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UNIVERSITY OF LOUISVILLE

INVESTIGATIONS ON WHOLE-PART LEARNING
FROM 1930 THROUGH 1939

A Dissertation
Submitted to the Faculty
Of the Graduate School of the University of Louisville
In Partial Fulfillment of the
Requirements for the Degree
Of Master of Arts

Department of Education

By

Agnes Catherine Lemaire

1940

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TITLE OF THESIS: Investigations on Whole-Part Learning
from 1930 through 1939

APPROVED BY READING COMMITTEE COMPOSED OF THE FOLLOWING MEMBERS:

NAME OF DIRECTOR: Dr. Joseph K. Long

DATE: May 10, 1940

PREFACE

In the spring of 1935 the members of the Educational Statistics and Experimental Education Class, Adult Education Division, University of Louisville, Louisville, Kentucky, conducted a group of investigations in the field of learning. The purpose of these investigations was to ascertain whether or not it is better to learn by wholes or by parts--to determine, for example, whether or not a greater number of persons learn a poem in its entirety or break it up into parts, learning by lines, stanzas, or even by groups of stanzas. A report of these investigations, together with a résumé of literature in this field, was published in the *Journal of Educational Psychology*, January, 1937.

This thesis represents a continuation of the research in the field of whole-part learning, with an intensive study of available literature and reports of investigations dealing with the problem for the ten-year period, 1930-1939. It necessarily includes a detailed account of the writer's individual experiment made in 1935, as well as a discussion of the other experiments conducted at that time.

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CHAPTER I

INTRODUCTION

INTRODUCTION

Since the turn of the century, numerous investigations have been made in an effort to determine the best way to learn either an article or an act of skill. There are many educators who believe that it is better for an individual to learn materials by practicing them as entire units until memorized, while others believe that it is better to break them into parts and then learn these parts separately. This question as to the better practice for learning of materials has always been a debatable one, and even at present, it has not been definitely settled after forty years of investigation. Much of the available literature dealing with this problem points out the advantages of learning articles or acts of skill by going over them again and again in their entirety until the learning has been brought up to the point of complete mastery, though many investigations show part-method learning to be superior to whole-method learning.

Whether or not the practice of learning an article in its entirety is, or is not, superior to the learning of an article broken up into its component parts depends upon a number of factors, some of which will be mentioned later. On the other hand, there are many known advantages and disadvantages of both methods of learning.

The purpose of this study is to summarize available data and pertinent conclusions of the investigations made in this field. In no sense is a critical analysis intended. Its scope is limited to a brief discussion of the studies that were conducted and made available during the past ten years, 1930 through 1939. In 1931, Grace O. McGeoch published a critical analysis and summary of investigations from 1900 to 1930.¹ This present paper takes up the research in 1930--the overlapping of the two reviews being almost negligible.

Much of the available earlier literature on whole-part investigations, dating back to the early 1900's, has been reviewed in an effort to become better acquainted with this entire field of experimentation. From many of these investigations prior to 1930, definite conclusions cannot be drawn as to the superiority of any one method over another. This is probably true for many reasons. Four of the most important reasons are: (1) poor control of the learning situation, (2) poor administration of the investigation, (3) too few subjects, and (4) lack of valid or reliable measures of efficiency. In many of these earlier studies, no statistical measures were employed.

1. Grace O. McGeoch, "Whole-Part Problem," Psychological Bulletin, 28: 713-739; (1931).

Before proceeding with the report of the experimental investigations on the problem, it would be well to define some frequently-used terms occurring in these studies and in the present paper.

I. Definitions of Terms Used in Investigations

A. Whole Method of Learning

The memorizing of learning materials or acts of skill in their entirety, until verbatim reproduction of the article can be accomplished, or complete mastery of the act of skill can be achieved without error, is known as the whole method of learning. This definition is the one ordinarily given by most investigators as their interpretation of the term, "whole method of learning."

B. Part Method of Learning

The breaking up into parts of an article, or an act of skill, and the learning of these various parts separately, is referred to as the part method of learning. It is soon discovered, however, that there are many ways of going about learning by the part method. They fall in these classifications: (1) pure part, (2) progressive part, (3) direct repetitive part, (4) reversed repetitive part, (5) part connecting method, (6) definitive part, (7) progressive definitive part, and (8) combination part.

Pure Part Method.--The breaking up of the learning material into parts or units and the thorough learning of each of the various parts in consecutive order before proceeding to the next, usually not reviewing the parts previously mastered, is known as pure part learning. Sometimes, however, all the parts are repeated together for the final learning trial.

Progressive Part Method.--The first two sections of an article are learned as separate units, and connected as soon as the second is mastered. A third unit is then learned separately and immediately added to the first two parts and all three are repeated together. Then a fourth section is learned and immediately joined to the others, and so on through the article. Thus, in a four-part learning unit, the sections would be learned as follows: Section I, then Section II, then Sections I and II together; next Section III, then Sections I, II, and III together; then Section IV, and finally Sections I, II, III, and IV together.

Direct Repetitive Part Method.--This method provides that the first section in a learning unit be learned as a separate unit and that the learner review this section after an introduction to the second section. The previously-learned sections are reviewed each time as each new section is memorized, so that in a four-part learning unit, the memorization procedure would be: Learn Section I, then Sections I and II, next Sections I, II, and III, and lastly, Sections I, II, III, and IV.

Reversed Repetitive Part Method.--This method permits as the first learning unit the last section of the series, whereupon the learner is introduced to the new next-to-the-last section, reviewing the previously-learned unit as the final part of each learning effort. As soon as these units are memorized, the learner is introduced to the next-earlier unit and then repeats all the previously-learned sections as the final part of the learning situation, thus: Section IV, then Sections III and IV, then Sections II, III, and IV, and for the last trial, Sections I, II, III, and IV.

Part Connecting Method.--For this method, the learner memorizes Part I, then Part II, then repeats Parts I and II together; next, he learns Part III, then Parts II and III; and so on throughout the learning trial. For example, each section of a four-part learning unit would be learned separately first and then practiced in conjunction with the immediately preceding section. Lastly, the entire four sections would be reviewed together as a single unit.

Definitive Part Method.--This method, as applied particularly to the solving of puzzles, defines the parts within the whole. The subjects know the size and shape of the entire puzzle, because they solve the parts on a base board the size and shape of the whole puzzle, the parts being marked off by diagonal lines. "The purpose of the definitive part was to indicate to S while he was working with the parts the position

of each part in the whole puzzle and its relation to the others comprising the whole. . . ."²

Progressive Definitive Part Method.--This method, as applied to puzzle solving, is "simply a combination of the progressive and definitive part methods. . . . That is, separate parts were solved on a base board the size of the whole puzzle and divided into parts as in the definitive method, but Parts I and II combined were solved as one unit after each had been separately mastered, as in the progressive part. The base board used for the latter work conformed to the requirements of the definitive procedure in that it was the size of the whole puzzle and bore one diagonal black line marking off Parts I and II and combined from Part III."³

Combination Part Method.--Upon the completion of the learning of the first section, a part of it is then combined with another section, the two being learned together. As soon as this combination has been mastered, a new combination composed of a section of the second division and an entire new section is then learned as a unit. Proceeding thus through the article, mastery is achieved by a series of combinations of parts.

2. Leland W. Crafts and Harriet M. Kohler, "Whole and Part Methods in Puzzle Solution," American Journal of Psychology, 49:p. 602; (1937).

3. Ibid., p. 602.

C. Kinds of Practice

Distributed or Spaced Practice.--This term refers to the learning of materials or acts of skill between which a period of rest or changed activity takes place. Sometimes this rest period is only for a few seconds, while again it may be an interval of several hours or several days between the learning trials.

Massed Practice.--By massed practice is meant the complete mastery of an article or an activity at one sitting, so to speak. No interruptions occur in the learning trials, until the selection has been thoroughly learned or the motor act can be performed without error.

Successive Practice.--Successive practice means the doing of a muscular skill single-handedly, such as tracing around a disc or the running of a maze or the tossing of balls.

Simultaneous Practice.--This term refers to the performance of an act of skill by the using of the two hands at the same time, that is, simultaneously--such as tracing around discs, mirror drawing, tossing balls.

D. Kinds of Recall

Immediate Recall.--By immediate recall is meant the reproduction of the material learned, immediately upon the completion of the learning trial.

Delayed Recall.--By delayed recall is meant the reproduction of the material learned, at a time somewhat removed from the learning trial.

II. Concluding Statement

From this introduction, which includes a statement of the problem and definition of terms, the immediate task is to proceed with the review of literature and investigations in the field of whole-part learning for the ten-year period, 1930 through 1939. After the review of investigations, a complete report of the writer's experiment in the field of type-writing will be given; following this account will be a brief report of other local investigations on whole-part learning.

CHAPTER II

REVIEW OF INVESTIGATIONS ON THE WHOLE-PART PROBLEM FROM 1930 THROUGH 1939

REVIEW OF INVESTIGATIONS ON THE WHOLE-PART PROBLEM
FROM 1930 THROUGH 1939

Educators in many parts of the world have been interested in various phases of the whole-part problem of learning for a great many years. Accordingly, many investigations have been made in numerous subject fields, various factors believed to condition the efficiency of the whole and part methods of learning have been tested, and a wide variety of learning materials have been used. In this chapter, a résumé of literature concerned with experimental investigations dealing with many of the various phases of whole-part learning is presented for the purpose of showing what has been accomplished by research workers in this learning field during the past ten years.

The studies reviewed here, while following some patterns of grouping, do not lend themselves to strict classifications, and frequently, therefore, there are overlappings. For convenience of discussion, however, the studies that might easily be classified under several captions will be listed only once. In some instances, only the review of a single experiment will appear under a heading, while in others, numerous reviews will appear--some fields of experimentation seem to have been more interesting to investigators and more conducive to investigation.

I. Investigations on Memorization

A. Poetry

In 1931, Grace O. McGeoch published a critical analysis of over thirty experimental investigations on the whole-part problem conducted prior to that date, only six of which yielded¹ statistically reliable results. She found that while the data on memorizing ability showed rather consistent results in favor of the whole method, at least with abler learners, there really was no "inherently superior method."² Conflicting data on this problem suggested that the efficiency of any method of learning depends on a number of factors, and McGeoch lists the following:

1. Subjects--age, training, memorizing ability, and intelligence.
2. Material--type, nature, difficulty and length.
3. Practice--amount, and distribution, and nature of practice periods.
4. Form of part method used.
5. Method of measuring learning efficiency.
6. Method of measuring retention efficiency.
7. Length of interval.³

1. Grace O. McGeoch, "Whole-Part Problem," Psychological Bulletin, 28:713-739 (1931).

2. Ibid., p. 738.

3. Ibid., pp. 737-738.

In an experiment to test the possible influence of I. Q. on methods of learning, she compared the learning and retention abilities of a group of gifted boys and girls (having a mean I. Q. of 151.2) with a group of boys and girls of average intelligence (having a mean I. Q. of 99.4)⁴. Short selections of poetry and vocabulary materials were learned by the whole, pure part, and progressive part methods. Data showed no reliable differences in either the learning or the retention of poetry. It was found that gifted children learned and retained more and were less variable than the normal boys and girls when learning both poetry and vocabulary pairs. The I. Q. was concluded to be a conditioning factor in the relative efficiency of the three methods, at least in the comparison of gifted and normal children.

