The Position of Common Logarithms in Mathematical Training

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Miss H. M. Cook opened a discussion on :

THE POSITION OF COMMON LOGARITHMS IN MATHEMATICAL TRAINING.

IN discussing the teaching of other branches of their science, mathematicians often assume that children of school age are capable of using tables of common logarithms with considerable accuracy. This is by no means always the case. If the discrepancy is due to essential differences in the development of children in different parts of the country any attempt to make practice uniform must of course meet with failure, but I would claim that some appreciation of the use of logarithms is possible for every child in our schools.

It remains to decide at what stage relatively to other mathematical subjects this particular study should be introduced, and three main questions must influence our discussion :

- (1) What is the present position of common logarithms ?
- (2) What ought the position to be ?
- (3) Ought the Mathematical Association to take active steps to hasten the movement from the present position to the ideal position ?

The present position, at any rate in the smaller schools, seems to depend on the particular external examination for which pupils are encouraged to work. The Oxford and Cambridge Local Examinations now include questions on the use of tables of common logarithms, without requiring formal proofs of the Index Laws, and so do the papers set for the Northern Universities Joint Matriculation. This corresponds to the recommendations made by the Mathematical Association Committee, but the London University—proverbially slow to alter its regulations—makes no mention of logarithms (except to forbid their use) in the syllabus for the compulsory Matriculation papers. Nor are they compulsory for Responsions. There are still a few students entering the Mathematical departments of our University Colleges who know practically nothing of the use of tables, and I think it is fair to infer that their class-mates who enter other faculties, or begin business life on leaving school, have received no fuller mathematical teaching as a part of their general education, and will in most cases never have any idea as to how logarithms simplify calculation.

In the schools in which the use of logarithm tables is taught, there is still considerable difference of opinion and practice as to its proper place in the curriculum. I have known boys with no particular mathematical bent—indeed very backward in all forms of book-work—who greeted the subject as a pleasant change from commercial arithmetic, and attained considerable mechanical skill in using tables after a very slight numerical introduction to fractional indices, some time before their algebraical powers had advanced far enough for them to appreciate the excellent chapter in Messrs. Godfrey and Siddons book, which gives a graphical introduction to the subject.

Personally, I like to use this graphic method. In any case the demands of science teachers suggest that logarithms should come early in the algebra course—see the General Mathematical Syllabus for non-specialists, Part I. Certainly geometrical progressions are very artificial if taken before logarithms, as either the number of terms or the ratio must be limited in any example set for children to work out.

The use of some form of tables ought to be taught in every school. Children may themselves construct tables of squares—a much more stimulating exercise than haphazard practice in simple multiplication, and they may then be taught to appreciate tables of square roots. Logarithm tables naturally follow, and if all the business community understood their tables of Compound Interest, Annuities etc., would be less mechanically and more intelligently

used. This is the "outlook" justification for logarithms, as a school subject, and suggests that they could be profitably taught in the new Continuation Schools. I have myself talked with children, who, having passed Standard VII. and been admitted as factory hands, were required by their employer to attend evening classes. The teacher was the headmistress of the elementary school, and their complaint was that they learned no new arithmetic, but simply worked through the Standard VII. sums again. To say the least of it, this seems to have been an opportunity lost.

Ought we to approach the London University and other educational authorities to make the teaching of the use of common logarithms more general?

H. M. COOK.

A discussion ensued, in the course of which the following comments were made:

Prof. T. P. NUNN—The exclusion of logarithms from the syllabus of the London Matriculation Examination in mathematics is undoubtedly a serious and mischievous thing. The explanation appears to be that the University Board of Studies in Mathematics assume that the doctrine of logarithms necessarily rests on the doctrine of fractional indices; since the latter is not required, the former cannot be included. Miss Cook quite properly rejects the excuse, but she weakens her position, I fear, by accepting the assumption that gives it what force it possesses. That assumption is, of course, entirely untrue—as is proved by the historical fact that Napier had worked out his theory of logarithms many years before Wallis invented, in a totally different connection, the fractional index notation. In fact, given the ideas (1) of a doubly endless geometric sequence with unity as its middle term and (2) of a doubly endless arithmetic sequence with zero as its middle term, it is easy to work out an entirely satisfactory theory of the logarithmic tables—and that is, surely, all that even the purist can demand before permitting us to place the tables in our pupils' hands.

Prof. MILNE commented on the necessity of a knowledge of trigonometry and logarithms for students entering a university, it not being at present a compulsory subject in the papers on Mathematics in various Higher Certificate and Matriculation Examinations.

