

sort of questions in geometry that could come into such a test. The object is not to find out which students may go on (of course those as good as the average are to go on), nor to in some more or less mechanical way determine a grade, though it will well serve these purposes; but to discover the habits of thought of all the students. Thus is one prepared to lead them to better habits. There should be tests in which the student answers on the spur of the moment, and tests in which he is given all the time he wants, a year, if need be. There should be problems suited to all capacities and every encouragement should be offered to all to work at them. Not infrequently a dull student will succeed when all the rest fail, showing, perhaps, that both his more usual failures and his exceptional success are due to his having simply a different mode of thought from the majority. it may be a better habit.

I said this would do for a beginning. It will be a break with formalism. The bond once broken, few, I imagine, will desire to return to the service of Dame Formality.

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## THE OUTLOOK FOR ARITHMETIC.

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The movement begun nearly twenty years ago in this country, looking to the elimination of obsolete matter from arithmetic, has been more or less successful. Like all such movements, reformatory in character, it has also been destructive. Destruction of a decayed structure not only requires less exertion than the construction of a solid edifice, but if one is to build on the same ground, it is almost a prerequisite. For some time, however, we have simply been contemplating the dust and rubbish pile, glad that the old building is gone, but uncertain as to what should go in its place.

There have not been wanting suggestions as to the new edifice. It has always been true, and it is true still, that the first thought at such a time is to move some house from up the street to the vacant spot. In years past they moved a so-called

theory of numbers, inherited from Boetius and Nicomachus, down into the grades; they put into elementary arithmetic (and we still keep there, in spite of our period of destruction) an unduly large array of symbols of operation, filched from the early algebras and now more nearly obsolete than we usually think; and so, in general, the world has pushed the higher subjects down to fill gaps. We have seen the same attempt since the recent edifice has been demolished. There has been an insistence that there is now room for algebra in the grades, and for geometry, although why square root should go out and algebraic fractions should go in we have not heard. Now all this moving of the higher subjects into the grades may be the best educational policy, but it has not been done with any evidence of careful consideration; rather has it seemed a part of the world's very old policy of somewhat thoughtlessly filling the gaps by moving higher subjects down. That this is so appears from the fact that in spite of the urgent demands for help, there has not yet appeared a well-defined system of geometry for the upper grades, that seems to be at all at home among its sister subjects.

Every period of this kind is, however, followed by a period of thoughtful construction, and upon this period there seem evidences that we are entering. What is the outlook for arithmetic? Does it promise a thoughtless moving down of higher subjects, or a thoughtful introduction of a new range of work?

Unfortunately a very common phenomenon is now being observed, the offering of a panacea in the form of "method." Now method is a most desirable thing in education, but the word has always been abused, and the old term "laboratory method" has probably been, and seems about to be, even more abused than most similar expressions. In the first place we shall find a host of people content merely with "method," nurses telling their patients how to eat without giving them food. In the second place we shall see all sorts of stupid, lifeless, slow, individual work palmed off in place of real, live, work-shop labor, energetic with a sparkling *esprit de corps*. Hence it behooves all who propose to do much talking about "laboratory methods" to preface their remarks by a denunciation of these dangerous tendencies, and to seek some happier term for the plan itself.

But something beyond method is needed, and that is substance. What is the substance; not merely the upholstery of the new edifice? The answer must be, *the quantitative side of the life which the child meets, directly or indirectly, in America today*. In the first two grades this means the counting of his games, a beginning in the problems of the house, and some measurements in his manual training. It does not mean problems on marbles unless he is using marbles in his play, nor problems on apples unless the season or locality suggests some reality to the question. Problems on four marbles or on four apples, as usually stated, are about as abstract as problems on four, *per se*. It means that a rug-weaving problem in grade two may be far more valuable than a page of ordinary text-book problems. In grade four, where interest begins to center about the problem of food supply, a rich field opens in the farming life of the country, the cost of production, and the transportation to market. The boy's interest in a locomotive, the experience of children in the cars or on a boat, all suggest an interesting range of problems that may well replace the dead topics of our books. In the later grades the great industries of the country, the cost of mining ore, of transporting it, and of extracting the metal, the cost of manufacturing, the cost of growing cotton, of transporting and of spinning and weaving it, the ever interesting topic of the growth of our own country in all of its lines of activity, and the graphic representation of statistics, these are the matters that are to replace the dead topics of partnership involving time, equation of payments, and compound proportion.