After an analysis of seven well-known psychology texts and a review of several statistically valid investigations, she challenged the right of some of the authors to accept the superiority of the whole method, by saying: "Practically speaking, the present scientific data do not justify the recommendation of any particular learning method for classroom

4. Grace O. McGeoch, "The Intelligent Quotient as a Factor in the Whole-Part Problem," Journal of Experimental Psychology, 14:333-358; (1931).

use. There is no scientific answer to the question: should⁵ a pupil memorize by the whole or by the part?"

In a later review of investigations dealing with memorization of poetry, she pointed out that there had not been enough studies sufficiently reliable to determine definitely the factors upon which the efficiency of the different learning methods really depend.⁶ In testing the effect of practice on methods of memorization habitually used by 9-, 10-, and 11-year old pupils, she found no statistical differences between line-by-line learning and verse-by-verse learning, although there was a very slight difference in favor of the latter method.

In another study using 843 children of the same ages as in the previous experiment learning selections of Howitt's poem, "The Spider and the Fly," McGeoch also found no statistically reliable difference for the whole or for the pure part methods in the learning or in the retention of poetry which appealed⁷ to learners. The children learning by the whole method tended to show more reminiscence than those learning by the part

5. Grace O. McGeoch, "A Revaluation of the Whole-Part Problem in Learning," Journal of Educational Research, 26 : 1-5; (1932-33).

6. Grace O. McGeoch, "The Whole-Part Problem in Memorizing Poetry," Pedagogical Seminary, 43:439-447; (1933).

7. Grace O. McGeoch, "The Condition of Reminiscence," American Journal of Psychology, 47:65-89; (1935).

method. Such factors as age, sex, intelligence, and familiarity with the material did not seem to have much effect upon the conditions of reminiscence, so far as this study was concerned.

It is interesting to discover from data on scores made by college students learning poetry by the whole, pure part, and progressive part methods, when practice was massed, that the whole method was less economical than any of the part methods in the learning of these meaningful materials.⁸ Practically no difference was found to exist between these three learning methods in respect to retention of the poems.

Petri, using 5B and 6B pupils, paired on the basis of intelligence and memorizing ability, found no reliable difference between the whole and progressive part methods of learning poetry for either immediate or delayed recall.⁹

Children at three school levels learned four poems of equal length and style, but of increasingly difficult thought content, in order to determine the relative efficacy of the

8. J. B. Stroud and C. W. Ridgeway, "The Relative Efficiency of the Whole, Part, and Progressive Part Methods When Trials Are Massed--A Minor Experiment," Journal of Educational Psychology, 23:632-634 (1932).

9. Lucie Anna Petri, The Whole Versus the Progressive Part Method of Memorizing Poetry: An Experimental Investigation of Elementary School Pupils. Doctor's, 1934, New York.--Abstract, Bibliography of Research Studies in Education, (1933-34).

10

whole and part methods of learning. It was found that invention occurred to a great degree when recall became inaccurate. The whole method proved to be the most advantageous, for as the author stated:

. . . If difficulty is a function of the amount that material has to be re-formed in order to become meaningful, the reason that whole learning is most superior for certain material becomes clearer. A certain poem is of such difficulty that it is meaningful to the subject, and becomes part of his psychological field when it is presented to him as a whole; when, however it is broken into parts, these parts as such are not absorbed by the subject, but have to be knit either into the whole which corresponds to the objective whole given by the poem, or into some other whole satisfactory to the subject. That is, the parts have to be transformed, while the whole is absorbed in its own form. With more 'difficult' material both the whole and part presentation have to be transformed by the subject, and with much easier material, both presentations can be absorbed in their own right....¹¹

A report of ten separate experiments on the whole-part¹² problem was made by Jensen and Lemaire in 1937. Five of these investigations showed statistical differences between the whole and part learning methods, three being in favor of whole learning and two in favor of a form of part procedure.

10. Mary L. Northway, "The Nature of 'Difficulty'; With Reference to a Study of 'Whole-Part' Learning," British Journal of Psychology, 27:399-403 (1936-37).

11. Ibid., p. 402.

12. Milton B. Jensen and Agnes Lemaire, "Ten Experiments on Whole and Part Learning," Journal of Educational Psychology, 28:37-54 (1937).

In two of the three studies yielding significant differences in favor of the whole method, poetry was the learning material used, while prose was the learning material used in the third one. Prose was also used for the learning materials in the two investigations showing significant differences in favor of the part method.

B. Letter-Number Substitutions

A study of the data on 281 men and women students learning a simple letter-number substitution test showed that under massed practice the whole method was slightly inferior to either the pure part and combination part methods employed in this experiment.¹³ Under spaced conditions, however, the whole method proved to be consistently superior to either of the part methods used.

C. Circles, Lines, and Geometric Figures

In the learning of three types of visual spatial material --irregular arrangements of circles and of unrelated lines and geometric figures--305 undergraduates of a college found that the whole method was reliably superior to pure part, progressive part, and combination part methods with circles and fig-

13. Leland W. Crafts, "Whole and Part Methods with Unrelated Reactions," American Journal of Psychology, 42:591-601 (1930).

ures only; no method was found to be reliably superior to any¹⁴
other in the learning of the more difficult unrelated lines.

The investigator, in reviewing his findings, drew these conclusions: "(a) that in the field of visual 'perception' as well as in that of motor or of verbal learning, neither the whole nor any one form of a part method will invariably be superior; and (b) that the whole method can be expected to be especially advantageous with easier and with more closely re-¹⁵
lated materials."

D. Words and Nonsense Syllables

One hundred and four college students learned 264 stimulus cards, containing simple di-syllabic English words and nonsense syllables, by the whole and part methods. The data yielded the following results as to place association, sex, age, capacity, and habitual methods of learning as conditioning factors in determining the efficiency of learning methods: (1) place association is not a factor determining the relative efficacy of the whole method over the part method; (2) habitual method of learning is not a determining factor; (3) age is not

14. Leland W. Crafts, "Whole and Part Methods with Visual Spatial Material," American Journal of Psychology, 44:526-534, (1932).

15. Ibid., p. 534.

a determining factor when age difference is not great; (4) sex is a factor determining the relative greater efficiency of the whole method over the part method; and (5) capacity is not a determining factor, where the groups compared do not differ significantly in gross test scores.¹⁶ Males and females learned approximately equally well with the part method, but the males were superior to the females with the whole method. The investigator, in his conclusions, writes: "The relative efficiency of the whole and part methods of learning is not a resultant of place association or of the variables tested in this investigation, with the possible exception of sex. Positive and dogmatic statements about the determinants of the relative efficacy of the methods cannot as yet be made."¹⁷

E. Puzzles

Crafts, in collaboration with Kohler, experimented with 100 undergraduate college students in comparing the efficiency of the whole method with that of four kinds of part learning, i.e., pure part, progressive part, definitive part, and progressive definitive part, when learning a nine-piece rectangu-

16. Alonzo J. Davis and Max Meenes, "Factors Determining the Relative Efficiency of the Whole and Part Methods of Learning," Journal of Experimental Psychology, 15:716-727, (1932).

17. Ibid., p.727.

lar-shaped puzzle of the jig-saw type.¹⁸ While the whole method was found to be superior only to the pure part method, it was quite inferior to the progressive definitive part method. This latter method was clearly superior to all methods used--both the whole and the other part procedures. The authors, in attempting an explanation of the reason for failure of the superiority of the whole method in this case, suggested the possibility that a mixed method, which possesses some of the good qualities of both the whole and part methods, might often turn out to be the most effective learning method, except in the case of learning material whose nature is such that its unity pattern would be completely destroyed by any breaking up of this material into segments.

Small and unreliable differences were found between groups learning a disc transfer puzzle by the whole and part methods of learning; however, a group learning by the part method with verbal instruction was decidedly superior to either of the other learning groups.¹⁹ Data clearly indicate that verbal guidance may assist considerably in the solution of the disc transfer problem.

18. Leland W. Crafts and Harriet M. Kohler, "Whole and Part Methods in Puzzle Solution," American Journal of Psychology, 49:597-610 (1937).

19. Thomas W. Cook, "Guidance and Transfer in Part and Whole Learning of the Disc Transfer Problem," Journal of Educational Psychology, 30:303-308 (1939).

F. Shorthand

In a study to determine whether or not the sentence unit* method is superior to the word unit method** in the learning of shorthand, Clark and Worcester reported that their study yielded results statistically significant in favor of the sentence method.²⁰ They have this to say about the sentence method upon the completion of their experiment:

. . . The individual has more confidence in himself and is more interested in the sentence unit method than in the word unit method. The sentence unit plan brings out to the learner the fact that he must learn rules--not verbatim--but the application of them. The method exemplifies the rule that one should always begin doing a thing as nearly as possible in the way it is eventually to be done.

While the sentence unit method may not be considered by some educators in the business field to be a typical example of the whole method of learning as applicable to shorthand, it does illustrate one of the various methods of presentation of the

*It is the aim of the sentence unit method to familiarize pupils immediately with shorthand as it will be used in sentences, instead of acquainting them with the characters of the shorthand outlines and the rules governing the writing of the outlines.

**It is the aim of the word unit method, or conventional method, to teach the pupils the rules of the shorthand system so that they may apply them to the learning of the words classified under the separate rules.

20. Mildred Clark and D. A. Worcester, "A Comparison of Results Obtained from the Teaching by the Word Unit Method and the Sentence Unit Method," Journal of Educational Psychology, 23:121-131 (1932).

subject and when comparing it with the word unit method, which is commonly called the conventional or Manual method, it might be thought of as a whole method after all.

The direct method of teaching shorthand is usually considered to be a "whole method" approach to this subject and is labeled as such by Odell, Rowe, and Stuart in their discussion of the direct method and the Manual method of teaching shorthand.²¹ The direct method approach is by no means synonymous with the sentence unit method; however, the Manual method and the word unit method are synonymous. The following excerpts are taken from the discussion by Odell, Rowe, and Stuart:

In the direct method, in general, the learner considers each shorthand outline that he confronts as a unit, or as a whole. He is not shown the sound alphabet, nor is his attention called to the fact that most outlines are composed of various segments, pieces, or parts. Each shorthand outline is a unit, or whole, to the direct-method learner. On the other hand, from the very beginning, the Manual-method learner is taught to analyze outlines into their component parts. The direct method, therefore, proceeds as a whole method, whereas the Manual method represents a parts method of learning. In terms of shorthand sound alphabet, the generalizations, if any, are pupil-initiated in the direct method; whereas, in the Manual method, the sound alphabet is teacher-imposed from the beginning.

.....

21. Odell-Rowe-Stuart, Teacher's Manual and Key, "Direct Practice Units for Beginning Gregg Shorthand," Gregg Publishing Company, 5-48, (1936).

Still further, it is reasonable to believe a student taught to recognize outlines as wholes will develop better shorthand writing habits from the very beginning, just as he develops better shorthand reading habits. Presumably, also, these writing habits will persist permanently.

.....