He also referred to the unexpected applications of mathematics in industry, instancing the fact that "scales of notation" are fundamental in the mathematical basis of the textile industry.

Miss E. M. READ had always taught logarithms before G.P. On showing a series such as 2, 4, 8, 16 . . . to 50 terms, she found that the attempts at guessing the 50th term were very wide of the mark. She then worked out

$$2^{50} = (10^{0.3010})^{50} = 10^{15.05} = 10^{15} \times 1.122.$$

To drive home the magnitude of this result she took 11220000000000, which did not, however, seem so convincing to her pupils as 1122386294716218, where the last twelve digits were written down at random.

Mr. M. FINN—Boys of 13 can be led in ten minutes to *discover* for themselves the desirability of the use of the zero index, negative indices and fractional indices, after they have grasped such statements as $a^2 \times a^3 = a^5$, $a^7 \div a^3 = a^4$ and $(a^2)^3 = a^6$. Write in a vertical column the series 1,000,000, 100,000, 10,000, 1,000, . . . 1/1,000,000. In a parallel column, let the first few terms of the series be replaced by their equivalents, 10^6 , 10^5 , 10^4 , Zero and negative indices will immediately be suggested by the boys in order to complete the series in this *shortened* notation.

Now take the series 10^8 , 10^4 , 10^2 , 10^1 , In order to continue it, we are compelled to introduce $10^{1/2}$, $10^{1/4}$, etc. We are thus led to fractional indices and their meaning.

Tests should now be applied to see if the rules which apply to positive integral indices also hold good for these "newcomers."

No further real advantage of any sort is obtained by the boys from a formal study of the "Theory of Indices."

The idea of logarithms and the rules concerning the log. of a product, etc., should be introduced by merely paraphrasing the corresponding statements in the Theory of Indices.

In her reply, Miss Cook welcomed Prof. Milne's suggestion of an attack on London University from the flank. She recognised that London was not the only offender, but in view of its external degrees it had a wider influence, and might therefore be considered the worst offender.

She would not necessarily postpone all mention of the geometric sequence till after logarithms, but she thought the formula for the sum of the series could be usefully employed only when logarithms were known and used.

No exhaustive treatment of the Theory of Indices need precede the use of logarithmic tables—indeed, if taught as part of an arithmetic course, numerical bases might be used throughout, and this would probably be done in elementary and continuation schools, but the fundamental index law must be explained.

40. *J.* [Arago's] character was noble, generous, and singularly energetic; his manners lively and even gay. He was a man of very general information, and, from his excitable temperament, he entered as ardently into the politics and passing events of the time as into science, in which few had more extensive knowledge. On this account I thought his conversation more brilliant than that of any of the French savans with whom I was acquainted. . . . The Marquis de la Place was not tall, but thin, upright, and rather formal. He was distinguished in his manners, and I thought there was a little of the courtier in them, perhaps from having been so much at the court of the Emperor Napoleon, who had the highest regard for him. Though incomparably superior to Arago in mathematics and astronomical science, he was inferior to him in general acquirements, so that his conversation was less varied and popular. . . . M. Arago had told M. de la Place that I had read the *Mécanique Céleste*, so we had a great deal of conversation about astronomy and the calculus, and he gave me a copy of his *Système du Monde*, with his inscription, which pleased me exceedingly. . . .—*M. S. Loc. cit.*, pp. 108-109.

[Some may think that the Preface to Laplace's *Théorie Analytique des Probabilités* borders on the sycophantic; at any rate it seems to bear out Mrs. Somerville's suggestion as to there being "a little of the courtier" about him.

A

NAPOLÉON-LE-GRAND

Sire,—La bienveillance avec laquelle VOTRE MAJESTÉ a daigné accueillir l'hommage de mon *Traité de Mécanique Céleste*, m'a inspiré le désir de Lui dédier cet Ouvrage sur le Calcul des Probabilités. Ce calcul délicat s'étend aux questions les plus importantes de la vie, qui ne sont en effet, pour la plupart, que des problèmes de probabilité. Il doit, sous ce rapport, intéresser VOTRE MAJESTÉ dont le génie sait si bien apprécier et si dignement encourager tout ce qui peut contribuer au progrès des lumières, et de la prospérité publique. J'ose La supplier d'agréer ce nouvel hommage dicté par la plus vive reconnaissance, et par les sentiments profonds d'admiration et de respect, avec lesquels je suis,

Sire,

De Votre Majesté,

Le très-humble et très-obéissant
serviteur et fidèle sujet,

LAPLACE.]