ATM Association of Teachers of Mathematics

The Calculator in Court: A Second Opinion - Kenneth Ruthven

Micromath - vol.12 no.1, Spring 1996

Constable Gardiner has collared the calculator. The flashy little fellow with the RayBans up top; the quintuple-breasted coat with more buttons than sense: this is not the kind of company he wants kids to keep!

In his recent article: *Time To Take Stock* [1], Tony lambasts what he sees as the baleful influence of the calculator on school mathematics, reporting that his personal experience 'consistently contradicts [the] optimistic nonsense' advanced in official reports and research studies. Although elsewhere [2] I have highlighted some weaknesses in the evidence available, there can be no doubt that it offers little comfort to Tony's position. How much stronger his case would be if he could assemble some systematic evidence to support it.

His first charge is that the = key of the calculator sells short the algebraic concept of equality. Let's get this straight. The calculator simply took up a usage that was already commonplace in everyday arithmetic. Like it or not, there is a longstanding tradition of interpreting the **=** symbol as a 'gives the answer' sign in presenting and recording arithmetic calculations both inside and outside school. Well back in the BC (Before Calculators) era, researchers were aware of the prevalence of this interpretation; and of the associated views that a 'sum' such as ? = 3 + 4 is 'the wrong way round', or that one like 7 = 7 is 'missing what to do'.

Indeed, it is awareness of the conflict between this everyday arithmetic conception of the = symbol and the scholarly algebraic conception which has prompted the replacement of = by ENTER on many recent calculator models. For similar reasons, during the nineteen-sixties, there was experiment in school mathematics with symbolisations such as $3 + 4 \rightarrow 7$. This use of the directed arrow highlights the unidirectional character of the everyday conception; focusing on completion of a calculation. The scholarly conception qualifies and extends the everyday one: it is an idea encapsulating both the completion of a calculation and its reversal; both the equivalence of calculations and the possibility of no calculation at all.

Tony's second charge is that the calculator is not exact. Let's get this in perspective. For most practical purposes of addition, subtraction and multiplication, the calculator is as exact as any other means. Certainly, inexactness arises in division, but this is an issue that cuts both ways. In a world of realistic measurement, the spurious accuracy encouraged by habits of exact calculation can be as much of a problem as the approximation associated with the decimal representation of calculator values to a limited number of decimal digits. Only last week I read a research paper from a university mathematics department, where item success rates for a smallish student group were reported as percentages to 2 decimal places.

In my view, however, there *has* been too great an emphasis on checking calculator answers by approximative methods independent of the machine. I would like to see more encouragement of structural methods of checking, such as using the calculator to work back from an answer to original data. Not only would this highlight those occasions on which use of the calculator does sacrifice exactness; it would focus attention on the taking apart of what has been put together in the original calculation, and hence on the reverse relationship which underpins the algebraic conception of equality.

Nonetheless, the idealised world of exact mathematics can be a strange one. From my schooldays BC, I recall the astounding incidence of circles with radii which were multiples of 7; the frequency with which circumferences proved to be divisible by 11; exceeded only by the proportion of students who believed **π** to be exactly 22/7. However, there is good news for those of us who remain fanatics of exact mathematics: we are moving into the AD (After Derive) age of symbol-crunching calculators at ease both with fractions such as 22/7 and special constants such as **π**.

This brings us to the charge that the calculator condemns all numbers to be equally uninteresting. This is a strange claim to anyone who has known the almost audible pleasure of many students when the results of their labour turn out to involve a familiar decimal fraction, or look to be an old friend such as 1.4142136 or 3.1415927; even more so to anyone who has seen the passion for number that students can develop through experimenting with their calculator.

The final charge is that the calculator encourages a preoccupation with answers rather than methods, at the expense of insight and reason. Here Tony touches on important matters, but they are matters which are far more closely related to the whole mathematical culture of the classroom than to the presence or absence of calculators. A careful reading of reports from recent generations of school inspections would record the generally marginal impact of calculators on the classroom alongside modest overall progress towards greater concern with insight and reason.

Kenneth Ruthven works at Cambridge University.

References

[1] Gardiner, T. (1995) 'Time to take stock', *Micromath* 11 (3).

[2] Ruthven, K. (1995) 'Pressing on: towards considered calculator use', in L. Burton and B. Jaworski (eds.) *Technology in Mathematics Teaching - a Bridge between Teaching and Learning*, Chartwell Bratt, 231-256.

ATM, 7 Shaftesbury St, DERBY DE23 8YB