Presumably, the direct method develops better basic writing habits than does the Manual method. This, again, is due to the fact that the direct method is a whole method, whereas the Manual method is a parts method.²²

G. Red Indian, Logarithms, and French Vocabulary

Griffiths, giving a group of school boys three tests--Red Indian, logarithms, and French vocabulary--as an experimental investigation, found (1) that difficult material was more easily learned when presented to the learners as a "whole" first, and then in its separate parts, and (2) that simple material, or material having no inherent connection between its parts, was just as effectively learned by the part method as by the whole.²³

II. Investigations on Motor Learning

A. Maze Learning

Hanawalt reported four studies on the whole-part problem as applied to the running of mazes; in two of these investiga-

22. Odell-Rowe-Stuart, op. cit., pp. 8-15.

23. M. M. Griffiths, "Part and Whole Methods of Presentation," (Aust. Coun. Educ. Res. Ser., No. 52) Melbourne: Melbourne University Press, 1-92 (1938).--Abstract--G. R. Thornton.--(Nebraska).

tions, white rats were the subjects and in the other two human beings were used, all subjects being thoroughly trained and experienced in maze-running. In the first study, using fifteen white rats for learning a complex maze pattern of the Shepard universal type, she found the whole method superior to either the pure part method, the progressive part method, the direct repetitive part, or the reversed repetitive part.²⁴

Desiring to find out whether or not the waste in part learning occurred in the act of connection of parts, she again²⁵ experimented with white rats, using only nine this time. She compared what she termed "the part connecting method" with the whole and the other four part methods just mentioned. Data from this study showed the part connecting method to be less economical than the whole method and the least economical of all methods experimentally tested for rats in learning maze patterns. One important reason for waste in part learning she attributed to the breaking up of the unity of the whole patterns, thus requiring the learning of a great number of separate acts.

24. Ella M. Hanawalt, "Whole and Part Methods in Trial and Error Learning," Comparative Psychology Monograph, 7, pp. 65 (1931).

25. Ella M. Hanawalt, "Whole and Part Methods in Trial and Error Learning, A Supplementary Study." Journal of Comparative Psychology, 15:395-406 (1932).

In another investigation, when comparing the whole method in turn with the pure part method, direct repetitive part, reversed repetitive part, and progressive part methods, using human beings as subjects, she obtained much the same results as²⁶ in her previous experiments with rats learning maze patterns. The whole method was superior in every case. She concluded that "important factors causing waste in part learning are believed to be breaking up the unity of total patterns, increasing the number of separate learning acts, and confusing subjects by requiring practice in directions different from the²⁷ one in which learning must ultimately function."

Repeating her first experiment, this time with human beings, however, she found that a mastery of parts at first did contribute somewhat to the mastery of the whole later on, but it was "not enough to compensate for the extra energy²⁸ spent in learning the parts." For human subjects, the order of effectiveness for learning, from greatest to least, was

26. Ella M. Hanawalt, "Whole-Part Learning," Psychological Bulletin, 30:p. 701 (1933).

27. Ibid., p. 701.

28. Ella M. Hanawalt, "Whole and Part Methods in Trial and Error Learning," Journal of Experimental Psychology, 17:691-708 (1934).

as follows, as compared with that for rats as found in the first study:

<u>For Human Beings</u>	<u>For Rats</u>
Whole	Whole
Pure Part	Direct Repetitive Part
Direct Repetitive Part	Pure Part
Reversed Repetitive Part	Progressive Part
Progressive Part	Reversed Repetitive Part

Other investigators also conducted some experiments in the field of maze learning. In 1935, Cook, Morrison, and Stacey in experimenting with a visually perceived maze found the part method superior to the whole in time and number of errors, but no difference in methods insofar as trials made
29
were concerned.

During the next four consecutive years, Cook reported four additional investigations of his own on maze learning with different sizes of learning patterns. He found part learning to be most effective with the 24-unit pattern mazes and about equally economical for the 12-unit and 48-unit pat-
30
terns.

Using a spider maze of 38 patterns in four sizes (2-, 4-, 8-, and 16-unit parts) with three subjects, he found for later

29. T. W. Cook, S. H. Morrison, and C. L. Stacey, "Whole and Part Learning of a Visually Perceived Maze," Journal of Genetic Psychology, 47:218-232 (1935).--Abstract--J. F. Dashiell --(North Carolina).

30. T. W. Cook, "Factors in Whole and Part Learning a Visually Perceived Maze," Journal of Genetic Psychology, 49:3-32 (1936).

trials that the part method was, in general, superior in errors, and the whole method was superior in trials and time, but any large advantage in errors was accompanied by a small or moderate superiority for the part method in time. However, he remarked that "the relation of practice to the relative economy of the part and whole methods in initial learning is a function of the location of the most 'economical' unit."³¹

In investigating the learning of 32-unit spider mazes with the same three subjects--a young man, a young woman, and a 10-year old girl--he found in later trials that part learning was strikingly superior to whole learning in errors and only slightly superior in time.³² Practice had little or no influence upon relative economy of part and whole procedure within the limits of this experiment.

He next investigated the significance of the whole-part problem of identity between successive sections of 32-unit spider mazes with three practiced subjects learning 8 mazes, each of three types--a 5-unit one repeated throughout, and a 2-unit or 4-unit pattern each specific to an 8-unit pattern,

31. T. W. Cook, "Whole Versus Part Learning the Spider Maze," Journal of Experimental Psychology, 20:477-494 (1937).

32. T. W. Cook, "Whole and Four Part Learning the 32-Unit Spider Mazes," Journal of Experimental Psychology, 22:439-450 (1938).

and nonsense mazes containing no repetitive patterns. He found that the nonsense mazes yielded results practically identical to the findings of the previous experiments on spider mazes. Insofar as the data on the other mazes having repetitive patterns were concerned, Cook's conclusions are as follows:

The part method is markedly superior to the whole in errors, moderately superior in time, with little or no difference in number of trials required by either method. The presence of repetitive pattern in maze material is no guarantee that subjects will respond to them. Discovery of repetitive pattern, on the other hand, may lead to a large and sudden increase in the efficiency of tracing. Within the limits of the experiment, 8-unit part learning of 32-unit spider mazes, favors discovery of patterns specific to those 8-unit parts, but 5-unit patterns throughout 32-unit mazes are learned with equal economy by the whole and (8-unit) part procedure.

B. Single-handed Versus Double-handed Efficiency

From his study on simultaneous combination and simultaneous division in an act of skill, such as tracing around a metal disc with a stylus, Beeby, employing blindfolded subjects with distributed practice periods, found that a combination of very simple movements into a movement-whole resulted in a loss of efficiency just as a division of a movement-whole into its simultaneous constituents likewise resulted in a loss

33. T. W. Cook, "Repetitive Patterns in Whole and Part Learning the Spider Maze," Journal of Experimental Psychology, 24:530-541 (1939).

of efficiency.³⁴ It appeared from these data that the whole method of learning a muscular habit was preferable to the part method, but Beeby suggests that further research along this line needs to be undertaken to substantiate these findings.

In both speed and trials, the 'Hands-together' method was found by Brown to be more efficient than the 'Hands-separate' method in an experiment conducted to test the relative efficiency of two methods of learning to play piano music.³⁵ She also found that the 'Hands-separate' method was "progressively inefficient owing to the fact that music for each hand became partially memorized which militated against their sublimation."³⁶ In the 'Hands-together' method, the subjects found more pleasure.

Crafts and Allen reported a study of two methods of learning an act of skill requiring the use of each hand separately or of both hands together.³⁷ Mirror-drawing was the act of

34. C. E. Beeby, "An Experimental Investigation Into Simultaneous Constituents in an Act of Skill," British Journal of Psychology, 20:336-354 (1929-30).

35. Roberta W. Brown, "The Relation between Two Methods of Learning Piano Music," Journal of Experimental Psychology, 16:435-441 (1933).

36. Ibid., p. 441.

37. L. W. Crafts, and R. M. Allen, "A Comparison of Two Methods of Learning an Act Requiring the Simultaneous Use of the Two Hands," Psychological Bulletin, 31:625-626 (1934).-- J. F. Dashiell (North Carolina).

skill tested in this experiment. Forty college students traced around four-pointed starts either single-handedly, which is known as successive practice, or with both hands together, which is known as simultaneous practice. The successive practice group proved to be reliably superior to the other group, according to the criteria of both time and errors, but especially so in the number of trials made. The investigators concluded that the positive transfer from one hand to the other was very great in the case of successive practice; in simultaneous practice, the very beginning of the act was too confusing and difficult for the learners.

Luh, using fifteen subjects ranging in age from sixteen to thirty, made an investigation on the efficiency of whole (double-handed practice) versus part (single-handed practice) learning in tossing balls continuously in the air.³⁸ The results showed that in order to acquire a double-handed skill the whole method or practice, i.e., the use of both hands simultaneously, was superior to part procedure, i.e., single-handed practice. Due to the effect of interference in changing from the one-handed method to the other, the single-handed method proved to be worse than no practice at all. This effect of interference was most noticeable when practice was changed from single-handed to double-handed practice.

38. C. M. Luh, "Combination and Division of a Motor Skill," Chung. Hwa. educ. Rev., 23:233-238 (1935).--Abstract--C. F. Wu. (Nat. Res. Inst. Psychol., Acad. Sinica, Nanking).

C. Gymnastics

In the field of gymnastics, two college freshmen classes were chosen to learn the upstart on the horizontal bar, one group learning by the progressive part method and the other by the whole method.³⁹ The results of Shay's investigation indicated that the whole method was superior to the progressive part method in the learning of these particular muscular skills. One of the reasons cited for the efficiency of the whole method was that attention was not distracted from the entire performance by the need for perfecting each part separately before proceeding to the next one, as was true in the progressive part learning procedure.

D. Handwriting

Segers reported the results of an experiment dealing with the learning of handwriting by the whole method versus learning by the part method.⁴⁰ With the exception of two cases, children of normal intelligence, ranging in age from five

39. Clayton T. Shay, "Progressive Part Versus the Whole Method of Learning Motor Skills," Research Quarterly of the American Physical Education Association, 5:62-67 (1934).

40. J. E. Segers, La fonction de globalisation et l'enseignement de l'écriture. Le graphisme et l'expression graphique. (The Globalization Function and the Teaching of Writing. Writing and Graphic Expression.) Sem. univ. Pedag. Univ. libre Brux., 1:51-66 (1935).--Abstract--R. Nihard (Liege).

years, six months to six years, eleven months, were the subjects in this study. At the end of the year, the children who had learned to write by means of entire phrases wrote just as legibly as those youngsters who had learned by means of practice and emphasis on the elements in writing.

E. Typewriting

Three studies were reported on investigations made to determine which method was superior in the learning of the typewriter keyboard. Lomax, using college students as subjects in her experimental study, found very little difference in the final results between groups when achievement⁴¹ scores on the two methods were compared. She also found that the students learning to type by the whole method progressed in a more continuous and uninterrupted manner than those learning by the part method did, but that the type of errors made by both the learning groups was practically the same.

In the preliminary tests to find out which method was superior in the learning of the typewriter keyboard, Fleming, using ordinary typewriting speed test copy furnished by the

41. Beatrice Loyer Lomax, A Comparative Study of the Results Obtained in College Groups Learning Typewriting by the Whole and Part Methods. Master's Thesis, New York University, 1930.--Abstract--Research Applied to Business Education, Haynes and Humphrey, Gregg Publishing Company, New York, 192-193 (1939).

typewriter companies, found an advantage in favor of the whole method.⁴² However, when using Blackstone Stenographic Proficiency Tests as final measures of achievement, she found opposite results--four of the five tests given showed the part method to be superior.

