This method it is believed is a generally workable plan by which the artificial line that has so long existed between algebra, geometry and physics may be erased and the three subjects may be correlated into one fundamental science subject running through three years of the secondary school.

ALGEBRA AND GEOMETRY SHOULD BE TAUGHT SIDE BY SIDE IN THE HIGH SCHOOL.

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My experience in the teaching of mathematics and science in secondary schools has been limited; but I have seen the work in a good many schools, and as a teacher in college for a number of years I have had abundant opportunity to examine the results. My remarks will be mainly confined to the subject of mathematics, but the argument can be used with almost equal force in regard to mathematical science. However, I leave that matter to those who have more experience than I have in elementary science teaching.

The college freshman must in most cases after admission to college do additional work in algebra and geometry; and it is here that I have opportunity to see the results of his preparatory work. My experience is that in a large majority of cases the student has a much firmer grasp of the principles of geometry than of algebra. While I can take for granted that he is well enough prepared in plane geometry to go on successfully with solid, I find that his knowledge of algebra is often too defective to enable him to take up profitably the work at the point to which his high school training is supposed to have carried him, and a considerable amount of valuable time must be consumed in a review of fundamentals. No doubt a part of this is due to the greater inherent difficulty of algebra for the average student; but it seems to me that the order of presentation of the subjects, which almost precludes mutual aid, is responsible for a considerable part of the trouble.

The average high school course—algebra first, then geometry,

and perhaps a brief review just before graduation after a year of rest from all mathematics—seems to me the worst possible arrangement. I am glad to say that it does not obtain in all schools. A considerable and, I trust, an increasing number teach the subjects side by side.

Experience no doubt shows that it is not very difficult to teach first and second year high school pupils a certain amount of manual dexterity in algebraic manipulation. But their minds are still too immature to gain any adequate grasp of the real science. They are not old enough to appreciate the underlying principles, and it is scarcely worth while to attempt to give a really scientific presentation of the subject at that stage of their development. The time for review at the end of the course must be given almost wholly to getting back what has been forgotten in their year or two of rest from algebra—forgotten because at the time they first studied the subject their minds were too immature for a comprehensive grasp. What has been learned as a mass of disconnected processes and more or less uncomprehended rules cannot in the nature of the case be any very vital part of their permanent mental equipment. The great majority of students evince a permanent dislike for algebra largely for the reason that their main training in the subject was given at a time when they were not sufficiently developed mentally to assimilate it properly.

If algebra and geometry are to be taught “tandem,” it seems to me that the better plan is to take up geometry first and to follow with algebra; but I think the side-by-side method is still better. The young student acquires a comprehension of the subject matter and the method much more easily in geometry than he does in algebra. The former is so much more concrete and definite. Experience and sensation, especially of vision, render an aid lacking in algebra. A concrete representation of the steps of the process as well as of the conclusion is possible. This is hardly possible in algebra until there is some store of geometric facts at the command of the pupil. If he has, in addition, work in some science requiring measurement and computation from measurement, he has another great aid toward his comprehension of algebra.

Algebra may be studied entirely apart from geometry, and geometry may be learned without algebra. The Greeks developed a beautiful system of geometry, the same we now use in the high school, only slightly modified along algebraic lines. But this slight modification means an enormous gain in ease of presentation, as any one who has attempted to teach Euclid's theory of proportion to a class of young pupils can testify. In like manner algebra gains greatly in comprehensibility by the introduction of graphic, that is geometric, methods in many places, and text-book makers are beginning to realize this more and more. The two belong together in an educational scheme, and neither should be studied without continual reference to the other and illustration by the other.

When this scheme of carrying on the two side by side becomes general, I predict that the great preponderance of pupils who "don't like" (that is, don't understand) algebra, over those who "like" (understand) geometry will in a measure disappear. Not entirely, however, as the experiential, concrete conceptions of geometry will always appeal to a larger circle of students than the more abstract conceptions and processes of algebra. This preference for the concrete to the abstract is one of the fundamental qualities of the mind, and it seems to me to be a reversal of the natural order to make the pupil finish his algebra before he has the aid of geometry to help him over many hard places.

The theory that the development of the individual is an epitome of the development of the race lends strong support. Geometry was a full-fledged science while men were still doubtful about vulgar fractions, many centuries passed before the meaning of negative numbers dawned upon the human intellect, and a rational conception of an imaginary is scarcely a century old. Yet the negative comes to the surface as soon as the simplest equations are studied, and the imaginary appears simultaneously with the quadratic. Why then should it be a cause for surprise that the average fifteen-year-old schoolboy is so often hopelessly befogged over his algebra? And is it not sound pedagogy to give him a few geometric concepts before he gets very far into the subject so that he may have a little aid toward a better understanding of the subject matter and processes in his work?