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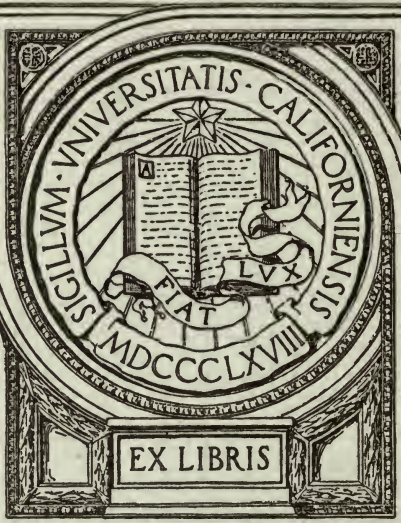

THE OUTLOOK FOR ARITHMETIC IN AMERICA

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PUBLISHERS' NOTE

STRANGELY enough, arithmetic is one of the last subjects in the school curriculum to fall in line with the modern movement in education looking to a wider development and to a more practical application. To a great degree the subject is still in a state of transition, and educators everywhere are deeply interested in seeing it attain speedily a position of pedagogical development commensurate with its importance.

With this thought in mind the publishers take pleasure in presenting for the consideration of teachers the suggestions contained in this pamphlet, which embody the ripest thought of an educator who, perhaps more than any one else in this country, has been intimately associated for many years with every phase of mathematical teaching from the kindergarten to the university. As a leader in the pedagogy of mathematics, and as the author of a new series of mathematical text-books for the grammar grades, his comment will doubtless prove of value to every teacher who is interested in the future development of the subject.

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THE OUTLOOK FOR ARITHMETIC IN AMERICA

BY

DAVID EUGENE SMITH

Professor of Mathematics in Teachers College, Columbia University. Author of Smith's "Primary Arithmetic," "Grammar School Arithmetic," and "Grammar School Algebra"

Copies of this pamphlet will be sent postpaid on request

The Ideal Arithmetic

IN fine, a book written for the use of those teachers who wish to preserve the best that was in the old-style arithmetic, with its topical system and its abundant drill, while giving to it a modern arrangement and securing "mental discipline" through problems of to-day rather than through the tiresome, meaningless, unreal inheritances of the past.

DAVID EUGENE SMITH, in his
Preface to the "Grammar School Arithmetic"

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The Outlook for Arithmetic in America

DAVID EUGENE SMITH
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Questions to be considered

AMONG the important questions ever confronting those teachers of arithmetic who are really leaders, there are three or four of peculiar interest. They do not disturb those who are hopelessly behind in educational progress, nor those who, feeling that they have attained perfection, wish the public to know the fact. But to the considerable number of earnest workers who are constantly seeking to advance along safe lines, who have no pet theories to exploit, and who are open-minded in striving for the best, the questions to be considered are of absorbing interest.

One of these questions relates to the immediate future of arithmetic, not in its small details, but as to its general nature. Another inquires into the best methods that have thus far been suggested for teaching the subject. A third seeks to know the probable nature of the text-books that shall serve as guides. The answers to these questions are so vital that their brief consideration in plain, non-technical language has been made the purpose of this monograph.

Some of the Earlier Struggles of Arithmetic

Any investigation of the immediate future of arithmetic should, for our present purposes, be limited to our own country. For just as that teacher would be thought much behind the times who should teach literature without emphasizing the contributions of our countrymen, or history without making prominent the achievements and the responsibilities of

our own people, or geography without seeing in our continental structure certain causes for our varied national achievements, so the teacher who presents arithmetic without showing its bearing upon certain great economic questions of our own people fails to keep abreast of the times in which he is living.

In order the more clearly to read the signs of these times, we should first see how the past has met the conditions presented by succeeding generations. When the first printed arithmetic appeared (at Treviso, Italy, in 1478), the western business world was just beginning to use the Arabic numerals. The old Roman notation had been worthless for computation, and people had done their calculating with *calculi* (Latin for "pebbles"), or counters, like our checkers, casting these little disks on a table, whence our expression "to cast on account." Their accounts had often been kept by cutting notches in a stick, whence our expression "to keep tally" (French, *tailler*, to cut). The new arithmetics tried to break away from such primitive plans, but it was more than a century before they entirely succeeded. Old-style schoolmasters talked loudly of the arithmetic of their fathers, of how much better the subject was formerly taught, of how rapidly they could work in the old-fashioned way; and they boasted of their conservatism, delaying progress then even as it is delayed to-day.

The new arithmetics sought also to introduce fresh problems of the day,—problems suggested by the awakening of commerce made possible by Columbus. But at this the conservative element also rebelled, and talked of the "mental discipline" in the study of amicable and deficient numbers, and of the development of the memory by learning definitions and rules which the business man never uses, and of the acuteness arising from the solution of problems about impossible men mowing imaginary fields in unreasonable hours. With this conservatism these early books had to struggle; but the best ones succeeded, and for the next century they touched the actual life of the people in northern Italy and in Germany in such a way as to make arithmetic a vital subject instead of a tradition.

The same battle had to be fought in France a little later when she became less an agricultural nation and more given to manufacture and

to trade, and when her educational system became more independent of the classical influence of Paris. England faced the same problem a little later when she abandoned her position as an agricultural nation, and Holland did the same when she awoke to see her advantageous position as a maritime power. But in every case the contest was the same: the "mental discipline" of the antiquated chapter and the obsolete problem are always invoked to hinder any large view of the demands of the time.

The Immediate Future of Arithmetic in America

To-day we are passing through this same old struggle. America has within a generation awakened to a knowledge of her commanding position as a manufacturing and trading nation, as distinct from an agricultural country content with producing only enough for her own demands. Her position as to arithmetic is that of Italy in 1478, of Germany about 1500, and of France, England, and Holland about 1575. A demand is now made that arithmetic shall touch our actual life in a way that it has not in the past. The schoolmaster who has continued to live in the mental atmosphere of a generation ago may still harangue about the good old problems of yesterday, but our people, as a whole, no longer care about the greatest common divisor, cube root, such common fractions as are not needed in practical business; about troy and apothecary's weight, compound numbers beyond the merest elements, compound proportion, or, for that matter, about simple proportion either. Alligation, duodecimals, equation of payments, and partnership involving time, have finally been relegated to the arithmetical museum, and the good common sense of our people will demand that these other inheritances follow them. This good common sense will tell them that any "mental discipline" connected with such topics can as well be secured from subjects that touch the needs of the ordinary citizen to-day. Because a fraction like $\frac{1}{2}\frac{5}{3}\frac{0}{2}\frac{2}{9}$ might have been useful before the world knew decimal fractions, and because the greatest common divisor was necessary for its simplification, every one knows to be no sufficient reasons for wasting a child's time on such things

to-day. And because a lumberman needs to know Scribner's rule and a diamond merchant to know the carat weight and a jeweler to know the troy table and a coal dealer the number of tons to fill a given bin, this is no reason for asking children, with no interest in or prospective need for these things, to give any time to them.

The great danger is that we may fail to supply the place of the obsolete matter with topics that have an equal disciplinary value. One thing is certain, we shall not succeed by simply putting in a mass of algebra that children and the business world cannot use, and that is as abstract and unreal as what it replaces. Neither shall we succeed by hastily getting together some work in constructive geometry with no apparent end in view except to fill the gap. Nor can we hope to satisfy the demand, as the present fashion seems to be, by drawing at random a body of ill-selected problems from science, by demanding an unreasonable amount of graphic work on uninteresting statistics, and by substituting for the topical method an undigested mass of unrelated number facts.

What the new material will probably be may be inferred from the experience of the past. Arithmetic has always failed of success save as it has aroused the interest of children and met the present demands of common life. To replace the obsolete matter by topics that shall do this is the problem of the future.

What is the Best that the Method Writers have Suggested?

It is not strange that the word *method* has been in disrepute with the great majority of the world's best teachers. The reason is that method has usually meant either a hobby, — the magnifying of some single idea to the neglect of others of equal importance, — or else it has stood for mere devices for doing something that could as well be done in a dozen other ways. Of the latter, valuable as such methods may be in the primary instruction of a teacher, it is not the purpose of this paper to speak. As to the former, they are not at all difficult to devise

and to exploit. They often make a temporary stir, and they always subside thereafter. In the main, however, they do good; for they make the world think, and they usually emphasize, although beyond all reason, some phase of work that has been neglected.