Peltier, also using Blackstone Stenographic Proficiency Tests as the measure of achievement for the whole and part methods of learning the typewriter keyboard, with 9B pupils, found for the duration of her study that "the 'whole' method of learning the operation of the keyboard was more rapid and more economical than the 'part' method of learning."⁴³ A few of her conclusions follow: ". . .the group learning by the 'whole' method showed the greater improvement than the group learning by the 'part' method." "The group, learning by the 'whole' method, practiced typewriting from the beginning as the subject will be used in later life--by the use of sentences and paragraphs--while the group learning by the 'part' method practiced on letter combinations which presented⁴⁴ 'unreal and fantastic problems.'"

42. Elizabeth A. Fleming, A Comparative Study of the Whole and Part Methods of Teaching the Typewriter Keyboard, Master's Thesis, Pittsburgh, 1930--Abstract--Summary of Research in Commercial Education, Eighth Yearbook, 97-98 (1937-1938).

43. Gladys Smilie Peltier, A Comparison of the 'Whole' and 'Part' Method of Learning Typewriting, Master's Thesis, Norman, Oklahoma, 1934.

44. Ibid., p. 54.

As a result of these studies made on the whole and part methods of learning typewriting, it can be readily seen that the superiority of either method is still not proved. It might be well to comment at this point that the great majority of schools teaching the subject of typewriting are using textbooks that employ the use of part-method presentation of the keyboard. There are a few quite well-known typewriting textbooks now in existence, however, that, while not advocating any particular learning approach to the subject, are using meaningful drills--words, phrases, sentences, and paragraphs--in the beginning presentation of the keyboard instead of the traditional letter-drills. These letter-drills are usually difficult to master as well as meaningless to the learner and are never used as such in the individual's later use of the machine.

It is interesting to note, however, that there is now a trend toward referring to one method of presentation of the subject of typewriting as the whole method and to another as the part method, even in the textbooks. At present, there is one typewriting textbook available, whose authors claim that the approach to the typewriter keyboard as presented in the text is a combined whole and part method approach.⁴⁵ (The whole method as presented here does not have the same meaning as that used in the experimental investigations previously

45. L. W. Korona and Clyde E. Rowe, Business and Personal Typewriting, New York: Ginn and Company, 1938.

mentioned. In the experiments, learning by the whole method meant the memorizing of the entire keyboard prior to attempting to type, instead of mastering a few keys by means of letter-drills as the pupil learned to operate the typewriter.)

As used in the textbook mentioned above, the whole and part method approach employs words and meaningful phrases or sentences in presentation of the parts of the keyboard. The book refers to the use of "meaningless drills" and separate presentation of keys or sections of the keyboard as the part method of presentation. The writer of this thesis has neither personal knowledge of any school's using the above-mentioned text, nor any data as to the results achieved by this method.

III. Investigations on Application of Gestalt Psychology

In her criticism of investigations on whole-part learning, Seagoe stated that much of the confusion arising because of conflicting results is due partly to the failure on the part of investigators to define the terms "whole" and "part" except in terms of length.⁴⁶ She suggested that these terms should be defined in a qualitative rather than in a quantitative sense, and that perhaps Gestalt psychology might offer a definition of a whole that could be used profitably in this study of the whole-part problem.

46. May V. Seagoe, "Qualitative Wholes: A Re-Valuation of the Whole-Part Problem," Journal of Educational Psychology, 27:537-545 (1936).

In an experiment to ascertain the influence of the degree of wholeness on whole-part learning, she used block designs as the learning materials, ranging from rather loosely integrated figures to very closely integrated ones.⁴⁷ Data indicated that the superiority of the whole method varied roughly with the degree of integration within the block design.

A further investigation with qualitative wholes in the learning of mirror drawing, number code, block design, and chess patterns yielded results that justified her beliefs as to the possible use of Gestalt psychology for this problem.⁴⁸ She concluded her article by saying: ". . . when a whole is defined as a Gestalt with important inner relationships, and when that unit involves a relatively large ideational factor, the material is more economically presented as a unit rather than as segments as judged by efficiency of mastery and by retention. Part presentation, however, saves time in the process of presentation, although mastery of the parts does not assure mastery of the whole."⁴⁹

47. May V. Seagoe, "The Influence of Degree on Wholeness on Whole-Part Learning," Journal of Educational Psychology, 19:763-768 (1936).

48. May V. Seagoe, "Additional Laboratory Experiments," Journal of Experimental Psychology, 20:155-168 (1937).

49. Ibid., p. 167.

IV. Investigations on Study-Learning

Wrinkle, in testing the merits of the whole method versus the part method of learning, when learning took place by means of reading over the material rather than by actual memorization of it, used a unit of work in social science, "The Reconstruction of the South,"⁵⁰ for study materials. He found the whole method better for this type of learning. The individuals learning by the whole method manifested greater interest in outside reading matter and showed greater gain in knowledge of subject-matter, as determined by objective tests. It was thought that a better opportunity was afforded for more effective directed study and for greater development of proper study habits; likewise, it was thought that a better opportunity for correlation of social science with English seemed to exist when the whole method was employed.

Hoskins, likewise, made an experimental study with 360 college students to determine the effectiveness of the part and whole methods of study-learning, as opposed to that of memorization-learning.⁵¹ Most previous studies have been made

50. William L. Wrinkle, "The Relative Merit of the Whole and the Part Methods in the Teaching of the Social Sciences," Historical Outlook, 22-23:338-341 (1931-32).

51. Albert Burleigh Hoskins, The Effectiveness of the Part and the Whole Methods of Study, Doctor's Thesis, 1936, George Peabody College for Teachers, Nashville, Tennessee. (Contribution to Education, No. 189).

on memorization-learning or complete mastery. Four inter-collegiate debates, arranged in graduated scale from 1,874 words to approximately 15,000 words, were used for study. Two equalized groups of students were employed for study-learning by both the whole and the part methods.⁵² Since this is the most recent and most complete investigation in the field of study-learning, as opposed to that of memorization-learning and verbatim reproduction, Hoskins' conclusions are listed in their entirety. They are:

1. That superiority of method is not characteristic of the individual.

2. That the superiority of the one or the other is not dependent upon size of the unit of study material.

3. That the level of mental performance is not a decisive factor in the superiority of the method of study.

4. That when measured in terms of immediate or delayed recall of facts and meaning, the two methods show no statistically reliable difference.

52. Albert Burleigh Hoskins, op. cit., p. 2, "The term study-learning as used in this discussion is intended to make a distinction between the type of learning which the student actually does under study situations and that learning which is carried to the point of complete memorization. In this investigation study is defined as three repetitions or readings. This arbitrary assumption is based on three assumptions. The first of these is that the undergraduate college student, on the average, will not go over the material more than three times. That is, he may go over it once in reading the assignment, once in the lecture, and a third time in review for examinations. . . ."

5. That if these data are reliable and valid, any intrinsic differential factors making for superiority of the one or the other method of memorization-learning become apparent somewhere in the learning process beyond the limits of study-learning as defined in this investigation.

6. That as a method of study-learning these data indicate that the selection of the Part or Whole method may remain a matter of personal preference rather than one which depends on a difference in the two procedures.

7. That generalizations based upon data of memorization-learning and applied to the complex practices of ordinary study-learning are unwarranted.

8. That, so far as the data of this experiment can be evaluated, statistically, there is no reliable difference between the two methods of study-learning.

9. That to achieve economy of study-learning through the instrument of method of study some other method or methods, factor or complex of factors must be established and employed.⁵³

Discussion of the Reviews of the Investigations

This ten-year period of investigations on whole-part learning has made a substantial contribution to the literature of the field. Many of the investigations for this period have been reviewed; a great diversification of learning materials and subject fields were employed in these investigations, thereby making classification of experiments into groups, though convenient for discussion, rather difficult at

53. Ibid., pp. 41-42.

times. In some cases it was possible for the studies to have been classified in two or more groups, but for the purpose of discussion and to avoid repetition, such studies were arbitrarily grouped under one caption and were reviewed only once.

The field of memorization with its variety of learning materials proved a very rich one for investigators, as numerous studies dealt with the learning of poetry at various school and age levels. Other studies in this memorization-group dealt with the learning of prose, lines, circles, geometric figures, nonsense syllables, puzzles, shorthand, etc. In all these investigations except two, verbatim reproduction of the material was required.

In the field of muscular or motor learning, numerous investigations concerned with widely different learning fields were conducted. Maze-learning of various kinds and patterns was used by many investigators with divergent results. Several studies dealing with single-handed versus double-handed proficiency were conducted. Even gymnastics, handwriting, and typewriting came in for their share of experimentation. Complete mastery of the motor skill was the usual requirement for learning in these experiments.

Studies suggesting the use of Gestalt psychology as a possible help in the solution of the whole-part learning problem were reported.

It is notable that this ten-year period has brought about a new kind of investigation on the whole-part learning problem--thought-getting or study-learning. This method is in contradistinction to the older memorization practice in learning with verbatim reproduction of the materials learned.

Conflicting results have been obtained in many experiments. In some cases the whole method of learning has proved superior to the part method, when certain conditions exist. When these circumstances were altered, however, the part method proved better, and vice versa. Many factors believed to condition the efficiency of the different learning methods were tested, and there was some accord among the investigators in the findings.

It was generally agreed that additional studies of a scientific nature need to be made before it can be definitely decided that one method is superior to another, since the conditioning factors are so numerous in all phases of whole-part learning.

The wide range of practice, the variety of learning materials used, the geographic spread of the investigations, the contributions of the many experiments to the body of knowledge relating to learning, all combine to make a review of the whole-part problem one of great interest.

CHAPTER III

AN INVESTIGATION ON WHOLE-PART LEARNING
IN CONNECTION WITH TYPEWRITING

1935

AN INVESTIGATION ON WHOLE-PART LEARNING
IN CONNECTION WITH TYPEWRITING
1935

This investigation was conducted in the Theodore Ahrens Trade High School, Louisville, Kentucky, in connection with a class project at the University of Louisville. In the spring of 1935 the Educational Statistics and Experimental Education class in the Division of Adult Education at the University of Louisville did some experimental work in the field of learning under the guidance of the class instructor. The phase of learning investigated was the whole-part problem. As all members of the class were classroom teachers in the Louisville Public Schools, each one carried on an investigation in his own classroom. The purpose of these investigations was to determine what difference, if any, exists between learning by the whole or by the part methods.

The following discussion is a detailed account of the experimental work conducted in the Theodore Ahrens Trade High School as part of the experimental investigations which were carried on by the teachers in the afore-mentioned class in Educational Statistics and Experimental Education, of which the writer was a member. Bookkeeping and typewriting pupils

were used as subjects either in the equating group or in the actual experiment. A description of procedures employed and results obtained in the investigations by other members of this education class will be given in a subsequent chapter, so that a clear picture of the complete experimental project will be presented.

As pupils in the Business Education Department were to be employed as subjects in my particular investigation in the field of learning, it was believed that simple typewriting directions or set-up problems would be the most appropriate learning materials in this instance. Accordingly, two sets of typewriting instructions, that were thought to be of nearly equal difficulty at the time, were composed in collaboration with a teacher of business subjects in another local high school. The method of determining whether or not these two sets of instructions were of approximate difficulty will be described in detail later, under the heading, "Equating Procedures Used."

