Mathematics counts

Report of the Committee of Inquiry into the Teaching of Mathematics in Schools under the Chairmanship of Dr W H Cockcroft

HMSO

1 Why teach mathematics?

1 There can be no doubt that there is general agreement that every child should study mathematics at school; indeed, the study of mathematics, together with that of English, is regarded by most people as being essential. It might therefore be argued that there is no need to answer the question which we have used as our chapter heading. It would be very difficult—perhaps impossible—to live a normal life in very many parts of the world in the twentieth century without making use of mathematics of some kind. This fact in itself could be thought to provide a sufficient reason for teaching mathematics, and in one sense this is undoubtedly true. However, we believe that it is of value to try to provide a more detailed answer.

2 Mathematics is only one of many subjects which are included in the school curriculum, yet there is greater pressure for children to succeed at mathematics than, for example, at history or geography, even though it is generally accepted that these subjects should also form part of the curriculum. This suggests that mathematics is in some way thought to be of especial importance. If we ask why this should be so, one of the reasons which is frequently given is that mathematics is 'useful'; it is clear, too, that this usefulness is in some way seen to be of a different kind from that of many other subjects in the curriculum. The usefulness of mathematics is perceived in different ways. For many it is seen in terms of the arithmetic skills which are needed for use at home or in the office or workshop; some see mathematics as the basis of scientific development and modern technology; some emphasise the increasing use of mathematical techniques as a management tool in commerce and industry.

3 **We believe that all these perceptions of the usefulness of mathematics arise from the fact that mathematics provides a means of communication which is powerful, concise and unambiguous.** Even though many of those who consider mathematics to be useful would probably not express the reason in these terms, we believe that it is the fact that mathematics can be used as a powerful means of communication which provides the principal reason for teaching mathematics to all children.

4 Mathematics can be used to present information in many ways, not only by means of figures and letters but also through the use of tables, charts and diagrams as well as of graphs and geometrical or technical drawings. Furthermore, the figures and other symbols which are used in mathematics can be manipulated and combined in systematic ways so that it is often possible to

Facts are items of information which are essentially unconnected or arbitrary. They include notational conventions—for example that 34 means three tens plus four and not four tens plus three—conversion factors such as that '2.54 centimetres equals 1 inch' and the names allotted to particular concepts, for example trigonometrical ratios. The so-called 'number facts', for example $4 + 6 = 10$, do not fit into this category since they are not unconnected or arbitrary but follow logically from an understanding of the number system. *Skills* include not only the use of the number facts and the standard computational procedures of arithmetic and algebra, but also of any well established procedures which it is possible to carry out by the use of a routine. They need not only to be understood and embedded in the conceptual structure but also to be brought up to the level of immediate recall or fluency of performance by regular practice.

Conceptual structures are richly inter-connected bodies of knowledge, including the routines required for the exercise of skills. It is these which make up the substance of mathematical knowledge stored in the long term memory. They underpin the performance of skills and their presence is shown by the ability to remedy a memory failure or to adapt a procedure to a new situation.

General strategies are procedures which guide the choice of which skills to use or what knowledge to draw upon at each stage in the course of solving a problem or carrying out an investigation. They enable a problem to be approached with confidence and with the expectation that a solution will be possible. With them is associated *appreciation* which involves awareness of the nature of mathematics and attitudes towards it.

241 Research shows that these three elements—facts and skills, conceptual structures, general strategies and appreciation—involve distinct aspects of teaching and require separate attention. It follows that effective mathematics teaching must pay attention to all three.

242 We wish now to discuss the implications of the previous sections for work in the classroom. **We are aware that there are some teachers who would wish us to indicate a definitive style for the teaching of mathematics, but we do not believe that this is either desirable or possible.** Approaches to the teaching of a particular piece of mathematics need to be related to the topic itself and to the abilities and experience of both teachers and pupils. Because of differences of personality and circumstance, methods which may be extremely successful with one teacher and one group of pupils will not necessarily be suitable for use by another teacher or with a different group of pupils. Nevertheless, we believe that there are certain elements which need to be present in successful mathematics teaching to pupils of all ages.

243 **Mathematics teaching at all levels should include opportunities for**

- exposition by the teacher;
- discussion between teacher and pupils and between pupils themselves;
- appropriate practical work;
- consolidation and practice of fundamental skills and routines;
- problem solving, including the application of mathematics to everyday situations;
- investigational work.