AN INTERMEDIATE ARITHMETIC: UNITING MENTAL AND WRITTEN EXERCISES IN A NATURAL SYSTEM OF INSTRUCTION

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649111619

An intermediate arithmetic: uniting mental and written exercises in a natural system of instruction by E. E. White

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E. E. WHITE

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Trieste

WHITE'S GRADED-SCHOOL SERIES.

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IN A

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By E. E. WHITE, M. A.

UNIV. OF CALIFORNIA

VAN ANTWERP, BRAGG & CO.,

CINCINNATI. *NEW YORK.*

QA 102
W63
1876
Educ.
Dept.

Entered according to Act of Congress, in the year 1870, by
WILSON, HINKLE & CO.,
In the Clerk's Office of the District Court of the United States for the Southern District of Ohio.

Entered according to Act of Congress, in the year 1873, by
WILSON, HINKLE & CO.,
In the Office of the Librarian of Congress, at Washington, D. C.

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EDUCATION DEPT.

ECLECTIC PRESS:
VAN ANTWERP, BRAGG & CO.,
CINCINNATI.

PREFACE.

It is claimed for this treatise that it possesses three very important characteristics, to wit:

1. *It is specially adapted to the grade of pupils for which it is designed.* It presents only those operations and principles which can be mastered by intermediate classes, and each subject is treated as thoroughly as the advancement of such pupils will permit. It is also believed that the subjects are introduced in the best possible order. There are reasons in favor of placing United States Money before Fractions, but stronger reasons favor the arrangement in this work.

2. *It combines mental and written arithmetic in a practical and philosophical manner.* This is done by making every mental exercise preparatory to a written one; and thus these two classes of exercises, which have been so unnaturally divorced, are united as the essential complements of each other. This union is natural and complete; and, as a consequence, the several subjects are treated in much less space than is possible when mental and written exercises are presented in separate books.

3. *It faithfully embodies the Inductive Method.* Instead of attempting to deduce a principle or rule from a single example, as is usually done, each process is developed inductively, and the successive steps are thoroughly mastered and clearly stated by the pupil before he is confronted with the author's rule. This method not only places "processes *before* rules," but it teaches "rules *through* processes," thus observing two important inductive maxims.

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Attention is also called to the use of *visible illustrations* (objects or pictures) *in developing new ideas and processes.* In the fundamental rules, this illustrative or perceptive step is omitted, since it is fully presented in the PRIMARY ARITHMETIC. The engraved cuts in Fractions, United States Money, and Denominate Numbers, are specially designed to be used as a means of developing and illustrating the subjects considered.

Two other features, worthy of special notice, are *the great variety of exercises,* and *their preëminently progressive character.* Generally, each lesson contains both concrete and abstract examples, and every new process or combination is at once used in the solution of problems involving mental analysis. This arrangement avoids the mechanical monotony which characterizes long drills on a single class of exercises. The problems, all of which are original, are so graded that they present but one difficulty at a time, and all difficulties in their natural order. The pupil's progress is thus made easy and thorough.

It is hoped that these and other features may commend this work to all progressive teachers, and that it may prove as successful in the school-room as its plan is natural and simple.

COLUMBUS, OHIO, *May*, 1870.

THE LAST EDITION.

The recent addition of the more useful processes in Percentage and Mensuration adapts the work to those pupils who do not attend school long enough to master an arithmetic designed for advanced classes. It now presents a SHORT COURSE IN ARITHMETIC, with thorough drills in all elementary processes, and with a brief and simple treatment of those practical applications which are most frequently used in business.

LAFAYETTE, IND., *May*, 1876.

SUGGESTIONS TO TEACHERS.

In the preparation of this work two facts were kept in view, viz.: (1) that it is to be studied by pupils who must largely depend upon the living teacher for explanations; and (2) that those methods which are most natural and simple are most successful in practice. Hence, its pages are not cumbered with long verbal explanations and peculiar methods, of little practical use to pupil or teacher. The author has left something for the teacher to do; and that this may be done wisely, he offers the following hints and suggestions:

1. *Mental Exercises.*—These exercises should be made a thorough intellectual drill. They should be recited mentally, that is, without writing the results; and, since the reasoning faculty is not trained by logical verbiage, the solutions should be concise and simple. See pages 23, 88, 89. They should also be made introductory to the Written Exercises, of which they are often a complete elucidation. The corresponding examples in the two classes of exercises should be recited together as well as separately. Many of the written problems may also be solved mentally.

2. *Written Exercises.*—The pupils should be required to solve every problem of the assigned lesson on the slate or paper, and the solutions should be brought to the recitation for the teacher's inspection and criticism. From three to five minutes will suffice to test the accuracy and neatness of each pupil's work. The mental problems should also be solved on the slate or paper in preparing the lesson, and then recited, not only mentally as above described, but also as a written exercise. This will increase the number of written problems, and, at the same time, it will secure a careful preparation of the entire lesson.

3. *Definitions and Principles.*—These should be deduced and stated by the pupils under the guidance of the teacher, and usually in connection with the solution of problems. Take for illustration the definition of multiplication. The pupil multiplies 304 by 5. The teacher asks, What have you done? "I have multiplied 304 by 5." *T.* Do not use the word "multiplied." (If necessary, the teacher shows what is meant by taking a thing one or more times.) "I have taken 304 five times."

T. By what process have you taken 304 five times? "By multiplying it." *T.* What, then, is multiplication? "Multiplication is the process of taking one number ——." *T.* How many times is the number taken in the above example? "It is taken five times, or as many times as there are units in the multiplier." *T.* Now complete your definition. "*Multiplication is the process of taking one number as many times as there are units in another.*" These steps should be repeated with other examples, until the definition is clearly reached and accurately stated. It should then be written and compared with the author's definition, which should be thoroughly memorized.

4. *Rules.*—These should also be deduced and stated by the pupils. The true order is this: 1. A mastery of the process without reference to the rule. 2. The recognition of the successive steps in order, and the statement of each. 3. The combination of these several statements into a general statement. 4. A comparison of this generalization with the author's rule. 5. The memorizing of the latter. Take for illustration the rule for adding fractions. *T.* What is the first step? "Write the fractions, separating them by the plus sign." (Pupils write an example.) *T.* What is the second step? "Reduce the fractions to a common denominator." *T.* What is the third step? "Add the numerators of the new fractions." *T.* The fourth step? "Under their sum write the common denominator." These questions should be repeated until the answers are promptly and accurately given, and then they should be united in a general statement. The first step may be omitted in the rule.

5. *Questions for Review.*—These are designed as a final test of the pupil's knowledge. Before they are reached, the definitions, principles, and rules should be thoroughly mastered, and the pupils should be able to make a topical analysis of them and recite each in order.

6. *Fractions.*—This section presents only the elements of Fractions, and these in the simplest manner. The subject is more exhaustively treated in the COMPLETE ARITHMETIC. The reduction of compound fractions is made introductory to the multiplication of fractions, as the two processes are best taught together.

7. *One Method.*—Elementary instruction in arithmetic should aim to make the pupil ready and accurate in the use of one method for each operation. This may not be the shortest method in every case; but, as a rule, the pupil will reach the result sooner by it than by a method that is less familiar. The attempt of the young pupil to use several methods, results in hesitation and confusion.

For other suggestions see the MANUAL OF ARITHMETIC.

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