between the total test scores for the matched pairs was determined by computing the coefficient of correlation using the relevant data from Table II. For \( df = N-2 = 26 \), \( r \) must equal .374 at the 5% level or \( r \) must equal .478 at the 1% level. The \( r \) was found to be .656 which is significant beyond the 1% level and indicates a marked relationship between the test scores for the two groups.

Table III presents the distribution of scores for both groups in a form which supplements Table II. The range of scores of the control group was from 3 to 42, and the range of scores of the experimental group was from 12 to 41. It might be pointed out that four scores in the control group were 9 or below, while the lowest score in the experimental group was 12, received by only one student. Although the slower
students in the experimental group did not score highly on the test, they did score much better than the slower students in the control group.
Table II
Total Test Scores

<table>
<thead>
<tr>
<th>Pairs</th>
<th>E</th>
<th>C</th>
<th>Diff: E-C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>40</td>
<td>40</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>41</td>
<td>39</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>39</td>
<td>39</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>29</td>
<td>42</td>
<td>-13</td>
</tr>
<tr>
<td>5</td>
<td>33</td>
<td>40</td>
<td>-7</td>
</tr>
<tr>
<td>6</td>
<td>33</td>
<td>23</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>32</td>
<td>20</td>
<td>12</td>
</tr>
<tr>
<td>8</td>
<td>25</td>
<td>37</td>
<td>-12</td>
</tr>
<tr>
<td>9</td>
<td>38</td>
<td>37</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>40</td>
<td>23</td>
<td>17</td>
</tr>
<tr>
<td>11</td>
<td>40</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>12</td>
<td>32</td>
<td>29</td>
<td>3</td>
</tr>
<tr>
<td>13</td>
<td>35</td>
<td>32</td>
<td>3</td>
</tr>
<tr>
<td>14</td>
<td>32</td>
<td>38</td>
<td>-6</td>
</tr>
<tr>
<td>15</td>
<td>35</td>
<td>30</td>
<td>5</td>
</tr>
<tr>
<td>16</td>
<td>24</td>
<td>36</td>
<td>-12</td>
</tr>
<tr>
<td>17</td>
<td>14</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>18</td>
<td>20</td>
<td>36</td>
<td>-16</td>
</tr>
<tr>
<td>19</td>
<td>26</td>
<td>18</td>
<td>8</td>
</tr>
<tr>
<td>20</td>
<td>17</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>21</td>
<td>12</td>
<td>23</td>
<td>-11</td>
</tr>
<tr>
<td>22</td>
<td>30</td>
<td>23</td>
<td>7</td>
</tr>
<tr>
<td>23</td>
<td>28</td>
<td>24</td>
<td>4</td>
</tr>
<tr>
<td>24</td>
<td>30</td>
<td>34</td>
<td>-4</td>
</tr>
<tr>
<td>25</td>
<td>28</td>
<td>25</td>
<td>3</td>
</tr>
<tr>
<td>26</td>
<td>18</td>
<td>25</td>
<td>-7</td>
</tr>
<tr>
<td>27</td>
<td>18</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>28</td>
<td>15</td>
<td>3</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>E</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>28.71</td>
<td>27.42</td>
</tr>
<tr>
<td>S.D.</td>
<td>8.08</td>
<td>10.99</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>E diff.</th>
<th>C diff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>1.28</td>
<td></td>
</tr>
<tr>
<td>S.D.</td>
<td>8.76</td>
<td></td>
</tr>
<tr>
<td>SE diff.</td>
<td>1.68</td>
<td></td>
</tr>
<tr>
<td>t</td>
<td>.76</td>
<td></td>
</tr>
</tbody>
</table>
### Table III

**Frequency of Scores**

<table>
<thead>
<tr>
<th>Total Scores</th>
<th>E</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>40-42</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>37-39</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>34-36</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>31-33</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>28-30</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>25-27</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>22-24</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>19-21</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>16-18</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>13-15</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>10-12</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>7-9</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>4-6</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1-3</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

\[ n = 28 \quad \text{for E} \quad \text{and} \quad \text{n = 28 for C} \]
Tables IV, V, and VI show the distribution of scores on Sections I, II, and III of the test.

