

Mathematics and the Sciences.

I AM grateful to your reviewer for so freely quoting (p. 591) examples from *Descriptive Mathematics*. To these I shall refer in reverse order. The example on rhythm in prose I cannot take space here to explain; I would merely extend it by putting the question, whether there be in any language a group of words or syllables, other than the specific "tra la la", which do for three-time in music what "due, duty, dutifully" do for four-time. The example is evidently a "wandering away from well-trodden paths" on which the reviewer frowns.

The excuse for the example on the secant is that the speed with which the sun crosses the horizon is noticed at once by one who comes to the tropics, and it is the contrast with the insensibly slow speed in temperate latitudes that is suggested. Build on this astronomy if you will, but the example itself is based on a wide range of simple experience.

The quotation of Vieta's formula (*Descriptive Mathematics* 12, Ex. 8) is, I am afraid, divorced from its context, "calculate as far as the slide rule allows Compare with this....logarithms." There is nothing really terrifying about the calculations; the limitations of our tools are soon revealed! The other examples with the astronomical numbers are, for one thing, intended to deliver from the general fear of such numbers. It comes as a great relief to the students to see the ease of dealing with such examples from a commonsense point of view. I have found nothing to equal the slide rule as a means of teaching students commonsense. (Must I take the phrase "all the slide rules in the World" to be a response to my query as to discussions on slide rules?)

It may be useful if, following your reviewer's example, I mention a personal detail. I have no liking for statistical work, and I do none save what the students may require; I have often wondered if it be a disadvantage that I have had no intimate experience of computing.

(i) More important, however, than such matters is the suggestion advanced that the present courses in mathematics are really satisfactory, with the implied denial that there is any special need to make liaison between mathematics and the sciences. Doubtless there are somewhat rare scientific workers who "automatically cultivate the

required speed and accuracy in numerical work", but the general experience is that great numbers are handicapped, and that even books and researches in their subjects are practically closed to them, because they had been given a mathematical training of an unsuitable kind. One aim I should like to do something to achieve is to make such books as Barcroft's *Architecture of Physiological Function*, or A. V. Hill's books and papers, easy reading for the physiologist, and Keynes' *Money*, Vol. I, for the economist. Nine-point circles and factorizations give no aid here; their beauty must be reserved for specialist students.

(ii) As to what is teachable, it was actually the fact that we mathematical teachers generally fail to convey to our students anything more than the impression that we are dealing with interesting puzzles that started me on the investigation which has led at this stage to *Descriptive Mathematics*. The complaint made is that I have overloaded the course, and to the outsider it will certainly appear so. What, I believe, led the Board of Studies in Bombay University to arrange full facilities for teaching this course was that I gave the members of the Board every opportunity to inspect the actual work of the students and to question them personally. It is possible to give students the satisfaction of *Power* with regard to the mathematical operations in question: at the very least they are frequently in a position to apply critical tests to assertions which with the customary training they would have had to accept open-mouthed. '*Experto crede!*', and I am not alone in the Bombay Presidency in having tested this new approach.

JOHN MACLEAN.

Wilson College,
Bombay,
March 9, 1936.

I AM unwilling to continue the controversy, on the subject; I shall close with a few remarks. In the first place, I have been put at ease by Prof. Maclean's nearly frank statement about his "wandering away", and about his recording through an example one of his experiences as he came over to India from northern latitudes.

Prof. Maclean refers to "the suggestion advanced that the present courses in

Mathematics are really satisfactory". Wherever this suggestion may have come to him from, I am surely not its author or supporter. But in my opinion, the present book goes no way to remedy the defects of the existing system. The author aims at teaching the first year Intermediate students the elementary principles of mathematics and at the same time "deliver" them "from the general fear" of "astronomical numbers". I wish the author all success in the attempt but unless the Bombay Presidency students are, as human beings, made of some other material than their colleagues elsewhere, I can foresee only a very limited amount of success in the endeavour.

"Nine-point circles and factorizations...; their beauty must be reserved for specialised students"—so writes Prof. Maclean, though I made no reference to these. But in the

question papers set at the Wilson College, the non-specialised students are asked (i) to discuss the difficulty caused by irrational numbers in the theory of similar figures, (ii) to prove that any portion of an equiangular spiral is similar in form to any other portion within the same angular range, (iii) to evaluate a fourth-order determinant, etc., etc.

Mathematicians! Please don't be "Conservative" or "narrow-minded"!!

I shall close with the following sentence of Prof. Maclean, which, I trust, will amuse the general scientist, the student of Arts and the general educationist:

"I have found nothing to equal the slide rule as a means of teaching students common-sense."

C. N. S.

A Modification of Dixon's Constant Pressure Respirometer.

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PRACTICALLY all methods of determining the respiratory exchange in plants depend upon the use of some gas-analysis apparatus, the one devised by Haldane being usually employed. Gas-analysis is a tedious process and various investigators have felt the need of some simpler method. In the course of investigations on the influence of temperature on gaseous exchange in *Pisum sativum*, a study designed primarily to get an insight into the reactions involved in respiration,¹ the constant-pressure respirometer recently described by Dixon² was found to be highly convenient for respiration measurements. But it was found in practice that the temperature of the measuring pipette in the Dixon's respirometer frequently changes, thus introducing considerable errors. To obviate this difficulty, a "compensation" pipette (B') has been added to the Dixon's apparatus (Fig. 1). As a further safeguard against temperature fluctuations, the graduated pipette (B), the compensation pipette (B') and the manometer (M) have been enclosed within a glass jacket, the water in which is kept stirred to maintain a uniform temperature. The addition of the water jacket introduces

no inconvenience manipulation as the respirometer need not be shaken during experimentation. The 3-way tap (F) facilitates the introduction of the monometric liquid (paraffin coloured with Sudan III) into the U-tube (M). The vessels P and Q are of the type used by Haines (see Fraymouth³) in the modification of the micro-respirometer of Barcroft and Winterstein. Arising from the base of each vessel is a capillary tube which communicates with the outside air and may be closed by means of a tap (T). The right-hand vessel contains a glass-lattice platform on which the plant material is placed.

Attention has recently been drawn by various investigators to the existence of several metabolic groups among individuals of the same chronological age, an important consideration when it is not feasible to experiment upon single individuals. In investigations where a number of seeds are taken in a lot for experimentation, this error is considerably reduced, if not entirely eliminated, by a rigid control over the selection of a single variety and the conditions of germination in order to obtain a population more or less of the same meta-

¹ Crozier, W. J., *J. Gen. Physiol.*, 1924, 7, 123.

² Dixon, M., *Monometric Methods*, 1934 (Cambridge).

³ Fraymouth, *J. Ann. Bot.*, 1928, 42, 75.