Each set of instructions contained five simple typewriting directions. It was possible to make a total score of fifty-seven on each set. Great care was exercised in the composition of the materials in order that the difficulty of the two sets be as nearly equal as possible.

These two sets of directions given below were used as the learning materials and will be referred to hereafter as Forms I and II.

FORM I

1. Nine spaces from the top of the paper, type the word, Kentucky.
2. Space down fifteen times and write your home address.
3. On the eleventh line below this, type the name of your school.
4. Go down eleven spaces further and write to-day's date.
5. Now space down seven times and type your full name.

FORM II

1. Type your last name twelve spaces from the top edge of the sheet.
2. Eight spaces below this, write Ahrens Trade School.
3. Space down fourteen times and type the words, Jefferson County.
4. Fourteen spaces below this line, type the words, Louisville, Kentucky.
5. Space down eight times and type your first name in capitals.

I. Equating Procedures Used

After the composition of materials, it was necessary to determine statistically whether or not these sets of instructions were of equal difficulty. In an effort to decide this factor, the two forms were presented to a control or equating group, a beginning bookkeeping class of twenty-five members in the Theodore Ahrens Trade High School. These pupils were likewise members of a typewriting class and quite familiar with the typewriting terms as used in Forms I and II.

Typewritten copies of Form I were given to twelve members of this class, and at the same time typewritten copies of Form II were presented to the remaining thirteen members of the group. The pupils were instructed to memorize the materials given them in the manner they usually employed for learning assigned work. Only four minutes were allowed for memorization of this material, at the end of which time the typewritten copies were turned face down and the pupils were asked to write down what they could recall on the paper previously provided. Both the typewritten copies of the instructions and the pupils' written recall of these instructions were then handed in.

Next, typewritten copies of Form II were given to the children who had just learned Form I; copies of Form II were given to the pupils who had just memorized Form II. This

method of presentation was used in order to equalize the effect of practice on the forms.

After written recall had been made on the second learning attempt, the pupils were asked to express in writing their opinions as to the difficulty of Forms I and II. They were likewise asked to describe fully the method or methods of learning they had used for each of the forms presented to them for memorizing.

It is interesting to note at this point that six of the pupils thought Form I the harder, five considered Form II the harder, and fourteen said that they believed the materials to be of equal difficulty. Another interesting feature to be noted here is that for Form I, twelve members of this equating group used the whole method of learning, while thirteen of them used some form of part learning; whereas, for Form II, only nine children used the whole method, while sixteen used some form of the part procedure.

The raw scores made on Forms I and II are given in the Appendix. These scores are depicted graphically, however, in Figure 1, arranged from high to low score on Form I. It will be noted from this graph that, in most cases, the pupils made approximately the same scores on each form, with pupils 3, 9, 10, 11, 12, 15, and 25 having the widest variation in scores. The only extreme variation in scores was made by pupil 25, however.

Figure 1
Graph Showing Comparison of Raw Scores Made on
Forms I and II for Equating Groups

The raw scores made on Form I were correlated with the raw scores made on Form II, the following Pearson product moment formula being used for determining the coefficient of correlation:

$$r_{12} = \frac{\frac{\sum x_1 x_2}{N} - c_1 c_2}{\sigma_1 \sigma_2}$$

The means were found to be 43.6 for Form I and 44.3 for Form II. The reliability coefficient for these data was found to be .84 with a probable error of .04. Next, the difference between the means was divided by its probable error. Throughout this entire study, two forms of materials or two learning methods were considered to be significantly different when the difference between means for the raw scores made on the forms when divided by the probable error of the difference was four or more. If a quotient as large as four did not exist, then the two forms of learning materials or the kinds of learning procedures employed were considered to be very much alike.

The actual difference between means of scores for Form I and Form II, when divided by the probable error of the difference, was only 1.01, well below the limit of statistical significance as stated above. Since this quotient does not represent a significant difference, the two forms were considered to be of approximate difficulty, and, therefore, satisfactory for use in the experiment proper.

II. The Experiment Proper

Two typewriting classes served as subjects for the actual investigation on whole-part learning--a morning class and an afternoon class--a total of forty-one pupils participating in this part of the investigation.

Form I was arbitrarily selected to be learned by the part method, and Form II by the whole method.

A. Preliminary Instruction and Preparation

The pupils were told that the purpose of the experiment was to find out whether there was any difference between the memorizing of certain materials by reading over the complete articles each time and the memorizing of articles after breaking them up into parts and learning each part separately. They were also told that this learning exercise was not a part of their regular work and that they would not be graded for it, but they were encouraged to put forth their best effort in order to make the experiment a success. Each child was provided with two half sheets of paper, one for use in the written recall of what had been learned by the whole method, and the other for use in the written recall of what had been learned by the part method.

The pupils were likewise told that upon the completion of the learning of each form they were actually to carry out

the directions just memorized. Each pupil was provided with two regular letter-size sheets of paper ($8\frac{1}{2}$ " x 11") for this purpose. In order to facilitate the performance of this task and to prevent loss of learning upon completion of memorization, the pupils were instructed to set up their typewriters in advance of the learning experiment. Preliminary machine set-up was identical for both the whole and part procedures; namely, each typewriter was set for single spacing and a seventy-space line, and a letter-size sheet of typewriting paper was inserted in the machine in such a way that the top edge of the sheet was even with the cylinder scale. This part of the procedure was not really a part of the experiment itself but it did serve to tie up the experiment with the regular classwork and it made it more interesting for the children when they really performed the directions on the typewriters.

B. Whole Method

The whole method of learning in this experiment is interpreted to mean the learning of the entire set of directions (Form II) by reading it all the way through each time until memorized. In order to insure complete control of the experiment, the investigator read the set of five directions in its entirety to the pupils. This was done five times, a pause of only five seconds being made between the reading of each instruction and before the repetition of the entire form.

C. Part Method

The pure part procedure, as defined on page 4, was used in this experiment. The set of instructions was broken up into parts, then after the separate learning of the individual parts, the entire set was read through, thus integrating all the parts. The manner of presentation was as follows: The first and second instructions were read four times to the pupils by the investigator; next the third and fourth instructions were read to the group four times; then the fifth instruction was read to them the same number of times; lastly, the entire set of five directions was read to them once, thus joining together the separate parts. As in the case for the whole method, a pause of five seconds was made between the reading of the instructions and before the repetitions of the various parts.

D. Presentation of Learning Materials

This same method of presentation of forms was used in both the morning and afternoon typewriting classes, the order of presentation of forms being reversed, however. For the morning class, Form I (chosen for part procedure) was used as the first learning material, then Form II (chosen for whole procedure) was presented to the pupils. To the afternoon class Form II was presented first and Form I was presented last. The reversal of presentation of forms was used in an effort to

equalize any possible advantage of practice for one form over the other that might have resulted had the same form been presented first to both groups.

E. Correlation of Experiment to Classwork

Immediately following the completion of the reading, the pupils reproduced in pencil what they could recall of the instructions as read. After the collection of the papers, ample time having been allowed for recall purposes, the pupils were asked to perform, on the typewriter, the directions just learned. This actual performance of the directions tended somewhat to correlate the experiment with the regular classroom work, as pupils in the typewriting classes had done exercises of a similar type previous to the experiment. The purpose of such exercises was to train pupils to comprehend directions as presented the first time and to perform them without repetition or discussion.

These papers were not graded for typographical errors; however, they were checked very carefully to see how closely instructions had been followed. Mention might well be made here that the results compared most favorably with the pupils' regular classwork and their ability to follow verbal directions without repetition. Some pupils performed the instructions perfectly on the typewriter, but their scores on the memorization exercises were low. Conversely, good memorizers

frequently performed poorly. This is true because there are many children who comprehend directions readily but who cannot reproduce them verbatim. There were many instances of pupils' having the right idea but not the exact words, or of not having the directions in the proper serial order, though stated verbatim.

F. Statistical Treatment of Data

The papers for the written recall of the learning exercise were scored objectively, as in the equating procedure. Verbatim reproduction of the instructions was required in order to be scored as correct.

The means of the scores were found for both forms, the standard deviations were calculated, and the correlation between scores for the two forms was computed by the same Pearson product moment formula used with the equating data. Probable errors of the means were determined, and the difference between the means divided by the probable error of the difference was ascertained.

The mean of the scores for the whole method of learning was found to be 35.22, and for the scores for the part method of learning it was found to be 39.87. The standard deviation of the mean for the whole method was 7.9 and for the part method it was 8.4. The correlation coefficient for these

Figure 2

Graph Showing Comparison of Raw Scores Made on Whole and Part Learning for Experimental Group at Theodore Ahrens Trade High School

Part Method

Whole Method

forms was .56, and its probable error was .07. While .56 is not a very high degree of correlation, it does show that some relationship exists between the two methods of learning.

Raw scores for both methods of learning are shown in the Appendix. They are depicted graphically on the bar graph shown in Figure 2, arranged in descending order on the scores made by the part method. It was possible for each pupil to make a perfect score of fifty-seven on each form. This graph shows that no perfect score was made by any pupil by either of the learning methods used. The high score for part learning was 54 and the low score was 20, the range between scores being 34 points. The highest score made by the whole method of learning was 50, the lowest score was 16, and the range between these scores was 34, as in the case of the other set of scores.

The percentile chart, Figure 3, shows the distribution of the scores for the whole and part methods of learning. It will be noted at a glance that the part method was much superior to the whole method in this instance.

G. Findings

In an effort to determine how much difference really existed between the two learning methods, the obtained difference between the means was divided by the probable error of the difference. This procedure yielded a quotient of 5.8

Figure 3

Percentile Graph of Distribution of Whole-Part-Learning
Scores for Experimental Group at the
Theodore Ahrens Trade High School, 1935.

in favor of the part method. This means that the difference between means is 5.8 times greater than its probable error, a reliable indication of significant difference between the effectiveness of the learning methods. Therefore, insofar as this part of the investigation was concerned, the part method was statistically superior to the whole method.

III. Combined Data from Two Schools

An investigation similar to the one just described was conducted in another Louisville senior high school. The same forms were used for the same types of learning; i.e., Form I was used for the part method of learning and Form II for the whole method. The investigator in this school had helped compose the forms used for learning materials. Care was exercised that the two studies be administered as much alike as possible throughout, so that the scores from the two schools might be combined in order to have a much larger population of cases. Forty pupils participated in the experiment in this school, giving a combined total of 81 scores. The combined data from the two schools make up an important part of this experimental study. While the actual conducting of the experiment was done in the other school and the scoring of papers was done by the other investigator, the actual compilation of data, making of charts, statistical treatment of data, etc., represent the writer's individual work.

A. Statistical Procedures Used

These combined data were grouped into frequency tables. Means and standard deviations of the means were calculated for the scores for both methods of learning, and correlation was computed by the same formula as before. Probable errors of the means were found, and the actual difference between the means when divided by the probable error of this difference was obtained. Raw scores and frequency tables are shown in the Appendix.

The percentile curves in Figure 4 picture the distribution of the 81 scores for the learning by both the whole and the part methods. These curves show that in this case the part method was better than the whole. An inspection of the curves shows that the percentile differences in methods are greatest about and below the central tendencies and smallest for the high and low scores. By comparing this chart with the percentile chart for the 41 cases, it will be observed that there is some agreement as to the superiority of the part method, even though the degree of superiority is less for the larger population.

