A discussion on the Board of Education circular No. 711 was initiated by C. Godfrey, Esq., M.A., of the Royal Naval College. The chief points of Mr. Godfrey's address were as follows:

The reform policy was approved—the drawing of geometrical patterns was advocated. It is better to go slow than to go fast as advocated in the circular. Intuition should be encouraged, even when the work is entirely theoretical. The treatment of the fundamental propositions as advocated in the circular was approved. The sequence trouble is not serious. It is to be regretted that the Board did not give a stronger lead with regard to solid geometry. In France, Austria, and Germany two and three dimensional geometry go hand in hand.

In the discussion which followed the members generally were in agreement with Mr. Godfrey's position. Mr. Phillips, of the Hartley College Engineering classes, thought that the sequence difficulty was a real one, and Dr. Fenwick thought that it was better to go quickly through the geometrical course as advised in the circular.

CORRESPONDENCE.

To the Editor of the *Mathematical Gazette*.

Sir,—I have read with much interest the important letter by Miss Edith Stoney in your last issue, in which she criticises the method for calculating the coefficient of linear expansion recommended by the Joint Committee of the Mathematical Association and the Association of Public School Science Masters.

Whenever we consider the various methods of teaching any subject, it is important to distinguish between those suited to the mature and those best adapted to the immature mind: with the former it is possible, and since it saves time, probably wiser; to reason from the abstract to the concrete, *i.e.* to adopt mathematical methods, and such pupils will not be confused by the exact treatment of problems like that mentioned: but with those whose minds are as yet immature the teacher is forced to choose between letting them reason from the concrete to the abstract or being content that they shall adopt rule of thumb methods.

In teaching linear expansion to the younger boys in our Public Schools (and the report, in urging that lessons in heat shall precede any in chemistry, is clearly contemplating such pupils) the method adopted is first to give a demonstration of the qualitative fact of expansion, and then make the pupils themselves measure the amount; when this has been done the results obtained in the laboratory are used to furnish problems in the class-room. The form of apparatus used for determining the coefficient of linear expansion varies much, but the principles of almost all depends upon the use of a micrometer screw, and consequently the limit of accuracy which can be obtained is 1/100 millimetre; under these conditions no difference can be detected between the results obtained when the initial temperature of the rod varies, and it would only confuse the pupil to be told he should consider this. A few weeks later the expansion of gases is considered, and here it is at once found from the results of experiments made by the pupils themselves that the initial temperature makes a very considerable difference in the values obtained: the teacher may, and in my opinion should, when explaining this, point out that the assumption tacitly made when considering the expansion of solids is only approximately true.

When the pupil comes back to the subject two or three years later his mind will have developed, and he will have no difficulty in understanding either the exact scientific facts or the mathematical treatment of them;

at this stage, I need hardly say, the method mentioned by Miss Stoney is the correct one to adopt.—Yours faithfully,

DOUGLAS P. BERRIDGE,
Hon. Sec. Association of Public School Science Masters.

Malvern.

TO THE EDITOR OF THE *Mathematical Gazette.*

SIR,—My letter was written under the influence of warm enthusiasm for the main text of the Report on the *closer correlation* of Mathematics and Physics teaching in our schools. On p. 2 of that Report the chief obstacle to such correlation is assumed to be the lack of laboratory training amongst our mathematical teachers. I fear I venture to think it is also to some degree due to unwillingness amongst our science teachers to spend the necessary time in class in order to make our children use practically the knowledge which the mathematical teachers have (probably) already given them theoretically. Surely it is a delight to most children to find that their dry mathematics "are of some use"! Boys, and most girls from good modern schools, at say 13 years of age, know enough algebra to be able to multiply $(1+x)(1+y)$ or to divide $\frac{1}{1+x}$. It is not proposed, I believe, that such a subject as Heat should be taught at a younger age than about thirteen.

This is very elementary compared with the use of logarithms or a slide rule, and yet it is all the mathematics which I presuppose in my example and which is considered too abstract by Mr. Berridge.

Assuming that this amount of abstract knowledge has already been given, then my point was that the Physics teacher could well correlate it and shew its use in a concrete form. Certainly, to train the class in the practical use of their mathematical knowledge will be at the cost of a little time at first—though I believe at a great saving of time in the end. Soundness of training and not questions of time are however the chief consideration at such junior ages. This training will also shew the students how to allow for probable errors in their results due to micrometer screws, et cetera.

Of course it is true that experimental errors are likely to be greater in such experiments than those from using approximate formula; but are we to state so *ex cathedra* to our children, or are we to give them the means of estimating the effects of the various errors in the results for themselves? Using no such elementary mathematics as I suggested, I do not know how Mr. Berridge proposes to explain to a class that the vague and inaccurate theoretical method suggested in the example given in the Report is justified by probable errors in the micrometer screw! It is just those of my students who find Mathematics and Physics difficult who are most confused and made to feel unsound if I tell them all their work a few weeks before depended on tacit assumptions which I had induced them to slither through unconsciously.

If the school teaching of Mathematics and Physics is to be correlated, why not begin from the earliest stages of the Physics and use the Mathematics the children already know? The chief object of the Report may be to get our Mathematical teachers to make use of concrete Physical illustrations, but is not also one object of the Report to encourage us to continue no longer to teach the "emasculated kind of Physics without Mathematics which would not give a headache to a caterpillar" which Sir J. J. Thomson warned us is the present tendency?

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