Of course this is not new in theory. But neither in practice is it new, for it has not begun in any serious way, nor can it begin at once. It must come only by the efforts of our best teachers to introduce these topics little by little, to encourage the collection and publication of connected problems, and to experiment as to the proper topics for the various grades. No laboratory method is going to succeed without something to work with, and this something must not, in the long run, be disconnected problems; it must be sorted into groups of related problems. Think of a laboratory in which a student goes to one bench and weighs a test tube, then goes to a telescope and looks

at the sun, then hurries to a microscope to see the corpuscles in a frog's foot, and then is called to see some iron filings acted on by electricity! And yet that is what the laboratory method will degenerate into in arithmetic, unless we can group our problems, relate the groups to the child's other interests, and relate these groups not to nature alone, nor to trade alone, nor to the country's growth alone, but to as many sides of human activity as come at any given period within the region of the child's interests.

I therefore appeal for these results of our present healthy discontent with arithmetic as it stands:

1. Replace the eliminated material by *groups* of related problems, correlated as far as reasonable with the other work, but not touching merely one side of the child's life. The field is *the quantitative side of every interest the child has*, and if only the nature side, or the commercial side, or the industrial side, or the statistical side be touched, then there is a failure to secure the best results.

2. Let no laboratory or any other method draw us away from this question of material content of arithmetic. On the other hand, let no question of content blind us to the value of any plan of presentation that makes the subject tingle with life. Good teachers have always presided over laboratories; poor teachers will always make sorry work of it; but to the extent that a class is a genuine workshop, to that extent the subject will be real and the interest will be secure.

3. Let no question of applied problems and no question of method close our eyes to another vital question. The workman soon comes to see the need of tools, of sharpening these tools, and of machinery that is kept well oiled and in repair. He may not at first like to sharpen the tool or oil the lathe, but the results soon show him that his work is the better for it, and with this comes a joy in this less interesting labor. As applied to arithmetic, the habit of fairly rapid oral and written work must be acquired, and we shall never free ourselves from the necessity for abstract drill, at least until computing machines are more common and more comprehensive. Hence the

teacher who, in our generation, fails to interest children in abstract work, fails to make them skillful in "mental arithmetic" and in written computations, and fails to offer enough daily drill to keep the mental number-machine well oiled, cannot hope for success.

Never in the history of education has there been a better outlook for some genuinely good work in arithmetic. Never has there been a better opportunity for removing the just reproach that the subject is not taught as well as it was in the old district school, that good, old laboratory with a less pretentious name. With good content, with good form, and with a clear vision of the goal, the teacher of the next decade should regenerate this too neglected member of the old trinity of R's.

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### THE MATHEMATICAL LABORATORY.

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There is a widespread feeling, daily growing more insistent, that present methods of teaching mathematics are inefficient. Especially do teachers of physics point out to us the fact that the pupils who come to them are unable to apply the algebraic and geometric knowledge which they are supposed to have, to the problems presented to them. Those teachers of mathematics, who see and think, are becoming awake to the situation and many of them are searching for a better way. It is full time for us as teachers of mathematics to re-examine our ideals and methods.

Abraham Lincoln was accustomed to say that he laid the foundation of all his legal success by the study of Euclid. In that study he developed power to carry on a rigorous and logical course of reasoning; but in after years he used that power in a field entirely foreign to mathematics, in a field, indeed, where the reasoning is of a sort very distinct from that of geometry. For him, geometry was but a mental trainer; he learned to think. Such power is not native; it can be trained and developed; a man must learn to reason before he can reason well just as he must learn to ride or shoot. Such power must always be one of the results sought by a good education. Undoubtedly mathematics