The mean scores were found to be 39.78 for the part method and 37.96 for the whole method. The difference between the means is 1.82. This difference divided by its probable error is 2.73, indicating a tendency toward superiority of part learning. This ratio, however, is not sufficiently large to be

Figure 4

Percentile Graph of Distribution of 81 Whole-Part-Learning
Scores for Combined Groups of Two Louisville High Schools, 1935

considered conclusive evidence of a real difference in merit between the two methods of learning for the materials learned by these 81 subjects.

The coefficient of correlation is .42 with a probable error of .06. The probable error (.06) of this coefficient of correlation means that the chances are even that the true "r" falls between .36 and .48, or that it lies outside these limits. The chances of a correlation with a probable error of .06 having a true value as low as zero are less than one in a thousand.

The value of a correlation as low as this in prediction of scores is not very great. Knowing what a pupil would do, when using the part method of learning, would not be a very accurate measure, in this instance, for predicting achievement for the same pupil when using the whole method of learning. A reliable prediction would be impossible in this experiment because of the small population, the great variability of scores, and the low correlation coefficient.

TABLE I

Data for Three Learning Groups

GROUPS USED	N	MEANS		CORRE- LATION	PE	D/PE _D	Sig- nifi- cant
		Part	Whole				
Equating	25	43.6	44.3	.84	.06	1.01	No
Experimental (Ahrens)	41	39.87	35.22	.56	.07	5.8	Yes
Combined Group	81	39.78	37.96	.42	.06	2.73	No

IV. Findings

The study of this investigation may be concluded by stating that, for these groups, differences in favor of the part method were found, but in only one of them was the difference large enough to be considered of statistical importance. For this group of 41 cases, however, it may be said that the part method was the significantly superior method. Insofar as the other cases are concerned, it may be concluded that the part method tended toward superiority, but not to a highly significant degree.

CHAPTER IV

INVESTIGATIONS OF WHOLE-PART LEARNING

in

LOUISVILLE PUBLIC SCHOOLS

1935

INVESTIGATIONS OF WHOLE-PART LEARNING
in
LOUISVILLE PUBLIC SCHOOLS, 1935

This chapter will be devoted to a brief discussion of all the experiments performed by the members of the Educational Statistics and Experimental Education class at the University of Louisville, Louisville, Kentucky, in the spring of 1935. These experiments were conducted as part of a class project. The membership of the class included teachers from both elementary and secondary levels--one elementary school, one junior high school, and five senior high schools participated in the experimental work.

The teachers in the various schools conducted the investigations in their own classrooms, using some of their own pupils as subjects for both the equating groups and the actual experimental groups. The investigators either worked individually on these experiments or in groups of two.

The learning materials to be used for both the whole and part methods were selected by the individual teacher, or group of teachers, from sources believed to be unfamiliar to the learners. In some instances, these materials were chosen by the investigators from literature already available and in

other cases materials were composed by the investigators for use in their experiments.

Poetry was used as the learning material in six of the investigations. A set of five statements about the chemistry of a metal and another set of five statements about the chemistry of a non-metal were used in two of the experiments as learning materials. In the remaining two experiments, two sets of simple typewriting directions were used for memorization purposes.

I. Equating of Material to be Learned

After the selection or composition of these learning materials, they were presented to control or equating groups in an effort to determine whether or not learning difficulty was equal, as judged by the investigators at the time of selection.

For each investigation, two sets of learning materials were equated for difficulty--two stanzas of the same poem, or two groups of stanzas, or two sets of other learning materials. In most cases, the pupils of the equating groups were told that the two sets of materials might be learned by any method desired; however, in two cases, the way of learning was controlled by the investigators. Hereafter, for convenience of discussion, any two sets of learning materials will be referred to as Form I and Form II.

Various methods of presentation of learning materials were employed in the different schools. In some of them, typewritten or mimeographed copies of the materials were given to pupils, while in others, the materials were written on the blackboard; and in one experiment, the materials were read to the pupils by the investigator. Likewise, the time allowed for the actual memorization of the forms varied with the different investigations.

However, in all cases, the following procedure was used in order to prevent an advantage of practice for either form over the other one: Form I was presented to half of the equating group to be memorized in the way ordinarily used by the learners, while Form II was given to the other half of this group to be learned in any desired manner. As soon as the materials had been learned and the children had written down what they could recall, Form II was then presented to the pupils who had just memorized Form I, and Form I was given to the ones who had just learned Form II. It was hoped by this reversal of presentation of forms to equalize the practice effects on the forms.

The raw scores of Form I were correlated with the raw scores of Form II for each equating group. Rank order correlation or the Pearson product moment method of correlation was employed to ascertain the reliability coefficients for these equated materials. Table II gives complete data for the

TABLE II
DATA FOR EQUATING GROUPS IN EXPERIMENTS ON WHOLE-PART LEARNING
Louisville Public Schools
1935

Experiment	Material Learned	N	Grade	Highest Possible Score	Means		r_{11}	D/PE _D
					Form I	Form II		
I	Poetry	27	5 and 6	42	33.44	33.14	$.94 \pm .02$	.83
II	Poetry	28	7B	47	36.80	34.80	$.68 \pm .07$	1.77
III	Poetry	20	Senior High	42	33.10	32.40	$.85 \pm .04$	.59
IV	Poetry	30	Senior High	84	61.00	59.80	$.46 \pm .09$	.58
V	Poetry	20	Senior High	20	10.95	10.90	$.90 \pm .03$	.14
VI	Poetry	25	Senior High	16	6.44	6.32	$.82 \pm .04$	.41
VII	Chemistry	20	Senior High	25	14.40	14.30	$.72 \pm .07$	.13
VIII	Chemistry	Equating data taken from Experiment VII						
IX	Typewriting	25	Senior High	57	44.30	43.60	$.84 \pm .04$	1.01
X	Typewriting	Equating data taken from Experiment IX						

equating groups. A study of the table reveals that all of the reliability coefficients, with the exception of one, were high enough to be used for group comparisons; this one was not too low to be entirely valueless, however. It will also be noted that the differences between the means for the two sets of scores when divided by the probable errors of their respective differences ranged from .13 to 1.77.

The same criterion of determining whether or not one form was more difficult than the other was followed by all the investigators in these experimental studies; namely, that the actual differences between means be at least four times the probable errors of the differences. Since the quotients (D/PE_D) in all cases were all well below the statistical limits thus defined, the two forms to be used in each experiment were considered to be of approximate equal difficulty.

II, The Experiments Proper

After the satisfactory equation of the materials, the investigators then proceeded with the actual experiments. The form to be memorized by the whole method and the one to be memorized by the part method was now determined. The amount of time to be allowed for learning purposes was likewise determined. Since the length of learning materials varied with the different experiments, the number of minutes for the memorization of the forms likewise varied. Since no particular

form of the part method was specified, several modifications were employed.

In order to insure a better control over the learning situation, the materials to be memorized were read to the children by the investigators in all cases. After each form had been read to the learners the prescribed number of times, the number of times each line was read being the same for both the whole and part methods of learning, sufficient time was given to them for writing down what they could recall.

Whenever it was possible, the class participating in the experiments was arbitrarily divided into two groups of equal size. Then the forms that had been chosen to be memorized by the whole method was presented to section one of the class, the material to be learned by the part method being presented to the same group immediately after the written recall for the first learning trial. To section two of the class, the order of presentation of learning methods was reversed, thus: The part method was employed first, and then the whole method. In cases where only one class was used for experimental purposes, and it was divided into two sections, the experiment took two days for completion. When two separate classes, however, were used for experimental purposes, the experiment was completed in one day. The order of presentation of methods was likewise reversed when members of two or more classes were used as subjects for the investigations: The whole method was presented

first to one class, then the part method was presented to it; while to the second class, the part method was presented first, then the whole method. As in the case of the equating groups, the method of learning was reversed in an effort to equalize practice effects on both learning procedures.

After the papers had been scored objectively, the data for the whole method were correlated with the data for the part method (Pearson product moment method of correlation being used), standard deviations determined, differences between means ascertained, probable errors of these means calculated, and the critical ratios were obtained.

In all, there were ten different experiments carried on. Investigations were made as to: (1) the learning of poetry, (2) the learning of statements relating to the field of chemistry, and (3) the learning of simple directions in typewriting.

A brief description of each of these ten experiments, together with their findings, follow. No effort was made to correlate the data of these various experiments, so each investigation will be discussed separately. Nine of the experiments were the work of the fellow classmates of the writer in the Educational Statistics and Experimental Education class at the University of Louisville. However, the compilation of data from these experiments, the tables formed, the conclusions drawn, and the composition of the present report of the study of these investigations are the writer's own effort.

III. Description of Experiments

EXPERIMENT I

Equating of Materials.---Twenty-seven pupils in the 6B class of an elementary school participated in this part of the experiment. Typewritten copies of two stanzas from the poem, "Summer Days," were used for learning purposes. Ten minutes were allowed for learning by any method desired. Co-efficient of correlation was $.94 \pm .01$.

Experiment Proper.---Fifty-eight pupils from the fifth and sixth grades of the same school composed the main experimental group. Stanza I was presented by the whole method, Stanza III by the part method. Each stanza was read eight times. The form of the part method of learning used was as follows: The first line was read eight times, the second line eight times, and so on, until the stanza was completed, at no time returning to any previous line for review.

So far as group averages are concerned, the whole method is superior. The critical ratio (D/PE_D) of 2.27 indicates that there are 94 chances in 100 that the whole method will, on the average, always be superior.

Learning Materials for Experiments I and II

Stanzas I and III from the poem, "Summer Days," by D. Pond, age sixteen, from Anthology of Poems by Children.

Stanza I was used for the whole method in Experiment I and for the part method in Experiment III.

Stanza I

A gray sage stretches across the plains,
And the cactus blooms are red;
And the earth is fresh from a summer's rain,
And the winter days are fled;
The sweet-scented pines sway to and fro,
And the rivers are flooded with melting snow.

Stanza III was used for the part method in Experiment I and for the whole method in Experiment III.

Stanza III

A long trail winds to the sunset hills
Out over the mesas wide;
Through cañons cool, by tiny rills
With spruces on either side.
And I long with a longing I cannot still
To be home again near the sunset hill.

EXPERIMENT II

Equating of Materials.--Twenty-eight pupils from an 8B class of a junior high school were presented with typewritten copies of stanzas of poetry, eight lines each, to be learned by any method. Four minutes were allowed for memorization. Coefficient of correlation was $.68 \pm .07$.

Experiment Proper.--Thirty pupils from the 7B class of this same junior high school learned these two stanzas by both methods of learning, Stanza I by the whole method and Stanza II by the part method. For the whole method, the first stanza was read all the way through four times by the teacher. For the part method, each line was read four times by the teacher before proceeding to the next line, at no time returning to any previous line for review.

A very significant difference in favor of the whole method is found so far as group averages are concerned, the critical ratio being 7.83, nearly twice as large as it needs to be in order to guarantee significant superiority.

Learning Materials for Experiment II

By Marteena Adamson (Current Science, April 19, 1935).

Stanza I was used for the whole method of learning.

