1944 MATHEMATICS IN SCHOOLS 1984

FROM JEFFERY SYLLABUS TO COCKCROFT REPORT

PART 2

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The Cockcroft Report: School Mathematics in the early 1980s

When it appeared, in January 1982, the Cockcroft Report said what many people had been saying for a long time. The report was generally welcomed as a sound, balanced statement on the current position of school mathematics; perhaps it was too straightforward and insufficiently controversial to provoke heated discussion and debate. It argued that there should not be a panic "back to basics" move but that we should look carefully at the mathematical diet we provide and, by more judicious selection of material, we should strive to give pupils more success and less failure in mathematics. The report made sensible, middle-of-the-road, comment on teaching styles and pupil groupings, on mathematics used by adults, on examinations and assessment and on the training and in-service activities of teachers. There was wide-spread acceptance of the report and little adverse comment. There were two immediate dangers: (i) the report would become a "bible" for those involved in mathematical education to be quoted incessantly and without question and (ii) it would be read and agreed upon without any substantial action being taken — that is many would pay lip-service to the report without changing their old teaching styles and methods at all.

A big growth area in the early 1980s was in in-service work for mathematics teachers. Largely through the pioneering work of the Mathematical Association it became possible for teachers to take courses (usually leading to diplomas) in fields including: leadership in the primary school, low-attainers in the secondary school and the role of the head of department in the secondary school. With the help of some DES financial aid activity in the in-service area increased but, alas, such activity was taking place against a background of closures and contractions of institutions most likely to be able to provide suitable courses. Thus what was encouraged by one branch of central government was made difficult by another branch!

Two significant and major pieces of research began to make an impact. First, the work of the "Concepts in Secondary Mathematics and Science" (CSMS) project which looked at children's understanding of mathematics (Hart, 1981) and secondly, the work of the Assessment of Performance Unit (APU) which involved the testing of a large national sample of children at the ages of 11 and 15 (APU, 1980, 1981 (a) (b) (c), 1982 (a) (b)). Disappointingly, the results of these two projects did not become widely known to teachers: both sets of material provide much to provoke thought, cause concern and suggest ways in which mathematics teaching might be modified. An example from each project will serve as illustrations:

(i) From CSMS:
Question: "*Divide by twenty the number 16*"
Response Percentages:

	12 yr	13 yr	14 yr	15 yr
there is no answer	51	47	43	23
0, or 0 remainder 16	3	3	1	0
0.16	4	5	5	6
$\frac{16}{20}$ or $\frac{4}{5}$	1	0	2	1
0.8	7	12	25	36

(Hart, 1981 p. 53)

(ii) From APU:
Question: "*At the beginning of our holiday the mileometer on the car read 15975.0. At the end of the holiday it read 16225.0. How far did we travel on holiday?*
Response Percentages: (15 yr old pupils)

Correct	62
Incorrect	33
Omitted	5

(APU, 1980 p. 32)

After more than ten years of school mathematics lessons, the pupils surveyed produced disappointing results.

In the early 1980s it became hard to find any school *without* a computer. One of the most pressing problems for teachers was the role of the computer in mathematics teaching. Most schools acquired the necessary hardware but struggled uneasily and uncertainly as they tried to learn how to live comfortably with their machines. At one extreme computers came to be used as an occasional resource in mathematics lessons whilst at the other extreme (aided by much poor quality software) they threatened to take over to a frightening extent. In a helpful, well-argued paper Fletcher (1983) pointed the way to some sensible uses of the computer in the teaching of mathematics. He suggested that in primary schools "... the most promising approach may be to develop programs or packages which enable children to explore ideas for themselves". At secondary level he

argued that the opportunities were "immense" and one particular comment pertinent to all teachers suggested: "There is long experience that many pupils have great difficulty with the early stages of algebra because they cannot see the point of using letters. The computer provides an immediate motivation".

