

THE COCKROFT REPORT: A review

A Committee of inquiry was established in 1978 under the chairmanship of Dr. W.H. Cockroft, vice chancellor of the New University of Ulster, with the following terms of reference:

"To consider the teaching of mathematics in primary and secondary schools in England and Wales with particular regard to the mathematics required in further and higher education, employment and adult life generally, and to make recommendations."

The Report "Mathematics Counts", published in January 1982, comprises three main sections: first the mathematical needs of adult life, employment and further education are examined, then a detailed analysis is carried out of the current state of mathematical education in primary and secondary schools, and finally facilities for the training of mathematics teachers both initial and in-service are discussed.

A large number of recommendations is included in the body of the Report and a great deal of statistical information is appended. Accordingly, I can do no more here than present a small sample of this wealth of information and analysis in the hope of stimulating the reader to further investigation. Clearly, also, I cannot hope to make precise the relevance of the Report to the Irish context: such a task would be of an order of magnitude altogether different from this review. However, I believe that its relevance should not be underestimated. Perhaps it could provide a timely stimulus for an investigation into the teaching and learning of mathematics in Irish schools along similar lines to that undertaken by the Committee: perhaps taking less time, perhaps not so broad in its brief, but nevertheless with sufficient influence to recommend changes which may well be long overdue. Is such an investigation necessary?

There is a clear recognition in the Report of the spread of ability in mathematics found among schoolchildren. For example at the primary level

"It therefore seems that there is a 'seven year difference' in achieving an understanding of place value which is sufficient to write down the number which is 1 more than 6399. By this we mean that, whereas an 'average' child can perform this task at age 11 but not at age 10, there are some 14 year olds who cannot do it and some 7 year olds who can. Similar comparisons can be made in respect of other topics" (342)

[the number in brackets refers to the paragraph in the Report from which the quote is taken]

The principal implications of this lie in the organisation of classroom teaching to cope with the range of ability found within each class. The Report is quite firm in recommending that efforts should be made to adapt the curriculum and pace of learning as far as possible to suit the individual child. How far these efforts can go will obviously depend on the school concerned and on the enthusiasm and ability of the teacher. However certain helpful aids are discussed such as the use of workcards and textbooks, the deployment of teaching staff in a variety of alternative modes (for example the use of team teaching) and the provision of a "mathematics area" within the school. There is also a detailed discussion of the relative merits of the organisation of classes on the one hand into "sets" and on the other into "mixed ability" groups, with the former being regarded as the more appropriate at the secondary level. Even within the "sets" the range of ability is quite wide enough for any ordinary teacher to cope with!

The Report emphasises repeatedly the need to foster positive attitudes towards mathematics from the earliest days at school. The extremes of attitude which can and do occur are described thus:

"By the end of the primary years a child's attitude to mathematics is often becoming fixed and will determine the way in which he will approach mathematics at the secondary stage. He may thoroughly enjoy his work in mathematics, or he may be counting the days until he can stop attending mathematics lessons. He may have learned that mathematics provides a means of understanding, explaining and controlling his environment, or he may have failed to realise that it has any relevance outside the classroom. He may have learned the importance of exploration and perseverance when tackling a problem and experienced the pleasure which comes from finding its solution, or he may regard mathematics as a series of arbitrary routines to be carried out at the teacher's behest, with no opportunity for initiative or independent thought. He may be well on the way to mastering some of the mathematician's skills, or he may already see mathematics as an area of work which he cannot understand and in which he always experiences failure." (346)

It should therefore be the aim of any teaching programme to instil confidence in the pupil in his ability to use what mathematics he knows (and however little it may be) and to apply it in his everyday life. In the case of children whose attainment is low, advances should be made very gradually with frequent opportunity for repetition and reinforcement. Use should be made of

"extensive and varied practical and oral work related to everyday situations such as measurement, shopping and the use of money" (335)

In particular the Report provides a "foundation list of topics" or core which should be the basis for work in the secondary years (but which should of course not be regarded as limiting the scope of courses provided for children of higher attainment). The broad headings are: number, money, percentages, use of calculator, size, measurement, graphical and pictorial representation, spatial concepts, ratio and proportion and statistical ideas. Again the need to make mathematics at all levels of attainment relevant to everyday life is stressed. This is brought home very clearly by an extract from one of the submissions received by the Committee.

"Mathematics lessons in secondary schools are very often not about anything. You collect like terms, or learn the laws of indices, with no perception of why anyone needs to do such things. There is excessive preoccupation with a sequence of skills and quite inadequate opportunity to see the skills emerging from the solution of problems. As a consequence of this approach, school mathematics contains very little incidental information. A French lesson might well contain incidental information about France - so on across the curriculum; but in mathematics the incidental information which one might expect (current exchange and interest rates; general knowledge on climate, communications and geography; the rules and scoring systems of games; social statistics) is rarely there, because most teachers in no way see this as part of their responsibility when teaching mathematics." (462)

The Committee's abhorrence of the practice of teaching mathematical routines divorced from the everyday lives of the pupils is evident in the prominence it gives to this extract.