Of the t-ratios obtained, only one, \( t = 3.34 \) on Section I of the test was significant at the 1% level, in favor of the experimental group. This would seem to indicate that the pupils in this group had a significantly better understanding of the relationships between common fractions, decimal fractions, and percents, than did the pupils in the control group.

The Experimental group attained mean scores higher than the Control group on Sections I and III of the test. On Section II the Control group had a slightly higher mean.

Students in the Control group were instructed in a limited number of word problems in percentage during the experiment. However, the students in the Experimental group were given no word problems, either in common fractions, decimal fractions, or percentage, during this experiment.

Section III of the test contained six word problems in percentage. As shown in Table IV, 18 of the students in the Experimental group worked 3 or more word problems in percentage correctly, while only 13 students in the Control group worked 3 or more word problems in percentage correctly. This appears to indicate that although the Experimental group never had word problems of any type in their instructional period, they could handle word problems in percentage as effectively as students who had received specific instruction in word problems in percentage.
Table IV

Scores on Section I of Test

<table>
<thead>
<tr>
<th>Total Score</th>
<th>E</th>
<th>C</th>
<th>Diff: E-C</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>11</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>15</td>
<td>9</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>14</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>13</td>
<td>2</td>
<td>4</td>
<td>-2</td>
</tr>
<tr>
<td>12</td>
<td>0</td>
<td>1</td>
<td>-1</td>
</tr>
<tr>
<td>11</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
<td>3</td>
<td>-3</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>0</td>
<td>-1</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>1</td>
<td>-1</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>1</td>
<td>-1</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>1</td>
<td>-1</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>-1</td>
</tr>
</tbody>
</table>

n = 28  n = 28

E        C

M = 14.42 12.21

M diff = 2.21
S.D. = 3.43
SE diff = .66

t = 3.34
Table V
Scores on Section II of Test

<table>
<thead>
<tr>
<th>Score</th>
<th>E</th>
<th>C</th>
<th>Diff: E - C</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>0</td>
<td>1</td>
<td>-1</td>
</tr>
<tr>
<td>19</td>
<td>2</td>
<td>3</td>
<td>-1</td>
</tr>
<tr>
<td>18</td>
<td>3</td>
<td>2</td>
<td>-1</td>
</tr>
<tr>
<td>17</td>
<td>1</td>
<td>4</td>
<td>-3</td>
</tr>
<tr>
<td>16</td>
<td>0</td>
<td>3</td>
<td>-3</td>
</tr>
<tr>
<td>15</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>14</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>13</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>11</td>
<td>3</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>2</td>
<td>-1</td>
</tr>
<tr>
<td>9</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-1</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>-1</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>-1</td>
</tr>
</tbody>
</table>

\[ n = 28 \] \[ n = 28 \]

\[
\begin{align*}
E & \quad C \\
M = 11.28 & \quad 12.50  \\
S.D. = 5.43 & \quad S.E. \text{ diff.} = 1.04  \\
M \text{ diff.} = -1.21 & \quad t = -1.16
\end{align*}
\]
### Table VI

Scores on Section III of Test

<table>
<thead>
<tr>
<th>Score</th>
<th>E</th>
<th>C</th>
<th>Diff: E-C</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>6</td>
<td>-1</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>5</td>
<td>-2</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>5</td>
<td>-3</td>
</tr>
<tr>
<td>0</td>
<td>5</td>
<td>5</td>
<td>0</td>
</tr>
</tbody>
</table>

\[ n = 28 \]

\[ n = 28 \]

\[ \text{E} = 0 \]

\[ \text{M diff} = .285 \]

\[ \text{S. D.} = 2.35 \]

\[ \text{M} = 3.00 \]

\[ \text{SE diff} = .435 \]

\[ t = .63 \]
Further relationships were studied in Tables VII and VIII.