It looked as though the 1980s might prove to be an ideal time to attempt to consolidate the changes of the previous twenty years and to come to terms with calculators and computers. The iron grip of examination syllabuses continued to cramp the style of many teachers although there were hopeful signs that the grip would begin to relax. As pupil numbers fell there seemed to be a real possibility that soon there might be enough good, qualified mathematics teachers to go round. The most frequently quoted paragraph of the Cockcroft report (paragraph 243) suggested that 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.

As more and more teachers slowly became aware of this valuable advice (and many other helpful Cockcroft Report suggestions) there was hope that mathematics teaching might be entering a new era.

School Mathematics in 1985

Will we look back on 1985 as a year of change and revolution in mathematics teaching? Three significant developments might well lead to changes in styles of teaching and content of lessons in a manner undreamt of in the pre-Cockcroft era.

(i) Two important publications have come from Her Majesty's Inspectors, "The Curriculum from 5 to 16" (HMSO, 1985a) and "Mathematics from 5 to 16" (HMSO, 1985b). The former contains fairly brief mention of mathematics but includes:

> *"Although mathematics at one level is probably the most abstract of subjects, it should often arise from and give rise to, extensive practical activity and investigation".*
> *"... mathematical development to be grounded in relevant, practical experiences."*
> *"All pupils need to be encouraged to respond orally and to discuss their work."*

whilst the latter suggests ways of implementing Cockcroft ideas, enthuses about the use of calculators and computers and gives "official" blessing and support to "discussion", "investigation" and "practical work". The clear message is that we must rethink classroom mathematics, make it more relevant and attractive to pupils and look for ways of creating pupil success in mathematics.

(ii) With much attendant political publicity, the creation of over 300 "Cockcroft Missionaries" has been announced. These missionaries will be advisory teachers, employed by local authorities, who will work with teachers and aim to implement much of the philosophy embedded in the Cockcroft Report and the HMI publications.

(iii) "National Criteria" for the forthcoming GCSE examination have been published. In mathematics, the criteria emphasize practical and investigational skills, there is a stress on oral work and examinations will have to offer a course work element which will test pupils' ability to discuss mathematical ideas and carry out mental calculations and practical work. Three different levels of assessment are defined in response to the Cockcroft recommendation that examinations must be matched to pupils' attainment and must not undermine their confidence. The criteria make clear that from 1991 the following objectives must be realised fully in all schemes:

> *Any scheme of assessment will test the ability of the candidate to:*
> *(3.16) respond orally to questions about mathematics, discuss mathematical ideas, and carry out mental calculations;*
> *(3.17) carry out practical and investigational work, and undertake extended pieces of work.*

Are we on the verge of a new revolution? It is the compulsory inclusion of practical work, investigations and oral work in external examinations which will undoubtedly force teachers to modify and change what goes on in their classrooms. What will the bad or reluctant teacher make of these new pressures? The whole world of mathematical educators waits excitedly and hopefully — will mathematics at last lose its place as the subject most pupils hate? Is it possible to "teach" investigations etc. in a routine, boring manner? The "pendulum of reform" seems to be swinging, will it swing far enough? Or perhaps too far?

Some important questions remain to be answered. Who will replace over 300 good mathematics teachers who will be "lost" from classrooms? How can oral work, practical work etc. be assessed in mathematics? Will it really be possible to find time for *every* candidate for the GCSE to be subjected to a wide range of forms of assessment? Has *anyone* thought out the full implications of the new criteria for the assessment of mathematics? The dawn of the new revolution could become chaotic through lack of forethought!

Encouragingly, in the wake of work by CSMS and APU, publication of useful material has continued. The "SEEM" project (strategies and errors in secondary mathematics) has already produced books on errors in algebra (Booth 1984) and on ratio (Hart, 1984) and others are promised. A commendable attempt has been made to write a teacher's guide to recent research (Dickson, Brown and Gibson, 1984) arising from the work of the Schools Council "Low attainers in mathematics" project and a DES-sponsored appraisal of the APU mathematics material is eagerly awaited. Are there signs that at last some basic research messages might have a chance of filtering through to the teacher in the classroom?