Busse, over a century ago, suggested a valuable idea in his number pictures, the basis of our modern number cards, — an idea which several of his successors have carried to such extremes as to be ridiculous. Pestalozzi, a little later, gave the world some exceedingly valuable ideas, breaking away from the notion that arithmetic should not be taught in the first grade, and recognizing that a child wishes to count as much as he wishes to read when he comes to school. More than any of his predecessors, he asserted the necessity for knowing numbers rather than figures, of constant oral drill with abstract numbers, of using simple material for his early objective work, and of abandoning all material as soon as possible. A little later Tillich exploited a method with a set of specially prepared blocks and with the ratio idea made prominent. With him and with his immediate followers the plan succeeded, for children adapt themselves to anything; you can bend their bones, make jugglers of them, teach them foreign tongues, and make them display their powers in any method that the arithmetician devises.

About the same time Kranckes brought forward his method of concentric circles, proposing to teach a child all about numbers to 10, then to 100, then to 1000, and then to 10,000, — an idea which later led into the spiral method and influenced subsequent courses of study. Grube followed in 1842 with a method which insisted that all the processes be taught simultaneously, as if they were equally important or equally difficult; but the plan had too many absurdities of this kind to attract any large following. Later there arose the counting method of Tank and Knilling, which asserts that the world first needed numbers for counting things, that the ratio idea is a very late development, that counting is rhythmical and therefore pleasant, and that the child, learning somewhat as the world has learned, should base his arithmetic on number series. It argues that the series 2, 4, 6, 8, etc., first learned by counting objects and then memorized, is merely the multiplication table of two and the addition table of its multiples. This being true, it

proposes so to organize counting exercises as to make them the basis for all elementary operations with numbers. There also arose in Germany, about forty years ago, the spiral method, merely a modification of the concentric-circle scheme, — an idea which has influenced all modern courses of study, but which has gone to extremes that have been ridiculous. We have also had methods based on the idea that a number is always an operator and should always be treated as such, and we might as well have one asserting that a number is an operand. We have had arithmetics in rhyme, schemes for basing all number work on the measurement of lines, others that exploited rectangles, others that saw in paper folding the basis for all primary arithmetic; but to speak with any completeness of these various plans is impossible in a paper of this kind.

The Probable Nature of our Future Arithmetics

In view of the fact that arithmetic has never fulfilled its mission save as it has aroused the interest of the child and as it has touched the real life of the people, and that no one method has long endured, although many have served some good purpose, it ought not to be difficult to forecast the nature of the arithmetics of the immediate future.

The primary text-book will probably be arranged for introduction in the latter part of the second grade or early in the third grade. The children then know enough about reading to use a book to advantage, and a book serves to hold the class and the teacher to definite, well-planned work. It will present the subject in the sequence that the experience of teachers (as set forth in the best courses of study) demands, and not according to the idiosyncrasies of the author. It will suggest at first a large amount of thoughtfully selected, interesting, somewhat information-giving oral work; but it must be recognized that no text-book can ever be expected to supply more than mere types of such work. As the child progresses, the written work will increase, and in the grammar grades it will largely predominate.

The written work will be elaborate enough to avoid the waste of time attendant upon the dictation of problems, and it will provide abundant

drill with abstract numbers. The applied problems will appeal to the child's interests, and will not attempt to force upon him ideas of business in advance of his understanding, or, what is even worse, ideas of science far beyond his years. They will early touch upon his games, his toys, his genuine purchases, and such simple handiwork as may be within his knowledge. They may soon begin to appeal to the heroic, being so grouped as to tell such stories as those of the life savers on our coasts and the fire fighters in our towns. They will not elaborate small details at first, but will tell of the large things of nature in which the children take interest, of the big things in the sources of our supply of food and clothing, of the transportation of these supplies by rail or in ships, and of their sale in the cities. But all this will be presented naturally, as applications of the operations with numbers arranged in a conservative, steady progress. This progress will be made by adopting the best in all the methods, but by going to the extreme in no one of them. It will be made by using objects not of any one type exclusively but of such various kinds as to show the wide range of material for illustration. It will, however, abandon such objective work as soon as it ceases to be necessary, the crutch being harmful as soon as the invalid is ready to develop his own strength.

