THE VALUE OF A WORKBOOK IN TEACHING ARITHMETIC IN GRADES SEVEN AND EIGHT

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M. E. J.

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CHAPTER I

INTRODUCTION

The value of a workbook in teaching arithmetic is a matter that has provoked much discussion among educators. In the past nine years at least five persons have written Master's theses on this subject. One of the theses deals with grades four to eight, inclusive.[1]

Justification for this, another study to determine the value of a workbook in teaching arithmetic in the seventh and eighth grades, is found in the differences in the methods used in carrying out the two experiments. The chief differences are:

	PREVIOUS EXPERIMENT[2]		THIS EXPERIMENT
1.	One-group technique. One group in each grade.	1.	Rotation-group technique, with parallel groups. Two groups in each grade.
2.	Definite time set aside each day for drill with the practice pad when it was in use.	2.	No definite time given to workbook drill. Time varied, as needed to supplement the text.
3.	Workbooks used in alternate semesters.	3.	Workbooks used in alternate six week periods.
4.	Two tests given.	4.	Four tests given.
5.	Standardized tests used to measure gain.	5.	Informal tests used to measure gain.
6.	All testing done by the same person. (Presumably class instruction was given by other teachers.)	6.	All phases of the work, planning, teaching, and testing, were carried on by the same person.

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[1] Paul William Haller, The Value of the Arithmetic Workbooks in Teaching Arithmetic in Grades 4-8 inclusive. Master's thesis, 1930, Indiana University.

[2] Ibid. pp.1-43.

In a large number of schools in Oklahoma the state adopted textbook is the dominant instrument in the teaching of arithmetic, and promotions are made in groups at the end of stated periods instead of individually as the child demonstrates his ability to do the work of the next grade. In such schools the teacher usually obtains material for supplementing the text, drill for slow pupils or enrichment of the course for quicker ones, in one of three ways; one, when the material for two or more grades is bound within one cover, as in the case of the present text, she may use similar problems of greater or lesser difficulty found in other parts of the text; two, she may depend upon problems of her own devising or selecting, writing them on the blackboard or passing prepared copies of the problems to each child; or three, she may require that each child own a copy of the practice pad or workbook she selects from the many such books offered for sale by publishing companies.

Each of these methods has its strong and its weak points. Consider then briefly:

(1). Utilization of similar problems from other parts of the textbook. This involves no additional expense, but it demands a comprehensive knowledge of the text and effective planning on the part of the teacher. Before any assignment is made the teacher must be familiar with the problems, their degree of difficulty, and the type of work each presupposes. A review of the work done the preceding year may give added confidence to the pupil in the upper grade using the text,

especially if the child considers the work difficult, and he will feel less apprehensive about assignments in his own grade. With the pupil of the lower grade, when understanding of the new work seems assured, solving problems in the part of the book designated for the next grade seems to give a lift to the spirit that no amount of accomplishment in his own grade gives. Failure to solve problems in the advanced portion of the book because the teacher unwisely chose some that involved processes not yet studied not only destroys the elation, but gives rise to the "How do you expect me to do this? This is a grade ahead of me," attitude. Poor planning may destroy more than it builds. Another difficulty is encountered in finding sufficient material for the upper grade to practice new abilities, and enough easy material for slower pupils in the lower grade.

(2). Teacher devised, or teacher selected problems. This is an excellent idea, but difficult to carry out, because it requires so much time. Usually this method is used in the belief that the advantages of a workbook are gained at a cost lower than that of purchasing a workbook for each child. Actually, when the time element is considered, this is an expensive method. If the problems are written on the blackboard for the class to copy, the students lose time that could be more profitably spent than in merely copying accurately the problems assigned. Some gain may be derived from this copying, but certainly children do not need such practice two, three, or more times a week for the entire school year. Often

poor lighting, cases of defective vision, or limited blackboard space makes it imperative that the work be prepared for each pupil as hektographed or mimeographed sheets. If the time spent in preparing such copies is valued at that of the regular wage paid clerical help, it is estimated that the cost of such a workbook substitute would range upward from thirty cents per pupil, depending upon the quantity of supplementary material offered. Preparation may demand much of the teacher's time that should be devoted to other activities. Another weakness is the necessity for completing the preparation of the copies far in advance of the date needed, in order that unexpected events that limit the teacher's time will not disrupt the plan of study.