Coefficients of correlation were obtained, using intelligence quotients and total test scores. The following values were found:

- Control group: \( r = .678 \)
- Experimental group: \( r = .776 \)

Both coefficients are significant at the 1% level, the Control group showing a marked relationship between test scores and IQ's, while the experimental group shows an even more marked relationship between the two variables.
Table VII

Experimental Group

<table>
<thead>
<tr>
<th>IQ</th>
<th>Total Test Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>137</td>
<td>40</td>
</tr>
<tr>
<td>137</td>
<td>41</td>
</tr>
<tr>
<td>125</td>
<td>39</td>
</tr>
<tr>
<td>122</td>
<td>33</td>
</tr>
<tr>
<td>120</td>
<td>29</td>
</tr>
<tr>
<td>118</td>
<td>33</td>
</tr>
<tr>
<td>117</td>
<td>32</td>
</tr>
<tr>
<td>116</td>
<td>25</td>
</tr>
<tr>
<td>116</td>
<td>38</td>
</tr>
<tr>
<td>116</td>
<td>40</td>
</tr>
<tr>
<td>115</td>
<td>40</td>
</tr>
<tr>
<td>112</td>
<td>32</td>
</tr>
<tr>
<td>111</td>
<td>35</td>
</tr>
<tr>
<td>110</td>
<td>32</td>
</tr>
<tr>
<td>106</td>
<td>35</td>
</tr>
<tr>
<td>106</td>
<td>24</td>
</tr>
<tr>
<td>105</td>
<td>14</td>
</tr>
<tr>
<td>105</td>
<td>20</td>
</tr>
<tr>
<td>105</td>
<td>20</td>
</tr>
<tr>
<td>101</td>
<td>17</td>
</tr>
<tr>
<td>101</td>
<td>12</td>
</tr>
<tr>
<td>101</td>
<td>12</td>
</tr>
<tr>
<td>98</td>
<td>30</td>
</tr>
<tr>
<td>95</td>
<td>28</td>
</tr>
<tr>
<td>94</td>
<td>28</td>
</tr>
<tr>
<td>93</td>
<td>18</td>
</tr>
<tr>
<td>82</td>
<td>18</td>
</tr>
<tr>
<td>75</td>
<td>15</td>
</tr>
</tbody>
</table>

M = 108.54  
S.D. = 13.88  

r = .776
Table VIII

Control Group

<table>
<thead>
<tr>
<th>IQ</th>
<th>Total Test Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>133</td>
<td>40</td>
</tr>
<tr>
<td>130</td>
<td>39</td>
</tr>
<tr>
<td>124</td>
<td>39</td>
</tr>
<tr>
<td>125</td>
<td>42</td>
</tr>
<tr>
<td>122</td>
<td>40</td>
</tr>
<tr>
<td>118</td>
<td>23</td>
</tr>
<tr>
<td>116</td>
<td>20</td>
</tr>
<tr>
<td>115</td>
<td>23</td>
</tr>
<tr>
<td>115</td>
<td>37</td>
</tr>
<tr>
<td>114</td>
<td>37</td>
</tr>
<tr>
<td>114</td>
<td>32</td>
</tr>
<tr>
<td>113</td>
<td>30</td>
</tr>
<tr>
<td>113</td>
<td>29</td>
</tr>
<tr>
<td>110</td>
<td>38</td>
</tr>
<tr>
<td>107</td>
<td>36</td>
</tr>
<tr>
<td>107</td>
<td>18</td>
</tr>
<tr>
<td>105</td>
<td>30</td>
</tr>
<tr>
<td>105</td>
<td>5</td>
</tr>
<tr>
<td>103</td>
<td>36</td>
</tr>
<tr>
<td>102</td>
<td>8</td>
</tr>
<tr>
<td>102</td>
<td>23</td>
</tr>
<tr>
<td>101</td>
<td>23</td>
</tr>
<tr>
<td>97</td>
<td>24</td>
</tr>
<tr>
<td>97</td>
<td>34</td>
</tr>
<tr>
<td>95</td>
<td>25</td>
</tr>
<tr>
<td>93</td>
<td>25</td>
</tr>
<tr>
<td>83</td>
<td>9</td>
</tr>
<tr>
<td>77</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IQ</th>
<th>Total Test Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>108.47</td>
</tr>
<tr>
<td>S.D.</td>
<td>12.85</td>
</tr>
</tbody>
</table>

r = .678
CHAPTER V

SUMMARY AND CONCLUSIONS

I. Summary of findings.

The overall results of the complete testing showed that the two groups of students scored approximately the same. When the test scores on Section I were compared, the experimental group scored significantly higher than the control group. In both Sections II and III of the test, both groups scored about the same. Taking into consideration the results obtained in the testing, the following conclusions were drawn.