In building on the foundation list of topics the aim should be to provide a "differentiated curriculum" whose content is matched to the level of attainment and rate of learning of the pupils with the aim of improving their mastery of the mathematics they study and inspiring them to greater confidence in their approach to mathematics. This should be achieved by providing two "reference levels" for examination purposes (rather like the Higher and lower level syllabuses for Intermediate and Leaving Certificate courses). The Report questions the validity of including many of the topics at present appearing on examination syllabuses. For example

"We cite ... multibase arithmetic. Although this is a topic which offers opportunity for interesting and often challenging work at a variety of levels in the hands of a skilled teacher, and which can therefore appropriately find a place in some classrooms, we do not believe that a question of the kind

'evaluate 27×3 in base 8' is suitable as an examination question at any level."

One aspect of mathematics which in the opinion of the Committee has been largely ignored in recent years is the use of mental arithmetic. Those who can use mathematics effectively in their daily lives usually employ mental calculations with ease and these are very often based on quite different techniques from the ones they learned at school. Oral and mental work should therefore form a significant component of any mathematics programme. However, although a facility with addition and multiplication tables up to the 10 times table is desirable, the Committee totally reject the call for a "back to basics" approach to teaching mathematics. The movement towards such an approach has

"encouraged some primary teachers and some teachers of low-attaining pupils in secondary schools to restrict their teaching largely to the attainment of computational skills ... However, we hope that the argument ... makes it clear that the ability to carry out a particular numerical operation and the ability to know when to make use of it are not the same; both are needed ... An excessive concentration on the purely mechanical skills of arithmetic for their own sake will not assist the development of understanding in those other areas. It follows that the results of a 'back to basics' approach ... are most unlikely to be those which its proponents wish to see, and we can in no way support or recommend an approach of this kind." (278)

A detailed discussion of the Committee's comprehensive analysis of the examination system is inappropriate here as it deals of course with the current position in England and Wales. However their description of the spirit of an examination is perhaps worthwhile recording.

"We believe that there are two fundamental principles which should govern any examination in mathematics. The first is that the examination papers and other methods of assessment which are used should be such that they enable the candidates to demonstrate what they do know rather than what they do not know. The second is that examinations should not undermine the confidence of those who attempt them." (521)

One of the "other methods of assessment" adverted to is indicated:

"... we believe that provision should be made for an element of teacher assessment to be included in the examination of pupils at all levels of attainment." (535)

However even this combined with formal examinations may be inappropriate for lower-attaining pupils and the Report recommends that there be further research into the assessment of such pupils.

The subject of teacher training is similarly unsuitable for detailed discussion here. However it may again be worthwhile to pick out one paragraph: this one deals with the aims of courses provided by the universities for intending teachers of mathematics. According to the Committee these should be

- "to develop knowledge and mastery of mathematics substantially beyond the level at which they will be teaching and also, where appropriate, provide opportunity to pursue some topic in depth;
- to develop enjoyment of mathematics and confidence in its application;
- to provide an historical perspective of mathematics;
- to provide an appreciation of the relationship between mathematics and other fields of study;
- to develop the ability to communicate mathematical ideas both orally and in writing." (643)

There is also a great deal of room for improvement in the number of girls taking mathematics at degree level or as the principal subject in a teacher training course. Indeed, the Report includes a substantial appendix on "Differences in mathematical performance between girls and boys", which may point the way to the resolution of the problems of disparity of numbers and acute shortage of well-qualified teachers of mathematics.

The Committee urge a significant improvement in the in-service support provided for teachers

"... any improvement in the standards of mathematics in schools must come largely as a result of the efforts of those teachers who are already in post [and therefore] all those who teach mathematics need continuing support throughout their careers in order to be able to develop their professional skills and so maintain and enhance the quality of their work." (715,716)

In its conclusion the Report does not attempt to draw up a list of recommendations preferring rather to leave these to be interpreted in the context in which they arise. Instead the Committee identify six agencies

"whose active response ... [is] essential if the changes in mathematical education [recommended] are to be brought about." (809)

These are: teachers, local education authorities, examination boards, central government, training institutions and those who fund and carry out curriculum development and educational research. To these is added a seventh, namely the public at large whose support is a *sine qua non* of progress. There is a widespread belief among the general population that every boy and girl at school needs to develop an understanding of mathematics and confidence in its use.

"In our view this can only come about as the result of good mathematics teaching by teachers who have been trained for their work and who receive continuing in-service support. It must therefore be the task of all who share this belief to support and encourage the implementation of the changes which we believe to be necessary and to make it clear that, as part of the education which our children receive, mathematics counts." (810)

Reference:

Mathematics Counts, Report of the Committee of Inquiry into the Teaching of Mathematics in Schools, HMSO (1982) 57085.75, 311 pages.

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