The book of the future will not go to the extreme of measuring any and every thing with no well-defined purpose in view, or of thinking that its problems become concrete simply by talking of butterflies and of friction. On the contrary it will seek for problems with a motive, and will treat of business, of science, and of statistics only as these can be made real and interesting to a child. And in thus telling these stories, and in showing the real world on the quantitative side, the new arithmetic will not fail to enter the child's life in a way that its predecessor did not. By letting the old-style isolated problems about yards of cloth and heads of cattle give place to examples so grouped as to impart real information and arouse genuine interest, the new arithmetic will become in the best sense concrete, as the old one was too often in the worst way abstract.

And the grammar-school arithmetic, what of that? It, too, will probably follow the best courses of study that have been devised, and

will thus assure a sequence that is not eccentric. As far as circumstances will permit, it will eliminate everything that is not genuinely useful, seeking its "mental discipline" through the problems of real life. For some time to come it will have to cater enough to the demands of the past generation to give work on proportion as distinct from equations, on square root, and, to a greater extent than is really justifiable, on compound numbers and unused fractions. But in the applications of the processes it will so group its problems as to tell those parts of the story of our national resources and business life that are interesting and intelligible to children. It will tell of the manufacturing of the East, of the cotton fields of the South, of the mines of the Appalachians and the Rockies and the Lake region, of the fruit industry of the Pacific coast, and of the interests of the great prairie country. It will tell of the transportation of the products of the land, of their manufacture and their marketing. It will seek to ennoble labor, to make our national economy interesting, and to prepare the boy and the girl for the life they are soon to enter. It will forecast for them the way in which they will take their first steps into business, will tell them of their wages, their bank accounts, the common commercial papers they will use, and of the simple accounts of the home.

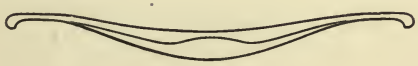
And yet the new arithmetic will not be such a great departure from the old in those features that made the old book successful, in its way. It will not offer an aimless mass of applications, ill-arranged and poorly paged. On the contrary, it will keep to the old topical arrangement, so that a child may see his own progress and may have the pleasure arising from feeling that he has mastered a definite part of some subject. It will, however, touch upon every important topic at least twice, both to avoid the weariness of dwelling too long upon it and to afford opportunity for a thorough review.

As to algebra, it will not yield to the thoughtless demand for it merely because it is a higher subject, but it will use the letter x where it is needed for arithmetic, and nowhere else. If it goes beyond this, it will let algebra grow naturally out of arithmetic and will give as many genuine applications as possible, as distinguished from the mere puzzles of our common books. That algebra can be taught to children

will be no argument for so teaching it, and that by teaching it to a child he becomes a better arithmetician has been abundantly disproved by modern psychology. If it is taught, as it doubtless will be, it will be for other reasons than these.

Such books as those described are very hard to make. They cannot be written with the shears. They come into being only as the result of much thought and experiment. As no one man has the monopoly of the common sense that inspires such books, so no one person has a monopoly of the brains that will work them out. The encouragement of progressive teachers will hasten their advent, just as the carping of advocates for antiquated topics will retard it. But when they really begin to appear, there will come a healthy reaction against the neglect of arithmetic that has, with sad results, characterized our school work for a number of years past. Of late we have been letting arithmetic slip from our hands because we could not justify the general arrangement of the books so at variance with our courses of study, or the general nature of the problems so at variance with our present life. That better computers were produced forty years ago than now was not owing to the dull rules, the stupid principles, and the absurd problems of that day; but because the work was definite, the teacher and the pupils could get their bearings, the curriculum was confined to the "Three R's," and this particular "R" had its share of the time. Make the new arithmetic as definite as the old, preserve the best of the topical arrangement, give enough problems and let them appeal to the common-sense business man as genuine and to his child as interesting, and the arithmetic of the future will be the best that the world has ever seen.

Columbia University, July 1, 1904.



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