Stanza I

When grandma was a little girl
She rode across the plains
In high-wheeled wagons rough and slow,
Because there were no trains.
The oxen slowly pulled the plow,
The grain was cut by hand,
The women spun their own coarse cloth,
The candles lit the land.

Stanza II was used for the part method of learning.

Stanza II

But now you speed across the land
In cars and aeroplanes;
Sometimes you take a touring bus,
Sometimes you go on trains.
Your clothes are soft and factory-made
You use electric lights
That light your homes, and towns and streets
And turn days into nights.

EXPERIMENT III

Equating of Materials.--Twenty girls from high school A took part in this phase of the experiment. The two stanzas from "Summer Days," used in Experiment I, were used as learning materials. These were written on the blackboard, four minutes being allowed for memorization by any method used ordinarily. Coefficient of correlation was $.85 \pm .04$.

Experiment Proper.--Fifty-two other girls from the same high school participated in the experiment proper. Stanza I was presented by the part method, Stanza III by the whole method, just the reverse of the procedure used in Experiment I. The following modification of the part method of learning was used: The first two lines of Stanza III were read three times, then lines three and four were read two times, then the four lines were read twice; next, lines five and six were read three times, then all six lines were read twice. The time used for each method was approximately three minutes.

Results favor the whole method, the critical ratio being 1.68--87 chances in 100 that the means are statistically different.

EXPERIMENT IV

Equating of Materials.--Thirty boys from senior high B learned, from mimeographed copies, two selections from Browning's "Andrea del Sarto," by the method preferred by each. Five minutes were allowed for the learning of the materials. The investigator told the pupils that the results of the experiment would be used in connection with their monthly grades.* Coefficient of correlation was $.46 \pm .098$.

Experiment Proper.--Fifty-four other boys from the same high school served as subjects. The pure part method was used, each part (two lines) being read seven times, at no time were any of the previously-learned parts reviewed.

A very slight difference favors the whole method of learning, the critical ratio being only .18.

*In all the other experiments, the pupils were told that these results made on the experiments would in no way affect their school grades.

Learning Materials for Experiment IV

From Browning's "Andrea del Sarto." Part I was used for whole-method learning.

Part I

But do not let us quarrel any more,
No, my Lucrezia; bear with me for once;
Sit down and all shall happen as you wish.
You turn your face, but does it bring your heart?
I'll work then for your friend's friend, never fear,
Treat his own subject after his own way,
Fix his own time, accept too his own price,
And shut the money into this small hand
When next it takes mine. Will it? Tenderly?
Oh, I'll content him--but to-morrow, Love!

Part II was used for the part method of learning.

Part II

I often am much wearier than you think,
This evening more than usual, and it seems
As if--forgive now--should you let me sit
Here by the window with your hand in mine
And look a half-hour forth on Fiesole,
Both of one mind, as married people use,
Quietly, quietly the evening through,
I might get up to-morrow to my work
Cheerful and fresh as ever. Let us try.
To-morrow, how you shall be glad for this!
Your soft hand is a woman.

EXPERIMENT V

Equating of Materials.--Another group of twenty girls from senior high school C learned the poem, "Significance of Color." This sixteen-line poem was divided into two equal parts, each part being read to the pupils six times. No mention was made of the manner of learning to be employed. Coefficient of correlation was $.90 \pm .03$.

Experiment Proper.--Forty-nine other girls from this same senior high school participated in the experiment proper. The first eight lines of the poem were presented by the whole method, the last eight lines by the part method. The progressive part method was used; The first line was read four times, the second line four times, then the first and second lines were read together; next the third line was read four times, the fourth line four times; then lines three and four were read together; lines five and six were then read separately four times, then they were read together; lines seven and eight were read in the same manner; next all lines were read through once.

Results favor the whole method of learning, the critical ratio being 1.50--84 chances in 100 that the obtained difference is significant.

Learning Materials for Experiments V and VI

"Significance of Color," was an original composition of the investigators.

The first eight lines were used for learning by the whole method.

Red is rich, vital, and warm
Often used as a sign of alarm.

Orange is bright, decorative, cheery,
Should not be displayed by the aged or weary.

Yellow is soft, cozy, and mellow.
Bask in the sun's glow, lazy yellow.

Green is the sign of something growing,
Refreshing, cool, life and vim glowing.

The last eight lines were used for the part method of learning.

Blue is aloof, distant, and cool,
Blue skies, blue water in a blue pool.

Violet, rich, warm, elderly, royal,
No characteristic of those who toil.

Black so forlorn, depressing like mourning,
Mystical, old folks adorning.

White is the symbol of cleanliness, truth,
Holiness, purity, background of youth.

EXPERIMENT VI

Equating of Materials.--Twenty-five additional girls from senior high school C learned "Significance of Color," the same poem as used in Experiment V. Eight minutes were allowed for learning by any method desired. Coefficient of correlation was $.82 \pm .04$.

Experiment Proper.--Sixty-three other girls from the same high school participated in the experiment proper. The first eight lines were used for whole learning, the last eight for part learning. Each part was read six times. The part procedure used was as follows: Lines one and two were read three times; lines three and four were read three times, then lines one to six inclusive were read together; lines seven and eight were read four times; then lines five, six, seven, and eight were read together; then, all eight lines were read through once.

A critical ratio of 4.90 was found in favor of the whole method of learning. This indicates a significant superiority of the whole method.

EXPERIMENT VII

Equating of Materials.--Twenty girls from senior high school C had two sets of chemistry statements read to them by the teacher, to be learned by the whole method; one set of statements related to Germanium and the other set related to Selenium. The materials were read through five times. Coefficient of correlation was $.72 \pm .01$.

Experiment Proper.--Eighty-one other girls from this same school participated in the experiment proper. The set of statements about Germanium was learned by the whole method, while those statements about Selenium were learned by the pure part method. Each set was read five times for each method of learning.

A very significant difference favors the whole method of learning, the critical ratio being 16.00, four times as large as it needs to be in order to guarantee that the true difference is greater than zero.

Learning Materials for Experiments VII and VIII

Used for part-method learning in Experiment VII and for whole-method learning in Experiment VIII.

Selenium

Selenium belongs to the sulphur family.
The atomic weight of Selenium is 79.
It is obtained as a by-product in the refining of copper.
It conducts **electricity** in the light but not in the dark.
It is added to glass to produce a fine red color.

Used for whole-method learning in Experiment VII and for part-method learning in Experiment VIII.

Germanium

Germanium is a white lustrous metal.
The melting point of Germanium is 958.
It was discovered by Winkler in the year 1886.
It dissolves in sulphuric acid but not in hydrochloric acid.
It unites with oxygen to form Germanium oxide.

EXPERIMENT VIII

Equating of Materials.--The equating of materials was done in high school C, as described in Experiment VII.

Experiment Proper.--Ninety-nine girls from high school A participated in the experiment proper. The statements about Selenium were used for the whole method of learning and the ones about Germanium for the part method of learning, just the opposite of the procedure used in Experiment VII. Each set was read five times for each method of learning. The pure part method was employed.

The data show a highly significant difference in favor of the part method, the critical ratio being 10.71. The results of this experiment are the reverse of the findings of Experiment VII at high school C. No satisfactory explanation for such dissimilarity of results between Experiments VII and VIII can be given.

EXPERIMENT IX

Equating of Materials.--Twenty-five pupils in high school D served as subjects for equating the two sets of simple type-writing instructions. Typewritten copies of the instructions were given to the children to be learned by whatever method desired. Four minutes were allowed for the learning of each set. This procedure for equating of materials was discussed fully in Chapter III of this paper. Coefficient of correlation was $.84 \pm .04$.

Experiment Proper.--Forty-one other pupils from this same school participated in the experiment proper. Form I was presented by the part method, Form II by the whole method. Each form was read five times by the investigator to the pupils. The pure part method, as defined in Chapter I, was employed in this manner: Instructions one and two were read to the class four times, then instructions three and four were read four times; next, instruction five was read four times, then all five directions were read together once.

A critical ratio of 5.80 indicates a significant difference in favor of part learning.

Learning Materials for Experiments IX and X

Form I was used for part learning in both experiments.

Form I

1. Nine spaces from the top of the paper, type the word, Kentucky.

2. Space down fifteen times and write your home address.

3. On the eleventh line below this, type the name of your school.

4. Go down eleven spaces further and write to-day's date.

5. Now space down seven times and type your full name.

Form II was used for whole learning in both experiments.

Form II

1. Type your last name twelve spaces from the top edge of the sheet.

2. Eight spaces below this, write _____*
School.

3. Space down fourteen times and type the words, Jefferson County.

4. Fourteen spaces below this line, type the words, Louisville, Kentucky.

5. Space down eight times and type your first name in capitals.

*The name of the high school participating in the experiments was inserted in the blank when read to the pupils.

EXPERIMENT X

Equating of Materials.--This part of the investigation was done in high school D, as described in Experiment IX.

Experiment Proper.--Forty pupils from high school E participated. The same sets of simple typewriting instructions were used for learning materials. Form I was used for the part method and Form II for the whole method. All procedures were the same as those used in Experiment IX.

A slight difference--a critical ratio of 1.49--is found in favor of the whole method; this ratio is not large enough to indicate significant superiority of the whole method, however.

COMBINED DATA FROM EXPERIMENTS IX AND X
(Designated as Experiment XI in Table III)

The data from Experiments IX and X were combined in order to have a larger population and to see in what ways this grouping would change the results obtained in the two separate experiments. Since the materials were the same in both of the schools and the procedures were as much as alike as possible, it was thought satisfactory to combine these data in this way.

The combined data show a difference in favor of part-learning. The difference between means divided by its probable error is 2.73--there are 97 chances in 100 that this difference is statistically reliable and only 3 in 100 that it is due to chance.

TABLE III
DATA FOR EXPERIMENTS ON WHOLE-PART LEARNING
Louisville Public Schools
1935

Experiment	Material Learned	N	Grade	Highest Possible Score	Means		r ₁₂	D/PE _D	Significant	Superior Method
					Whole Method	Part Method				
I	Poetry	58	5 and 6	42	22.63	19.51	.80±.05	2.27	No	Whole
II	Poetry	30	7B	47	37.30	27.80	.42±.10	7.85	Yes	Whole
III	Poetry	52	Senior High	42	28.30	27.00	.74±.06	1.68	No	Whole
IV	Poetry	54	Senior High	84	42.41	42.03	.35±.08	.18	No	Whole
V	Poetry	49	Senior High	20	6.25	6.08	.53±.07	.50	No	Whole
VI	Poetry	63	Senior High	16	7.08	6.11	.76±.04	4.90	Yes	Whole
VII	Chemistry	81	Senior High	25	21.18	17.30	.57±.05	16.00	Yes	Whole
VIII	Chemistry	99	Senior High	25	18.00	21.00	.54±.05	-10.71	Yes	Part
IX	Typewriting	41	Senior High	57	35.22	39.87	.56±.07	- 5.80	Yes	Part
X	Typewriting	40	Senior High	57	41.00	39.68	.33±.09	1.49	No	Whole
XI*	Typewriting	81	Senior High	57	37.96	39.78	.42±.06	- 2.73	No	Part

*Experiments IX and X combined.

