

SOME SUGGESTIONS ON THE TEACHING OF HIGH SCHOOL MATHEMATICS.

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It is a conceded fact that in most technical schools mathematics furnishes a source of considerable annoyance to both the faculty and the student. The cause for this may be varied. It may arise from lack of application, lack of preparation, lack of analytic power either inherent or from neglect on the part of the pupil, the teacher or both. That we may have a remedy for this state of affairs, radical changes in high school methods must in many instances be made. In some parts of the state the idea prevails that mathematics is easily taught, that little or no special preparation is necessary. One city superintendent informed the writer that any one could teach algebra, that an expensive teacher for this subject was unnecessary. In a school where such ideas hold little can be expected of the pupil. Often the teacher may have ample academic preparation and be hampered by the rules of the school or by his own lack of knowledge of how to present the subject so as to increase the student's interest and to give him mathematical power.

It occurs to the writer that the following changes will aid in the teaching of the elements of this important subject: First, the speed is far too slow. In any branch of the subject there is a continuity, the appreciation of which is entirely lost unless rapid progress is made. While it is granted that knowledge is a function of time yet rapid progress in the subject matter and one or more reviews over the same ground will be far better than a slow rate of speed. In mathematics more than in any other subject is the development made step by step. The student sees no use for his rules for factoring until he reaches fractions. If a month or more intervenes between his study of factoring and of fractions he will have lost much of his grip on factoring. It is the application of the subject that makes mathematics interesting and helps fix rule and method in the student's mind. More attention should be paid to factoring and to the reduction of complicated forms and to giv-

ing the student an insight into the shorter methods of solution. Likewise in geometry one theorem a day gives no idea of continuity or of relation. One theorem fades from the boy's mind before he has occasion to use it. Double the speed at least and then the progress will be too slow.

Some will say that the student cannot prepare lessons of such length. That depends upon the high school. There are high schools where the student carries nine subjects, has nine recitations a day. That means he does nothing in any of them. Four or five subjects are all that should be allowed any one. A school that does more cannot do acceptable work. It has been the writer's experience that one can carry a beginning class *through* the work in such a text as Well's "Academic Algebra" or Wentworth's "High School Algebra" in thirty-six weeks and have plenty of time for review. With the period of fifty-four weeks allowed by most schools for the completion of this work a student ought to go over the entire work at least twice. The watchword of every teacher of mathematics should be *review, review, review*.

Second: The student must have more analytic power. He goes to college with his mind still in the experimental state. He does not think things out. He finds by trial whether this or that scheme will do. While it is not always possible to give a young student analytic methods, he can be taught to think and that is three-fourths of the battle. If the teacher will so plan his recitations and so formulate his questions that the student will be required to think, the power of analysis will soon begin to develop. Too many teachers seem to think because *they* know their subject that no time is necessary for preparation. The successful teacher plans his work the fortieth time, more carefully than he did the first time over. The solution of original propositions in geometry is a great aid in the development of the analytic faculty.

Third: More graphical methods should be used. They arouse interest and give a meaning to a jumble of algebraic symbols and expressions. It is acknowledged that the equation is the cause for the existence of algebra. Introduce the graph as soon as the equation is reached. Many abstruse parts will be made clear and simple by the use of this method. Reasons for the limited number of integral solutions in problems in indeterminate equa-

tions, why two linear equations have a single solution, why two simultaneous equations of second degree have four and only four solutions, etc., are all seen at a glance when the equation is plotted.

It is gratifying to note that the mathematics of the high school is improving, that the student of today knows more of what he ought to know than did the student of a few years ago. It is to be hoped that progress may spread rapidly and that this movement toward modern methods may soon reach all schools.

SOME RECENT DISCUSSION ON THE TEACHING OF MATHEMATICS.

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7. In making men in any profession of applied science feel that they know the principles on which it is based and according to which it is being developed.

8. In giving to acute philosophical minds a logical counsel of perfection altogether charming and satisfying, and so preventing their attempting to develop any philosophical subject from the purely abstract point of view, because the absurdity of such an attempt has become obvious."

He believes most sincerely that these desirable functions would be performed well under the new system which is suggested. It may be well to quote a characteristic passage: "The ancients devoted a lifetime to the study of arithmetic; it required days to extract a square root or to multiply two numbers together. Is there any great harm in skipping all that, in letting a boy learn multiplication sums, and in starting his most abstract reasoning at a more advanced point? Where would be the harm in letting a boy assume the truth of many propositions of the first four books of Euclid, letting him accept their truth partly by faith, partly by trial? Giving him the whole fifth book of Euclid by simple algebra? Letting him assume the sixth book to be axiomatic? Letting him, in fact, begin his severer studies where he is now in the habit of leaving off? We do much less orthodox things. Every here and there in one's mathematical studies one makes