The mid 1980s could be a stimulating time for the mathematics teacher. But it would be wrong to consider mathematics in isolation and the present state of general low morale in schools will not be conducive to exciting reform. The severe financial pressures from central government are leading to undesirable cuts in resources, problems with teachers' salaries and are causing potential new recruits to mathematics teaching to think carefully before embarking on a teaching career. At the same time there seems to be an increasing desire and determination to measure, assess and impose uniformity as much as possible — there is a danger that an emphasis on assessment, testing and standards will assume exaggerated importance. Thus at a time when mathematics in schools could be on the threshold of a new leap forwards there seems to be a strong probability that progress will be severely limited by external constraints. The mathematical education world holds its breath and waits excitedly and expectantly, but not without some apprehension.

The Future of School Mathematics

The full impact of the calculator and computer has still to be felt. Undoubtedly the mathematical needs of school leavers are likely to become less in the future and school mathematics will have to adapt accordingly to cope with changing, and reduced, needs. The school curriculum is

constantly expanding into new subject areas and it will not be long before mathematics comes under pressure to give up some of its allocation of time as society sees mathematical needs decreasing. Thus perhaps school mathematics, whilst continuing to be a vital part of the curriculum, will find itself in a new role. It might, for example, be prudent to make the subject an *optional* one after the first two or three years of secondary school — for the majority of pupils their mathematical needs will have been more than adequately catered for by the time they reach the age of about 13. A secondary school might have (say) the equivalent of three lessons per week (instead of the usual five) with optional extra lessons for pupils who might become scientists or who merely want to do more mathematics. One can imagine mathematics teachers fighting a hard rearguard action to prevent such a reduction but it will become increasingly difficult to justify *every* pupil spending a thousand lessons on mathematics during a school career. Future school mathematics is thus likely to contain less teaching but, it is to be hoped, better, higher quality and more directly relevant work.

Soon every home will have its own computer. It would be nice to think that possession of a machine would stimulate and increase interest in mathematical ideas. However, beyond the use of some simple, logical thinking, it seems unlikely that the average household will need much mathematics — they will need little more than the basic skills required to load and operate machines. With increasing reliance on technological aids there is a real danger that the general level of "numeracy" will sink to a new low level.

Perhaps the reduced need for basic arithmetic and the use of new opportunities created by computers will mean that there is more scope for doing "real" mathematics with able and willing pupils. Maybe there will be a rekindling of interest in things like school geometry and the study of more abstract pieces of mathematics. Much of the drudgery of routine calculations or routine manipulation is likely to disappear. Consider, for example, how easy it is to produce on a computer screen a set of graphs for a series of functions and compare the effort needed if the same functions were plotted point by point by an individual. Here lies a possible danger: through overuse or overreliance on machines, pupils may well find themselves *doing* less mathematics and achieving a superficial understanding which would be avoided if easy methods were unavailable. So, in producing ways to help ourselves, we may be endangering pupils' understanding and experience of some vital parts of mathematics.

It would be nice to predict a healthy future for mathematics. The history of mathematical education over the last 100 years suggests that the teaching of the subject will continue to lurch from one crisis to another and from one reform to another. There will be an increasing reliance on technological aids and reduced demands on an individual's memory but, as in all subjects, the ultimate quality of the teaching in school will depend on the *teachers*. Good teachers, alas, are in short supply and there is little evidence to suggest that the future will produce a higher proportion of them. School mathematics will continue to face problems — perhaps if the number of lessons is reduced some bad teachers will go and more good ones remain.

A question asked in the APU secondary survey in 1979 (15 yr olds):

> *"I have x pence and you have y pence. How many pence do we have altogether?"*
>
> Response:
>
> | | |
> |---|---|
> | $x + y$ or $y + x$ | 46% |
> | xy | 34% |
> | Others | 12% |
> | Omitted | 8% |
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> (APU, 1981 b p. 52)

After all those hours of school mathematics, a disheartening response. In 2024 will the answers be any better, will the newfound emphasis on investigations, practical work ... have long since vanished? If fashions and emphases change again as much as they have in the last forty years then the state of school mathematics in 2024 must be totally unpredictable!

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