



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.

The attached document has been downloaded or otherwise acquired from the website of the Association of Teachers of Mathematics (ATM) at www.atm.org.uk

Legitimate uses of this document include printing of one copy for personal use, reasonable duplication for academic and educational purposes. It may not be used for any other purpose in any way that may be deleterious to the work, aims, principles or ends of ATM.

Neither the original electronic or digital version nor this paper version, no matter by whom or in what form it is reproduced, may be re-published, transmitted electronically or digitally, projected or otherwise used outside the above standard copyright permissions. The electronic or digital version may not be uploaded to a website or other server. In addition to the evident watermark the files are digitally watermarked such that they can be found on the Internet wherever they may be posted.

Any copies of this document MUST be accompanied by a copy of this page in its entirety.

If you want to reproduce this document beyond the restricted permissions here, then application MUST be made for EXPRESS permission to copyright@atm.org.uk

*This is the usual
copyright stuff -
but it's as well to
check it out...*



The work that went into the research, production and preparation of this document has to be supported somehow.

ATM receives its financing from only two principle sources: membership subscriptions and sales of books, software and other resources.

Membership of the ATM will help you through

*Now, this bit is
important - you
must read this*

- Six issues per year of a professional journal, which focus on the learning and teaching of maths. Ideas for the classroom, personal experiences and shared thoughts about developing learners' understanding.
- Professional development courses tailored to your needs. Agree the content with us and we do the rest.
- Easter conference, which brings together teachers interested in learning and teaching mathematics, with excellent speakers and workshops and seminars led by experienced facilitators.
- Regular e-newsletters keeping you up to date with developments in the learning and teaching of mathematics.
- Generous discounts on a wide range of publications and software.
- A network of mathematics educators around the United Kingdom to share good practice or ask advice.
- Active campaigning. The ATM campaigns at all levels towards: encouraging increased understanding and enjoyment of mathematics; encouraging increased understanding of how people learn mathematics; encouraging the sharing and evaluation of teaching and learning strategies and practices; promoting the exploration of new ideas and possibilities and initiating and contributing to discussion of and developments in mathematics education at all levels.
- Representation on national bodies helping to formulate policy in mathematics education.
- Software demonstrations by arrangement.

Personal members get the following additional benefits:

- Access to a members only part of the popular ATM website giving you access to sample materials and up to date information.
- Advice on resources, curriculum development and current research relating to mathematics education.
- