MATHEMATICS AND EDUCATION.

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Most mathematical activity is carried on in connection with educational institutions, and therefore the casual observer might expect to find that the views of the mathematics teacher, the educator, and educational administrator were in one accord on questions concerning educational values and the place of mathematics instruction in the curriculum. That such is not the case, however, is a matter of common observation. The educator of today is often rather skeptical of the value of mathematics and is rather inclined to question its right to its traditional place in our educational scheme. He often thinks that it should be replaced by other more "practical" subjects.

One of the causes of this attitude has been the reaction against the doctrine of formal discipline which occurred near the beginning of the twentieth century. There was a time when the main argument in favor of the study of mathematics was the one given by the philosopher, John Locke, which was that it "should be taught to all those who have the time and the opportunity, not so much to make them mathematicians as to make them reasonable creatures, that having got the way of reasoning, which that study necessarily brings the mind to, they might be able to transfer it to other parts of knowledge as they shall have occasion." The present status of this doctrine seems to be somewhat uncertain. There has doubtless been some reaction in its favor, but it is still possible to find among specialists all shades of opinion regarding it. Many elaborate experiments have been made either to verify or disprove it, but often two experts have been unable to agree on the interpretation of the results of the same test. In view of this uncertainty, perhaps the mathematics teacher is wise not to push his claims too far in this direction, especially since there are other good grounds upon which to base claims for his subject.

A second criticism made of mathematics by the educator is that it is abstract and remote from life, and therefore has no place in a scheme of education whose business is to prepare for social efficiency. Efforts have been made to meet this objection during recent years by reorganizing elementary courses in such a way as to defer the more difficult topics to the last part of the course and by introducing applications wherever possible. Here, a difficulty appears. Educators sometimes

seem to judge the entire utility of algebra for the student by the usefulness and applicability of the problems in the first courses. They seem to forget that beginning students have not at their command a sufficient body of elementary facts from the fields in which mathematics finds its most interesting applications to solve and appreciate problems taken from these fields. The full value of mathematics is not to be estimated from the first-year courses alone, but rather by the use which may be made of it in later work. The mathematicians have, perhaps, been too reticent on the question of applications. They study their subject chiefly because of the aesthetic pleasure which they experience in observing the harmonious relationships of number and form, but they must not forget that outsiders are, in most cases, utilitarians whom it is wisest to meet on their own ground.

The theory of statistics may serve as a bond to bring the mathematician and the educational theorist closer together in the future; it may bring home to the latter something of the practical value of mathematics. The schoolman of today is interested in the objective facts of the educational process; he is trying to found a science based on observation and experiment; he is trying to treat educational problems *quantitatively*. To do this properly, he must borrow tools forged by the mathematician for the treatment and analysis of statistics. For example, it is desirable for him to know the properties of the probability curve, $y = y_0 e^{-ax^2}$. Among other things, he must know the area under all or any portion of this curve. What a world of results from the realm of pure mathematics are implicitly related to this problem—properties of exponential functions, transcendence of e , the properties of infinite series, evaluation of infinite integrals, and so on.

There is a prevailing impression, too, that the applications of mathematics are confined to engineering; so that the prospective engineer is the only person benefited by its study. This idea surely needs correction. Mathematics is coming into wider use in other fields of endeavor every day. In psychology, sociology, and biology, the relations between certain groups of phenomena are being treated by mathematical methods and exhibited by means of correlation-coefficients and correlation-ratios. In economics, Professor Fisher has shown¹ that the general price level, that "high cost of living" which we are all so anxiously interested in these days, is dependent upon five

¹I. Fisher, *Why the Dollar is Shrinking*, p. 75.

other variables, and that the relation may be expressed *algebraically* in an equation of exchange. A recent writer on agriculture, at the close of an article dealing with the relations between plant growth and the chemical conditions of the soil, and involving some mathematics, remarks significantly, "It seems a far cry from the logarithmic curve expressing an absorption isotherm to the management of barley and turnips, but the relation is really simple and direct" ² Illustrations like these might easily be multiplied.

But it is not sufficient that mathematics is useful; that usefulness must be made known to the public. The mathematics teacher of today must be a propagandist; he must use every legitimate means to bring the importance of mathematics to those outside of the schools, so that they may better appreciate the worth of the enterprises upon which he is engaged. In the classroom, let him do as much as the immaturity of his audience will permit to suggest the human significance of mathematics. More than this, he should miss no opportunity to cultivate an appreciation of his subject on the part of those whose opinions direct school policies. The speeches which high school teachers are often called upon to make at gatherings of parents and teachers offer opportunities along this line.

The teacher should also see that the public library in his community is equipped with at least a few good mathematical books. Strange to say, there are libraries in cities of populations of thirty or forty thousands of people which are entirely without books on mathematics. After the books are in the library, he must do what he can to influence people of the right kind to read them. In these and other ways which will readily suggest themselves, the aggressive teacher can help to bring about a situation in which mathematics will be regarded with the respect which it so justly deserves.

²E. J. Russell, "Principles of Crop Production" in *The Scientific American Supplement* for July 8, 1916.

WHAT THE WAR COSTS.

On July 1 last, the first day of the present fiscal year, the war was costing:

\$18,000,000,000 a year.

\$50,000,000 a day.

\$2,000,000 an hour.

\$33,000 a minute.

\$555.00 a second.

On July 1 next, according to latest estimates by the War Department, the war, for the twelve months, will have cost \$31,000,000,000.