Calculators and mental calculation:

Incompatible or complementary?

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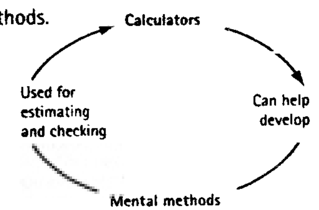
Despite all initial claims by the media – and even by the Government's press machine – the Numeracy Task Force's final report does **not** recommend that calculators be banned in primary schools, nor even that children under the age of eight must not use them. When several members of the Task Force complained that their views, agreed after much deliberation, had been misrepresented, David Blunkett was reported in the Times Educational Supplement to have stated that the **Government had not banned** the use of calculators in primary schools. In fact, the final report, **The Implementation of the National Numeracy Strategy**, recommends that 'teachers should teach pupils how to use them constructively and efficiently'.

In this article I shall look closely at the views expressed in this document on the use of calculators, and use these ideas to explain the following model, designed in order to illustrate some of the inter-relationship between mental and calculator methods.



CALCULATORS AND MENTAL METHODS

If you were to draw up a list of requirements for efficient and flexible mental calculation, the following would probably be included: Knowledge of number facts; a thorough understanding of the structure of our number system; and an awareness of 'permissible operations' within that system. For example, a six year-old finding 3 + 8 by counting on would benefit from knowing that 8 + 3 gives the same answer. A seven year-old needs to know what happens when you multiply a two-digit number by ten (and also needs to be able to execute the technique). The many studies of children's idiosyncratic use of flexible calculation strategies suggest that the more sophisticated an understanding a child has of these attributes of the number system then the wider the range of strategies that child has to call upon to deal with a given calculation.

The Task Force informs us that:

Used well . . ., calculators can be an effective tool for learning about numbers and the number system . . .

Consequently, one way in which calculators can contribute to the development of mental calculation skills is in their ability to help children learn about the structure of our number system and about the rules governing the basic arithmetic operations. For example, the calculator is the most appropriate tool for quickly generating mathematically accurate data for children to investigate. The aim of activities designed for this purpose is to get children to use the calculator to carry out specific calculations, which embody the concept or skill that the teacher feels needs developing.

An illustrative example is provided below along with a list of statements, which are included to give the reader a feeling for how the lesson might be delivered.

The National Numeracy Project Framework states that children in years 5 and 6 should be able to carry out mental multiplication using factors. The example provided for Y5 pupils is 15 x 6, which could be calculated as 15 x 3 = 45 and 45 x 2 = 90. For Y6 pupils the example is 35 x 18, calculated as 35 x 6 = 210 and 210 x 3 = 630. As well as making great demands on children's mental processing capacity, mental multiplication using factors is quite a sophisticated strategy. One way to introduce this technique to a class would be to use calculators and present children with the investigation overleaf, which is structured to embody the strategy:

'13 x 12 is 156.
If I multiply 13 by 2 and then by 4, the answer is 104.
Try multiplying 13 by different pairs of numbers, and make a record of those calculations, which give the answer 156.
Try getting 156 by multiplying 13 by three numbers (excluding 1).
What is special about the sets of numbers, which give the answer 156?
Investigate 13 x 15 and 17 x 16.'

The lesson could be delivered in the introductory part of a Numeracy Hour lesson either using an overhead projector calculator or by getting the children to work in pairs or small groups sharing a calculator between them. The lesson would then have the following structure:

- Generate the relevant data;
- Discuss what is going on;
- Generate more data;
- Try to make a generalisation;
- Test the generalisation;
- State the generalisation (or related skill) in words;
- Practise the skill in pairs – one child using the calculator;
- Practise the skill without a calculator;
- Teacher to add skill to list of those to be practised in mental warm-up sessions.

Mental methods and calculators

The Task Force report argues that primary teachers should:

Teach children the technical skills needed to use the calculator constructively and efficiently . . .

so that they are able to use the machine to advantage in other school subjects as well as mathematics.

Even when children are competent at using calculators it is still possible for them to make 'keying-in' errors such as: entering the same digit twice; missing out a digit; entering an incorrect digit; pressing the wrong operation key, etc. Because of the possibility of making the occasional technical error, it is important that children check their calculations. As the Numeracy Strategy document says:

Children should also have a sense of the approximate size of the answer they expect to get when using a calculator, and know how to check the answer . . .

Most estimation and checking strategies fall into one of three types: exact checks, partial checks and rough checks. Exact checks make use of inverse operations or equivalent alternative methods. Partial checks involve the use of number properties such as divisibility rules and odd/even rules for the unit's digits in a multiplication. Rough checks, on the other hand rely mainly on rounding techniques, operations with single digits and operations with multiples or powers of ten.

Most estimating or checking strategies can be seen as little more than a 'less precise' form of mental calculation. In most rough estimates the numbers to be calculated are rounded to the nearest convenient number – perhaps multiples of ten or a hundred – and then mental calculation strategies are used to work with these rounded numbers and the appropriate arithmetic operation. Consequently, to be a good estimator you need to be good at mental calculation. If we extend this argument then we can say that "to use the calculator constructively and efficiently" necessitates good approximating, estimating and checking techniques, which in turn demand good mental calculation skills.

I have outlined a symbiotic relationship between mental calculation and calculator use. Each supports the other in contributing to the calculative competence of individual children. There has not been space to include a discussion of written methods. However, unless children are competent in the use of all three calculation methods they will not be in a position to develop the confidence needed to satisfy the Task Force's demand that:

They should understand a calculation well enough to decide whether it is best to use their mental skills, write it down or use a calculator to work out the answer.

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