(3). Use of a practice pad or workbook purchased for each child. Because this involves the expenditure of a sum of money for a book for which there is no resale value, more parents have definite opinion concerning this type of supplementary material than any other. Many opinions are colored by the manner in which teachers have used the workbook. Comments will range from "I don't see how my child could have managed without his workbook", to "All she ever used it for was to keep them busy while she did something else", both comments prejudiced, and perhaps equally distant from the truth.

In an effort to learn the answer to the oft repeated question, "Just what is the value of an arithmetic workbook?", a study was made in the seventh and eighth grades of Roosevelt Junior High School, Oilton, Oklahoma, beginning in

September, 1938, and carried on over a period of twenty-four weeks. The state-adopted textbook, 'Steps in Arithmetic", Book III, by Bennett, Conger, and Conger, and the workbooks, "Arithmetic Workbooks", by the same authors, for Grade VII and Grade VIII, were the only books used. Methods (1) and (3) were used for obtaining supplementary work.

Umstattd's criticism on the use of a workbook as supplementary work should be recognized. He says that such a practice is only a half-hearted application of the workbook idea, and does not recommend it for general practice.[3] The purpose of this experiment is to determine the value of the workbook as a supplement to the text, and does not attempt to indicate its value when used in any other way.

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[3] James Greenleaf Umstattd, Secondary School Teaching, p.191.

CHAPTER II

PROCEDURE

At the beginning of the school year two tests were given all pupils in the seventh and eighth grades, The Otis Self-Administering Tests of Mental Ability, Intermediate Examination: Form A, and a teacher-devised survey of achievement in arithmetic. A standardized test[1] was considered for measuring achievement, but discarded in favor of the informal test measuring the same basic skills, but more closely paralleling the course of study in the selection of problems for use in testing.[2]

After the two tests were scored each grade was divided into two sections as nearly equivalent as possible with respect to (a) mental age, (b) chronological age, (c) intelligence quotient, (d) achievement in arithmetic, (e) sex, (f) health, (g) study habits, (h) attitudes of parents toward the child's school work, (i) socio-economic rating, and (j) extra-curricular activities planned for the year by the child.[3] With few exceptions the pupils were well known to the instructor and to other members of the faculty, and little difficulty was experienced in rating the children without formal tests other than the two mentioned in the opening paragraph.

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[1] Greene-Knight-Ruch-Studebaker, Compass Survey Tests in Arithmetic.

[2] Harry A. Greene and Albert V. Jorgensen, The Use and Interpretation of High School Tests, p. 20.

[3] Carter V. Good, A. S. Barr, and Douglas E. Scates, The Methodology of Educational Research, pp. 493-499.

Because the enrollment was small it was not possible to pair all pupils for the parallel sections, so the mean was chosen as the more important measure of central tendency in this study,[4] and a combination of parallel-group and rotation-group techniques was used.[5] This procedure was followed in order that the differences in time of day for class work, and other variables that may not have been perfectly balanced for the sections, would not result in a bias throughout the time the experiment was in progress.

As a matter of convenience, the seventh grade sections are designated as J and W, and the eighth grade sections as D and F.

