Applied Mathematics

Mathematics for Physicists and Engineers. Organisation for Economic Cooperation and Development, Paris, 1961 (available from O.E.C.D. Regional Office, Washington, D.C.). 223 pp.

This tract is the report of an international seminar which was held in Paris in 1961; the seminar was organized in response to a French proposal that stemmed from concern about the content and pedagogical philosophy of the mathematics courses customarily taught to engineers. The proposal stated that "Mathematical studies for the sole purpose of learning this abstract science are not necessary for future research workers and engineers. There is reason to fear that the teaching of mathematics, which is naturally in the hands of mathematicians, is often allowed to go too far in this direction. It would, therefore, be extremely interesting to come to some understanding as to how much mathematical knowledge is indispensable for engineers and experimental scientists."

The participants (about 80 attended) represented nearly all the countries of western Europe, as well Greece, Turkey, and Yugoslavia, the United States, and Canada. Seminar papers, reproduced in this tract, were presented by H. O. Pollak (U.S.), M. Jacob (France), H. Wallman (Sweden), Mrs. L. J. Abercrombie (U.K.), M. Fallot (France), A. H. Douglas (U.K.), J. Fagot (France), H. D. Baehr (Germany), T. L. Cottrell (U.K.), H. J. G. Meyer (Netherlands), A. Kaufmann (France), P. Naslin (France). The range of viewpoints and the criticisms of the status quo, represented in these papers and in the associated discussion, were what one might expect from a similar conference of engineers, physicists, and applied mathematicians in the United States.

Working groups prepared coordinated reports entitled "Upper level secondary school mathematics," "Preparatory training in its pure sense," and "Professional training leading to the first diploma of higher education, as well as to post-graduate training."

The essence of the conference and its reports is contained in its conclusions and recommendations, of which the most significant are: (i) In the elementary teaching of mathematics one should not go into abstraction for itself, but one is required to start from the concrete, even for the introduction of a new teaching approach. (ii) At the "propedeutic" and more advanced levels, the introduction of mathematical topics should be motivated by their relevance to science and engineering and should progress from the special to the more general; after their introduction, the mathematical topics should be presented with mathematical rigor by mathematically competent persons. This necessity for rigor is more important at teacher levels; exercises (supervised and at home) should be drawn from physical and engineering applications; their major aim should be to deepen the understanding. (iii) The mathematical requirements of many categories of engineers, as well as physicists and physical chemists, are similar in kind, but the level to be attained may differ in particular cases. (iv) These requirements are vector field theory, linear algebra and matrices, complex variables, integral transforms, ordinary differential equations, partial differential equations, special functions, and probability and statistics. Throughout the foregoing, the quantitative aspects of mathematics should be stressed and the value of numerical methods recognized. (v) If, because of restricted time, a choice must be made between depth of understanding and breadth of coverage, the former should prevail.

I would like to hope that this reiteration of familiar theses will lend its share of weight in persuading the body of teaching mathematicians to re-recognize their pedagogical obligations to their scientific brethren.

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Education and Productivity

The Economics of Education. John Vaizey. Free Press (Macmillan), New York, 1962. 165 pp. $4.

This brief book is largely a review of existing economic research on the contribution of education to productivity. It also directs some attention to the inputs of the education process—the alternative combinations of labor and capital from which choices of production techniques may be made—and to the problems of financing education.

Vaizey states in the introduction that he has "tried to apply economic analysis to education . . ." but it is not until he writes the conclusion, 138 pages later, that he admits to "tainting the pure milk of economics with a flavouring of the social purposes of public policy." Some readers may find that the mingling of value judgments with analysis makes the book more readable, but instructors may feel that this limits its usefulness in the classroom. And Vaizey hopes the book will find acceptance there.

There is much food for thought in this book, though we might wish that the analysis had been more acute. In a chapter entitled "The returns to education," Vaizey discusses what he sees as four approaches which have been used to measure returns. One employs aggregate-economic concepts. It attempts to discover how much economic growth is explainable by *quantitative* increases in labor and capital; it attributes the remaining, "unexplained," growth to other factors including *qualitative* changes in resources, of which education may be an important determinant.

The other three approaches view education as an investment analogous to construction of a machine. Vaizey calls them: (i) "Discounting of the additional earnings of the educated"; (ii) "Calculation of human capital"; and (iii) "Cost-benefit ratios." Without being precise, he seems to describe approach i as a means of evaluating the returns from, or the *benefits* of, investment in education, and ii as a means of evaluating the *costs* of resources devoted to education. Thus, iii encompasses i and ii, although Vaizey does not indicate this. If the profitability of education as an investment is one's focus, as it is for Vaizey in this chapter, and if his descriptions of the approaches are accurate, then iii is the only relevant approach; it is the only approach that compares the values of inputs and outputs. Yet, surprisingly, Vaizey "rate[s] the last *two* as most satisfactory" (p. 37, italics added). Actually, all of the economists mentioned by Vaizey as having worked with approaches i and ii have done so within a cost-benefit framework, so that there is really no significant difference between the three approaches. Vaizey's descriptions are simply incomplete.

In spite of its limitations, *The Economics of Education* is a useful presentation of current thinking in the area, blended with Vaizey's ideas concerning education as a contributor to lofty so-