IV. Discussion of Tables

Table II summarizes the data for the equating groups for the various experiments. The difference between the means of the scores for Form I and Form II, when divided by the probable error of the difference, was not large enough in any of the experiments to show a real difference in merit in the forms for learning purposes. The differences ranged from .13 to 1.77, all well below the limits of statistical significance. The reliability coefficients of correlation ranged from $.46 \pm .09$ to $.94 \pm .02$. While some of these coefficients of correlation were not very high, all of them were sufficiently large for group comparisons. Even the lowest correlation was not so low as to be of no value at all.

The data in Table III are for the experiments proper. Statistical differences were found in five of the experiments, three favoring the whole method of learning and two favoring the pure part method or some modification of it. Poetry was used as the learning material for two of the three experiments that showed a significant difference in favor of the whole method; statements relating to chemistry were used as the learning material for the third experiment of this group which showed a significant difference in favor of the whole method. For the two experiments in which a difference in favor of part learning was found, the statements relating

to chemistry were used in one case and simple typewriting directions in the other.

In Experiment VII, quite a significant difference, the largest favoring either method, was found in favor of the whole method, while in Experiment VIII, another quite significant difference was found in favor of the part method; this difference was the second greatest difference favoring either method. The statements about Germanium were used for the whole method for Experiment VII and for the part method for Experiment VIII. No good reason can be cited as to why the whole method proved superior for the group of 81 pupils in one school when learning the same statements that the group of 99 pupils learned in another school. Apparently the two experimental groups had comparable socio-economic backgrounds, and the experiments were conducted as nearly alike as possible in both the schools.

Experiment XI, as listed on the table, is not a separate experiment; the data from Experiments IX and X were combined in order to have a larger number of cases. As the learning materials used in both schools were the same, and as the method of presentation was as nearly alike as possible, it was thought permissible to combine the data for the two experiments. The results of these combined data show the part method to be superior, but the difference was not large enough to be considered of statistical importance.

V. Findings

1. Ten investigations were conducted in all. Six of them dealt with the memorization of poetry, two with the memorization of statements relating to the chemistry of a metal and a non-metal, and two with the learning of simple directions for typewriting. A total of 762 subjects participated in the experimental work--195 being used in the equating of materials, and 567 others actually participating in the experiments proper.

2. In all six of the experiments involving the memorization of poetry, the whole method was found to be the superior method; however, in only two of these investigations were the differences statistically significant.

3. In the two investigations using chemistry statements for the learning materials, the whole method proved to be superior for one group, while for the other group the part method proved superior. Both of these investigations showed differences that were of great statistical significance.

4. There was a significant difference found in favor of the part method for one of the experiments using simple typewriting directions as the learning materials. In the second experiment using the typewriting directions, the whole method proved slightly superior, though the difference between group results was not of statistical importance.

CHAPTER V

DISCUSSION AND CONCLUSIONS

DISCUSSION AND CONCLUSIONS

The findings of the studies reviewed for the ten-year period, 1930-1939, in the field of whole-part learning, strongly favored the whole method of learning. Approximately 45.7 per cent of the investigations yielded results in favor of the whole method, while 32.6 per cent favored part learning, and 21.7 per cent showed no reliable or statistical differences in favor of either learning method. However, in many of the investigations showing no statistical differences, there was a tendency toward the superiority of the whole method.

The same general results were found to exist in the two major classifications of the investigations reviewed, memorization and motor learning. Forty-two and nine-tenths per cent of the memorization studies favored whole learning, 33.3 per cent favored part learning, with 23.8 per cent showing no statistical differences. In the field of motor learning, 45 per cent of the investigations favored whole learning, 40 per cent of them favored part learning, with only 15 per cent showing no significant differences between methods.

The survey of literature also revealed that several factors conditioned the efficiency of learning methods, for example, I. Q. was found to be such a factor in comparing the learning abilities of gifted and normal children; likewise,

sex was found to be a conditioning factor in another instance.

Two relatively new fields in experimentation developed during the ten-year period; namely, (1) the contribution of Gestalt psychology to the whole-part problem, and (2) the study-learning technique. It was suggested that possibly this concept of wholeness, as contributed by Gestalt psychology, might offer a solution to the whole-part problem. In the field of study-learning, one investigation yielded results in favor of the whole method of learning, while in another study, no reliable differences were found to exist between the two methods where learning and retention were concerned.

A further study of these investigations showed that in many instances the number of cases was too small to justify the definite conclusions made. Conflicting results of the investigations create confusion of thought. No general agreement seems to exist as to ways of testing the efficiency of either learning or retention. Retention was checked in comparatively few of the experiments. Definitions were not clear in many cases, and the interpretations of the terms were varied.

From the foregoing review of investigations, it can be concluded that more extensive research of a scientific nature should be made. Continued research in the field of study-learning would be especially desirable since this is a new approach to the whole-part problem. Further experimentation

with Gestalt psychology might also prove worthwhile. An especially valuable contribution would be a general agreement as to definitions of terms. Likewise, the use of similar criteria in the measurement of both learning and retention would be of much value in assisting readers in their interpretation of data on the whole-part problem.

As it now stands, the available data favor the whole method of learning. It would be interesting to see what effect further research might have upon the problem.

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A P P E N D I X

RAW SCORES FOR FORMS I AND II
Equating of Materials, Theodore Ahrens Trade High School

<u>Pupil</u>	<u>Form I</u>	<u>Form II</u>
1	56	56
2	55	54
3	54	43
4	53	55
5	52	51
6	50	55
7	50	53
8	50	44
9	50	40
10	49	41
11	49	40
12	48	57
13	47	51
14	46	40
15	45	53
16	43	45
17	40	38
18	40	37
19	38	38
20	37	34
21	35	38
22	32	39
23	26	32
24	24	30
25	21	42

WHOLE METHOD--FORM II

Experimental Group at Theodore Ahrens Trade High School

1935

Class Indices	Class Intervals	Frequencies	x'	fx'	$f(x')^2$
54	52.5 - 55.4	0			
51	49.5 - 52.4	3	5	15	75
48	46.5 - 49.4	1	4	4	16
45	43.5 - 46.4	4	3	12	36
42	40.5 - 43.4	4	2	8	16
39	37.5 - 40.4	2	1	2	2
36	34.5 - 37.4	3	0	0	0
33	31.5 - 34.4	7	-1	-7	7
30	28.5 - 31.4	6	-2	-12	24
27	25.5 - 28.4	7	-3	-21	63
24	22.5 - 25.4		-4	0	0
21	19.5 - 22.4	1	-5	-5	25
18	16.5 - 19.4		-6	0	0
15	13.5 - 16.4	1	-7	-7	49
		$N = 41$	$\Sigma = -11$		313

 $M = 35.22$

Range = 34

 $\sigma = 7.9$

Interval = 3

PART METHOD--FORM I

Experimental Group at Theodore Ahrens Trade High School

1935

Class Indices	Class Intervals	Frequencies	x'	fx'	$f(x')^2$
54	52.5 - 55.4	3	5	15	75
51	49.5 - 52.4	4	4	16	64
48	46.5 - 49.4	3	3	9	27
45	43.5 - 46.4	5	2	10	20
42	40.5 - 43.4	3	1	3	3
39	37.5 - 40.4	5	0	0	0
36	34.5 - 37.4	6	-1	- 6	6
33	31.5 - 34.4	6	-2	-12	24
30	28.5 - 31.4	3	-3	- 9	27
27	25.5 - 28.4	2	-4	- 8	32
24	22.5 - 25.4	0	-5	0	0
21	19.5 - 22.4	1	-6	- 6	36
		$N = 41$	$\Sigma = 12$		314

 $M = 39.87$

Range = 34

 $\sigma = 8.4$

Interval = 3

RAW SCORES (COMBINED DATA) FOR WHOLE AND PART LEARNING
OF TYPEWRITING INSTRUCTIONS

<u>Pupil</u>	<u>Part</u>	<u>Whole</u>	<u>Pupil</u>	<u>Part</u>	<u>Whole</u>
* 1	54	45	13	44	50
2	54	42		44	49
3	54	37	14	44	45
	53	49	15	44	31
	53	42		43	47
4	52	48		43	47
5	52	44		43	40
	52	43		43	31
6	51	50		42	41
7	51	36	16	42	30
	50	52		42	25
	49	55	17	42	27
8	49	50		41	51
	49	31		41	42
9	48	31	18	41	33
	47	43		40	48
10	47	34		40	46
	47	29	19	40	32
11	46	41		40	31
	45	49	20	39	43
	45	43	21	39	27
	45	37		38	52
12	45	32		38	42
	44	51	22	38	27

RAW SCORES--COMBINED DATA--(Continued)

<u>Pupil</u>	<u>Part</u>	<u>Whole</u>	<u>Pupil</u>	<u>Part</u>	<u>Whole</u>
23	38	21		32	44
	37	39		32	39
24	37	34	35	32	28
	36	47	36	31	35
25	36	36	37	30	45
26	35	41		30	34
	35	38		29	44
27	35	31	38	29	35
28	35	28		28	36
29	35	28	39	28	30
30	34	38		27	29
31	34	33	40	26	28
32	34	33		25	47
	34	31		25	31
33	33	40	41	20	16
	33	33			
34	33	30			

*The numbered sets of scores indicate the scores of the 41 pupils of the Theodore Ahrens Trade High School. The other sets of scores are those obtained in another local high school. These scores were combined in order to have a larger population of scores.

WHOLE METHOD OF LEARNING

Typewriting Instructions

(Combined Scores from Two Louisville High Schools, 1935)

Class Indices	Class Intervals	Frequencies	x'	fx'	$f(x')^2$
54	52.5 - 55.4	1	5	5	25
51	49.5 - 52.4	7	4	28	112
48	46.5 - 49.4	9	3	27	81
45	43.5 - 46.4	7	2	14	28
42	40.5 - 43.4	11	1	11	11
39	37.5 - 40.4	6	0	0	0
36	34.5 - 37.4	7	-1	- 7	7
33	31.5 - 34.4	10	-2	-20	40
30	28.5 - 31.4	13	-3	-39	117
27	25.5 - 28.4	7	-4	-28	112
24	22.5 - 25.4	1	-5	- 5	25
21	19.5 - 22.4	1	-6	- 6	36
18	16.5 - 19.4	0	-7	0	0
15	13.5 - 16.4	1	-8	- 8	64
		$N = 81$	$\Sigma = -28$		658

 $M = 37.96$ $\sigma = 8.5$

Range = 39

Interval = 3

PART METHOD OF LEARNING

Typewriting Instructions

(Combined Scores from Two Louisville High Schools, 1935)

Class Indices	Class Intervals	Frequencies	x'	fx'	$f(x')^2$
54	52.5 - 55.4	5	5	25	125
51	49.5 - 52.4	6	4	24	96
48	46.5 - 49.4	7	3	21	63
45	43.5 - 46.4	10	2	20	40
42	40.5 - 43.4	11	1	11	11
39	37.5 - 40.4	10	0	0	0
36	34.5 - 37.4	9	-1	- 9	9
33	31.5 - 34.4	10	-2	-20	40
30	28.5 - 31.4	5	-3	-15	45
27	25.5 - 28.4	5	-4	-20	80
24	22.5 - 25.4	2	-5	-10	50
21	19.5 - 22.4	1	-6	- 6	36
		N = 81	$\Sigma = 21$		595

$$M = 39.78$$

$$\text{Range} = 34$$

$$\sigma = 8.1$$

$$\text{Interval} = 3$$