Class periods for the eighth grade were fifty-five minutes long, section D meeting at 9:00 A. M., F at 1:00 P. M.; the periods for the seventh grade were each fifty minutes, J meeting at 10:00 A. M., and W at 3:10 P. M. All teachers in the building followed the plan of dividing the period into recitation and study periods so that little or no home study would be required of the pupils. Report sheets sent parents were marked SATISFACTORY or UNSATISFACTORY, with the understanding that a child who spent each class period preparing his work to the best of his ability rated SATISFACTORY, while the child who wasted time, and did work that was not commensurate with his ability rated UNSATISFACTORY, no matter whether the achievement was less than, more than, or the same,

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[4]William A. McCall, How to Measure in Education, p.377.

[5]Carter V. Good, A. S. Barr, and Douglas E. Scates, The Methodology of Educational Research, pp. 504-505.

as that of his classmates. The marks for this study were given in terms of per cent, as set forth in a later paragraph.

Pupils were told at the first meeting of the classes that each should purchase a workbook for his grade, but that they would use them only during alternate six weeks periods for twenty-four weeks, then the classes could decide for themselves whether they should continue alternating the workbook, discard it, or use it continuously for the remaining weeks of the term.

When the grades were divided, sections D and W were permitted to keep their workbooks, and the workbooks of sections J and F were stored. This procedure was reversed at the beginning of the second six weeks period, J and F received their workbooks and the workbooks of D and W were collected and stored. Under this rotation-method one morning and one afternoon class used the workbooks each period, D and W using them during the first and third periods, J and F during the second and fourth periods. While the workbooks were stored the instructor was able to inspect them carefully for the amount and kind of work each pupil had done of his own volition, as well as the types of errors, to use as a basis for further instruction.

The textbook was considered of primary importance during the entire study, and all lessons were planned to develop the abilities designated in it. This does not mean that the material was presented to the classes in the order it is given in the textbook. Many times the order was changed to meet

the needs of the grades, or to take advantage of an interest that made a particular ability assume added importance. For example, standard time was taught early in the first semester when the children were concerned about the change in time of favorite radio programs attendant upon the change from daylight saving to standard time in some areas, and then it was reviewed just before the close of school when the change back to daylight time was made. Interest in standard time was greater then than at any other two periods during the entire year.

In teaching new material, or for a brief review before work ordinarily considered difficult by pupils was begun, the simpler types of problems of the type studied were selected from the material available. The textbook alone was used in one section of each grade, and the textbook and workbook together offered greater choice in the other.[6] As the children became more proficient the more difficult problems were studied. When regular assignments were completed the pupils were encouraged to practice any skill they wished, using the workbook, if available, or the tests given in their textbooks. Time tests were given both sections of the grade on the same days.

At the end of each six weeks period an informal test was given each grade covering the work done during that period in the regular assignments. These tests were constructed and administered in such a manner that each type of problem

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[6] James Robert Overman, Principles and Methods of Teaching Arithmetic, p. 59.

studied was tested separately, and so much material given that no pupil was able to complete any part of the test in the time allotted it. Each part of the test was scored separately. After all papers were checked the highest score made on each part of the test was given a rating of 100%, and all papers were then given relative per cent marks on that part. When the separate parts of the tests were all marked in per cent, the average per cent mark was computed for each pupil, and recorded for use in this study. This manner of presenting tests is fairer to the pupils who are capable of completing a greater amount of work, and at the same time the marking avoids placing undue emphasis on any particular group of problems. A study of the data will show a wide range of marks, with averages below the traditional "passing" level, but it must be emphasized that these marks were not assigned any child except for comparison with the others in his grade for the use of this study.

To curb any tendency of one class to help the class that followed by passing on information about the test, the instructor relied upon: (a) dividing the tests into two sections, A and B, giving A to the morning class and B to the afternoon class; (b) including so many problems that it would be difficult to remember any one; (c) grading on speed as well as accuracy so that previous knowledge of the type of problems would avail little if the necessary speed had not been acquired; and (d) the knowledge among the pupils that the marks on these tests were based on the highest score in the grade,

and that to help raise another's score would automatically cause a lowering of one's own mark.

