

THE EDUCATIONAL REVIEW.

On Calculus Dodging and other Educational Sins.*

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LADIES AND GENTLEMEN:—You are aware that we have recently been reorganising the classes in the department of Physics in this college, and that we now offer students courses of instruction in three stages of advancement. We have first an elementary class in Physics generally, in which we take a rapid survey of the whole subject, treating Dynamics only to the extent to which it is necessary as a foundation for the other sections of the subject. The members of this class are assumed to be familiar with the elements of Geometry (six books of Euclid) and of Algebra, but to have no knowledge of Trigonometry. We have next intermediate classes in Dynamics and in General Physics, the course of study extending in the case of the latter over two years. In these classes a knowledge of Trigonometry is assumed, but not of Analytical Geometry or of the Differential and Integral Calculus. Nevertheless in the endeavour to give as extended a knowledge of the subject as possible, the methods of the Calculus are frequently employed, though its symbolism is not introduced. We have finally the advanced classes in Mathematical and in Experimental Physics, the work of the former involving a knowledge of Analytical Geometry and of the Calculus, that of the latter consisting in the study of original memoirs and standard treatises, and in practical laboratory work. It is this organisation of classes which I wish to discuss with you to-day before entering upon the work of the session.

And first let me say that of course I admit that in a fully developed educational system the elementary class certainly should not find a place in the university. It is provided in our college only because our schools are not yet sufficiently far advanced to take it off our hands. And I wish to vindicate for it a position, not in the college course, but in our educational system somewhere. At present, if anywhere, it must be in the college. Ultimately, and let us hope soon, it may be transferred to the high school. Let me say also that just as certainly the advanced classes ought to find a place among university courses of instruction. There will be no difference of opinion on that point. But there is difference of opinion as to whether, either in school or in college, there ought to be classes such as those I have referred to as elementary and intermediate.

In organising our classes in the manner described, I have been influenced very greatly by strong faith in the educational as well as the practical value of a

study of Physics. It may be, perhaps, that as a teacher of Physics I am inclined unduly to glorify my office. But certainly, while I admit other subjects to be more efficient as means of training special faculties, I hold Physics to be, next to Literature, the best of all subjects of study as a means of general education. You are aware that it is the most highly developed of the physical sciences, that it is the best example we have of the combination of the inductive and deductive methods of reasoning, and that it embraces generalisations of all orders of generality and hypotheses of all degrees of probability. It therefore seems to me to provide, in the modes of reasoning which it calls into play, the closest analogue to the reasonings which we require to apply to our every day life. That being so, it would appear to be desirable that not only all our university students, but also all our youth, should as far as possible enjoy the advantage of a study of this subject before entering upon their life-work.

There is one difficulty in the way of the realisation of this ideal, however, and that is, that the peculiar benefit of the study of Physics is not derived unless the student already possesses a certain amount of mathematical knowledge. And hence the question arises as to the stages of mathematical advancement at which the subject of Physics may, with educational advantage, be taken up. On the one hand we have the fact that the more mathematical power the student possesses the greater will be the fruitfulness of his study of this subject, and on the other the fact that most persons enter upon their life-work with a comparatively small amount of mathematical knowledge, and that only the privileged few attain to any extensive mathematical power.

In settling this question I have naturally been guided by the circumstances in which we find ourselves. The arrangements of our school and college curricula make it comparatively easy for any one to obtain a knowledge of the six books of Euclid and of the elements of Algebra. I have therefore thought it desirable that an elementary class should be provided taking this amount of mathematical knowledge as the basis of its work. The great majority of those who go farther in mathematical study get at least a working knowledge of Trigonometry and of Geometrical Conics, but stop short of Analytical Geometry and of the Calculus. This class includes many men who, without any greater mathematical equipment, will enter the various engineering professions, and who, therefore, from a practical point of view, ought to be able to obtain as extensive a knowledge as possible, especially of Dynamics, but also of the other branches of Physics. I have therefore made

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