

**THE THORNDIKE
ARITHMETICS.
BOOK ONE**

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The Thorndike Arithmetics. Book One by Edward Lee Thorndike

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EDWARD LEE THORNDIKE

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By

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PREFACE

THESE books apply the principles discovered by the psychology of learning, by experimental education, and by the observation of successful school practice, to the teaching of arithmetic. Consequently they differ from past practice in the following respects:

Nothing is included merely for mental gymnastics. Training is obtained through content that is of intrinsic value.

The preparation given is not for the verbally described problems of examination papers, but for the actual problems of life. In particular, problems whose answers must be known to frame the problems or whose conditions are fantastic are rigorously excluded.

Reasoning is treated, not as a mythical faculty which may be called on to override or veto habits, but as the coöperation, organization, and management of habits; and the logic of proof is kept distinct from the psychology of thinking.

Interest is secured, not in pictures, athletic records, and the like, but in arithmetic itself and its desirable applications. Interest is not added as a decoration or antidote, but is inter-fused with the learning itself.

Nothing that is desirable for the education of children in quantitative thinking is omitted merely because it is hard; but the irrelevant linguistic difficulties, the unrealizable pretenses at deductive reasoning, and the unorganized computation which have burdened courses in arithmetic are omitted. The demand here is that pupils shall approximate 100 per cent efficiency with thinking of which they are capable.

The formation and persistence of useful habits is not left to be a chance result of indiscriminate drill and review. Every habit is formed so as to give the maximum of aid to, and the

minimum of interference with, others. Other things being equal, no habit is formed that must be later broken; two or three habits are not formed where one will do as well; each is formed as nearly as possible in the way in which it is required to function; each is kept alive and healthy by being made to cooperate in the formation of other and higher habits in the arithmetical hierarchy. If a pupil carries through the projects in computing and problem-solving of these three books under competent supervision, he will have abundant practice for the arithmetical insight, knowledge, and skill that the elementary school is expected to provide.

E. L. T.

NOTES ON BOOK ONE

Part One of this book is for use as a supplement to the informal work of Grade II, and as a basic text in Grade III. Part Two, or so much of it as the course of study makes advisable, is for use in Grade IV.

Experienced teachers will, by examining and using this book, understand the reasons for the choice of the exercises and problems, for the order in which they appear, and for the methods used, with three possible exceptions. These are: (1) the early, varied, and extended use of the equation form with a missing number or quantity to be supplied, (2) the introduction of two-place and three-place multiplicands before the products of 6, 7, 8, and 9 are learned, (3) the rationalizing of procedures by verifying the fact that they are right rather than by arguments to show that they must be right.

Such uses of the equation form as the book contains will be found admirable as preventives of rote memorizing without understanding, as stimuli to mathematical thinking, and as means to an economical organization of arithmetical knowledge. The time spent on them will be saved twice over in later work.

The introduction of two-place and three-place multiplicands

provides a genuine use for the multiplication facts learned, organizes the knowledge of the products of 5, 2, 3, and 4, gives a needed review, relieves the monotony of learning the tables, and enables the pupil to utilize rather than memorize the products of 6, 7, 8, and 9 as fast as these are learned.

The rationalization of procedures by the pupil's own experience in verifying the results obtained is superior to the use of formal proofs of the validity of the procedures before they are learned and used. With all save the most gifted, there is grave danger that the pupil, especially in Grades III and IV, will not know what is being proved to be true by the "analysis" or "explanation," or will forget the proof after he has mastered the procedure. The best way to secure eventual insight into the principles governing arithmetical operations is to learn to operate by imitation and the extension of past knowledge, then to make sure that the operation is right by verification from known facts, and last of all to learn why it is right and must be right.

It will be observed that in the early steps in subtraction the pupil learns to derive his facts about $8-5$, $6-2$, etc., from his knowledge that $5+3=8$, $2+4=6$, etc., but that care is taken that he distinguishes subtraction sharply from addition, gives it its proper name, understands its common uses, and soon comes to think of subtraction combinations fluently and directly. This is important. The pupil is also taught to increase both minuend and subtrahend rather than to "borrow." This is more scientific, businesslike, and economical of thought, especially in the case of subtraction with fractions.

In using this book, those expert in the teaching of arithmetic will follow its organization of arithmetical learning, adding other exercises of the same sorts to supplement it and using the daily life of the pupils as a source of problems, but not omitting sections or introducing new principles. For they will see in it a deliberate arrangement of arithmetical learning to fit the abilities and needs of the pupils and to organize a hierarchy of habits and powers for continuous growth.

The inexperienced teacher may well follow the order of the book even if the purpose of some one exercise here and there is not clear to him. Every 'section' has a definite part to play in teaching something new, reviewing something previously taught, relating elements of knowledge previously taught separately, or preparing for some advance to be made fully in later sections. The organization of topics is more subtle than in ordinary texts because it parallels childish learning rather than adult knowledge, because the interests and abilities of the pupils are allowed weight as well as the teacher's convenience, and because arithmetical learning is treated as an organic whole which lives and works rather than as a collection of isolated abilities to add, subtract, multiply, and divide with such and such sorts of numbers.

It should be observed that the games, activities, and topics upon which the exercises and problems are based permit framing many additional exercises and problems of the same types as those in the text. The pupil should be encouraged to frame such. When the teacher frames such, or states a problem from the daily life of the class, he should either reproduce the actual situation or event, or use language so clear and simple that the pupils understand just what the situation or event is. It is fruitless to train children to understand intricate verbal descriptions in cases where the real situation, as life offers it, explains itself.

CONTENTS*: PART ONE

I. ELEMENTS OF ADDITION, SUBTRACTION, AND MEASUREMENT: SUPPLEMENT TO THE WORK OF THE EARLIER GRADES

SECTIONS	TOPIC OR ACTIVITY	ARITHMETICAL CONTENT	PAGE
1, 2	Making 6-inch and 10-inch rules.	The meaning of numbers. Measuring. Inches.	1
3, 4	Measuring. Adding inches to inches.	Measuring. Adding 2.	2
5, 6, 7	Adding cents to cents. Playing store.	Adding 1, 2, 3, and 4.	3
8, 9, 10	Addition. Dominoes.	Review of addition with sums of 10 or less. Arrangement for written addition.	5
11, 12, 13	Problems. Hiding game.	The prevention of adding by mere counting. Adding 5, 6, 7, 8, and 9, with sums of 10 or less.	6
14, 15	Practice in adding.	Review. Introduction of written answers.	8
16 to 23	Playing store. Making change. "Which costs more?"	Subtracting from 9 or any smaller number (zero excluded). The meaning of <i>subtract</i> .	9
24, 25	Buying.	Adding three numbers, with sums of 9 or less.	13
26, 27	One half and one quarter. 12 inches make 1 foot.	Meaning of $\frac{1}{2}$ and $\frac{1}{4}$ in very simple cases. Inches and feet.	14
28, 29	Pints and quarts.	2×2 , 3×2 , 4×2 , 5×2 in very simple uses: qt. pt. yd. ft. in.	15

*The table of contents shows, in one column, the topics and activities in connection with which the learning of arithmetic is secured. In the second column are stated the main elements of the arithmetical content itself. What these are in detail and what applications of them are made to daily life can be discovered by inspection of the text. A still more summary order of topics is shown by the titles of the six main divisions. It should be understood, however, that the book provides for a continuous growth of arithmetical ability as an integrated whole, and that consequently each main division deals with much more than the one topic.