In the week following the close of the experimental period the same test for arithmetic achievement that was given in September was repeated, not for a comparison of the groups, since they had been in possession of the workbooks for equal periods of time, but to determine their achievement, and to see whether or not scores would be affected by the type and amount of extra work the students had completed in their workbooks.

All workbooks were retained by the instructor during the week that followed the close of the experiment, then returned to the pupils and used for a week. A vote by the classes showed an overwhelming majority in favor of using the workbooks all the remainder of the term.

To determine the reason for the popularity of the workbooks with the students, members of the classes were asked to write their candid answers to these questions: "Do you like, or dislike, your workbook? Why? If the authors planned to rewrite the workbook and asked your help, are there parts that you would ask to have changed in order to make a better workbook of it? If you plan to include arithmetic in your course next year, would you prefer the textbook alone, or the textbook and the workbook together?" Care was taken to have the children understand that the answers should be their own opinions, no matter what their feelings toward the textbook and the workbook might be; that constructive criticism would be of infinitely more value than insincere flattery.

CHAPTER III

DATA

At the close of the experiment, and before any comparisons were attempted, each child's report was carefully checked. Records of those who enrolled more than a week late or withdrew before the end of the twenty-four week period ended were discarded, together with those whose attendance reports showed excessive or prolonged absences in two or more of the six weeks periods. The records that remained in each section were subjected to the same statistical treatment that had been used in equating sections at the first of the period. In order that the sections remain comparable it was necessary that records of four or five others in the two grades be omitted from the report. The records retained after this second balancing process are the only records used in this study.

The data collected were treated statistically to determine the significance of any difference between the means of the experimental and control groups under two plans of organization:

A. Each grade considered a unit, with comparisons between the workbook and non-workbook sections of each grade. (Data presented in tables I, II, III, and IV.)

B. Grades seven and eight combined to form one unit, with comparisons between the workbook and non-workbook groups within that unit. (Data presented in tables V and VI.)

TABLE I

COMPARISON OF SECTIONS AT BEGINNING OF TERM GRADE SEVEN

Group	Boys		Girls		Class	
Section	J	W	J	W	J	W
Number	10	10	15	12	25	22
Mean C. A.	12-8	12-7	12-1	12-3	12-4	12-5
Mean M. A.	11-1	10-11	11-1	11-1	11-1	11-0
Mean I. Q.	88.9	88.7	92.6	91.8	91.2	90.4
Mean Score on Arithmetic test	18.1	19.0	17.3	17.0	17.6	17.9

TABLE II

COMPARISON OF SECTIONS ON INFORMAL TEST MARKS GRADE SEVEN

6 Week Period	I		II		III		IV	
Section	J	W*	J*	W	J	W*	J*	W
% Attend.	98.93	96.81	99.47	97.58	97.60	94.09	97.60	97.12
Mean	72.6	78.10	44.80	54.41	50.40	61.37	36.40	37.86
S. D.	16.25	15.85	26.25	26.11	22.75	25.00	25.62	26.11
S. D. Mean	3.25	3.46	5.25	5.57	4.85	5.00	5.12	5.57
S. D. Diff.	4.75		7.65		6.97		7.57	
C. R.	1.16		1.26		1.57		0.19	
Experimental Coefficient	.4		.5		.6		.1	
Approx. Chances	6.5 to 1		11 to 1		20 to 1		1.6 to 1	

* Section using Workbooks.