II. Conclusions.

A. Students in this investigation did as well on problems in percentage, if they have been taught, meaningfully, comparable work in common fractions and decimal fractions, as students who have had concentrated work on problems of percentage.

B. Knowledge acquired through meaningful instruction in problems in common fractions and decimal fractions transferred to problems involving percents.

C. This investigation showed that the pupils who are taught meaningfully common fractions and decimal fractions have a significantly better understanding of the relationships between common fractions, decimal fractions, and percents, than the pupils who concentrated their work in percentage.

D. The ability to transfer knowledge from one area of
this study to another related area seems to be rather highly correlated with a person's intelligence quotient.

III. Limitations.

A. This study was done with a small group of 28 matched pairs of students, which limits the conclusions drawn.

B. The instruction period for both groups covered only a four week period.

C. No attempt was made to measure the effect of other factors such as age, attitude, accuracy, interest, etc., on transfer of learning.

D. Intelligence quotients and total arithmetic achievement were the only measurements used in matching these 28 pairs of students.

IV. Suggestions for further study.

A. Use larger groups of students to see if the same results would be obtained.

B. Determine the effect this type of instruction has on the ability of fifth and sixth grade students to transfer work in fractions and decimal fractions to work in percents.

C. Do a similar study to determine the effect of other factors such as age, attitude, accuracy, etc., on transfer of learning.

D. Do a follow-up study to compare these two groups after the experimental group has received direct instruction in percentage.


Thorndike, E. L., Educational Psychology II, Teachers College Columbia University, New York, 1913, p. 358.


TEST

Directions: This is a test in percentage. The test is divided into three parts. Part I is changing fractions and decimals to percents, and percents to fractions and decimals. Part II is dealing with different kinds of examples with percents. Part III is problems involving percents. Space is provided for all of your answers and your figuring should be done on scrap paper.

Part I

Section A. Change to percents

(a) .6 = ________%  (e) 1/5 = ________%
(b) 175 = ________%  6/8 = ________%
(c) .16 = ________%  1/2 = ________%
(d) 109 = ________%  1/4 = ________%

Section B. Change to decimals

(a) 6% = ________  (a) 8% = ________
(b) 98% = ________  (b) 15% = ________
(c) 55% = ________  (c) 54% = ________
(d) 11% = ________  (d) 90% = ________

Part II Examples

Section A.

(a) 50% of 46 =  (a) 4 is ______% of 16
(b) 20% of 25 =  (b) 18 is ______% of 20
(c) 47% of 200 = (c) 16 is ______% of 160
(d) 1% of 50 =  (d) 5 is ______% of 60
(e) 6% of 50 =  (e) 24 is ______% of 30

Section C.

(a) 12 is 50% of ______

(b) 15 ______% of 45
(a) Jack has saved $6 towards the cost of a new baseball glove. This is 40% of the cost of the glove. How much does he have to save together to buy the glove?

Ans. _____

(b) There are 20 boys in the class 7B, 20% of these boys play on the school team. How many boys play on the school team?

Ans. _____

(c) Nine students from a class of 36 belong to the school chorus. What per cent of the class belongs to the school chorus?

Ans. _____

(d) A baseball team won 90 games out of 150 games played. What percentage of the total games played did they win?

Ans. _____

(e) John made $3.50 selling seeds. This was 35% of the money he collected. How many dollars worth of seeds did he sell?

Ans. _____

(f) There are 900 students in our school. Today 6% of the students are absent. How many students are absent from school?

Ans. _____