TABLE III

COMPARISON OF SECTIONS AT BEGINNING OF TERM
GRADE EIGHT

Group	Boys		Girls		Class	
Section	F	D	F	D	F	D
Number	8	8	12	12	20	20
Mean C. A.	13-8	13-2	13-6	13-3	13-7	13-3
Mean M. A.	11-2	10-11	13-0	13-3	12-2	12-4
Mean I. Q.	84.0	84.1	98.4	100.1	92.6	94.1
Mean Score on Arithmetic Test	19.0	17.8	28.1	25.3	23.3	22.1

TABLE IV

COMPARISON OF SECTIONS ON INFORMAL TEST MARKS
GRADE EIGHT

6 Week Period	I		II		III		IV	
Section	F	D *	F *	D	F	D *	F *	D
% Attend.	99.17	99.50	97.50	98.00	96.50	96.50	94.50	94.33
Mean	63.50	63.25	50.59	49.17	48.75	52.93	60.20	46.90
S. D.	17.05	17.10	27.23	26.11	24.00	26.90	22.19	24.15
S. D. Mean	3.81	3.82	4.11	4.03	3.62	4.20	4.96	5.40
S. D. Diff.	5.39		7.70		8.12		7.33	
C. R.	0.05		1.92		0.42		1.81	
Experimental Coefficient	.02		.7		.2		.7	
Approx. Chances	1 to 1		38 to 1		2.5 to 1		38 to 1	

* Section using Workbooks.

TABLE V

COMPARISON OF WORKBOOK AND NON-WORKBOOK GROUPS
AT BEGINNING OF TERM
GRADES SEVEN AND EIGHT COMBINED

Group	Boys		Girls		Class	
Section	J & F	W & D	J & F	W & D	J & F	W & D
Number	18	18	27	24	45	42
Mean C. A.	13-1	12-10	12-9	12-9	12-10	12-9
Mean M. A.	11-1	10-11	11-11	12-2	11-7	11-8
Mean I. Q.	86.7	86.7	95.2	95.9	91.8	92.0
Mean Score on Arithmetic Test	18.5	18.5	22.1	21.2	20.7	20.0

TABLE VI

COMPARISON OF WORKBOOK AND NON-WORKBOOK GROUPS
ON INFORMAL TEST MARKS
GRADES SEVEN AND EIGHT COMBINED

6 Week Period	I		II		III		IV	
Section	J & F	D & W*	J & F	D & W*	J & F	D & W*	J & F	D & W
Mean	68.56	70.85	50.59	49.17	48.75	52.93	46.98	42.17
S. D.	17.20	18.70	27.23	26.11	24.00	26.90	26.88	25.55
S. D. Mean	2.56	2.92	4.11	4.03	3.62	4.20	4.01	3.94
S. D. Diff.	3.88		5.76		5.55		5.62	
C. R.	0.59		0.25		0.75		0.86	
Experimental Coefficient	.2		.1		.3		.4	
Approx. Chances**	2.5 to 1		1.6 to 1		3.9 to 1		6.5 to 1	
% Attend.	99.04	98.10	98.59	97.78	94.31	95.24	96.52	95.79

*Group Using Workbooks.
**Chances that True Mean is between the Obtained Mean and 3 S.D.

Under both plans of organization the experimental and control groups are so divided that the differences of the means of the measures used in equating them have no statistical significance.[1] The per cent of attendance is high, and there is little likelihood that the attendance affects the test results in one section more than another.

In the first classification, test results show that sections W and F, the sections that met in the afternoon, have the greater means in all four tests. The chances that the true mean is between the obtained mean and ±3 S. D. are: for the seventh grade, 20 to 1 and 6.5 to 1 when the members of section W used workbooks, 11 to 1 and 1.6 to 1 when they did not; for the eighth grade, 38 to 1 each period that section F used workbooks, 1 to 1 and 2.5 to 1 when they did not. The difference in each case is less than 369 to 1, or practical certainty, that the section with the greater mean is the superior section.[2]

The second classification more nearly equates the groups with respect to the time of day the classes met, and provides a greater number of cases for greater stability of the S. D. and for more dependable results obtained from other formulas. In every period the mean of the group using workbooks exceeds that of the non-workbook group, but the differences are so

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[1] William A. McCall, How to Measure in Education, p. 406.

[2] Ibid. p 404.

small that the chances are only 2.5 to 1, 1.6 to 1, 3.9 to 1, and 6.5 to 1 that the true mean is between the obtained mean and±3 S. D.

Gains made on work completed by the children of their own volition were not measured completely on the tests, for most of them chose to build for speed in fundamentals. The achievement test given in September and repeated twenty-four weeks later bears out that assertion. When the test was given first, no student in the seventh grade made a perfect score on any one of the six parts of the test, and the mean score was 17.8. When the test was repeated there were six perfect scores on parts of the tests, and the mean was 28.7. The eighth grade showed an even greater numerical gain, their mean being raised from 22.7 to 38.0, and the number of perfect scores on parts of the test jumped from 4 to 27.

The survey of pupil reaction to the workbook shows marked differences between the grades, and between the sexes in the grade, except on the question of using workbooks next year. That question received affirmative votes in 100% of the cases. The answers given to the questions "Do you like, or dislike, your workbook? Why?" are given in table VII, together with the per cent of pupils enrolled who gave each answer.

TABLE VII

PUPILS' REACTION TOWARD WORKBOOK,
WITH PER CENT OF ENROLLMENT GIVING SUCH REACTION

	Grade 7		Grade 8	
	Boys	Girls	Boys	Girls
Wish to use workbooks next year	100%	100%	100%	100%
Problems are easier than the text	60%	56%	15%	44%
No need to recopy problems	50%	60%	30%	40%
Save time		28%	25%	28%
Help increase speed	5%	8%	5%	4%
Problems are fun to work	5%	8%		
Space for problems saves paper	25%	20%	5%	12%
Should be more room for solutions	25%	20%	5%	28%
Needs examples or explanations	15%	8%		16%
Good variety of problems	5%	8%		
Pages can be removed easily		8%		8%
Helps with text			20%	44%
Large print, easy to read			20%	4%
Keeps problems together			5%	4%
Doesn't cost much			5%	8%
Saves time for teacher, too				8%
Needs more short time tests	5%	44%		
Answer books would help in checking				12%

CHAPTER IV

CONCLUSIONS

In determining the value of the workbook in teaching arithmetic one must consider the matter from the standpoint of actual accomplishment of the pupils, attitudes of the pupils toward the workbook, and the teacher's reaction to the workbook.

Examination of the data on tests shows a slight difference in favor of the workbooks. In one classification the workbooks were slightly in the lead in every period, in the other the superior sections showed a greater degree of superiority when they were using workbooks. The differences are not statistically significant, but the fact that the difference exists each period gives added importance in interpretation. The second achievement test showed that all the pupils made great gains in the skills they practiced of their own volition in the workbooks.

The childrens' preference for the workbook is obvious in their voting 100% to use workbooks next year, and in their vote to continue using workbooks when they could have discarded them if they had so wished. The reasons they gave for liking their workbooks - saving time, wide variety of problems, and others, are reasons recognized as criteria for measuring the value of workbooks.[1]

This teacher's reactions are colored by the contrasts she found in teaching parallel groups by different methods.

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[1] James Greenleaf Umstattd, Secondary School Teaching, pp. 178-184.

Considering the class first, she found that the supplementary material in the workbook was equal, or superior, to that found in other parts of the textbook; that pupils had less difficulty following the assignments when they were in the workbooks than when they were on various pages in unfamiliar parts of the textbook; and that children were more willing to practice computational skills when using the workbook than when the problems had to be copied from the textbook in order to have ample space for solutions. The combination of factors that appealed to the pupils made teaching the workbook section easier for her than teaching the non-workbook section, where there was less interest in the instructional materials, and less of her time was required for planning assignments and checking papers in the classes when workbooks were used.

The value of the workbook as a supplement to the textbook in teaching arithmetic, then, lies not alone in the slight increase in achievement of the pupils, but in the stimulation of interest, help in providing for individual advancement, and aid in building good study habits, that contribute to the ease of learning and to the ease of teaching arithmetic; and in the saving of time for pupils and teacher.

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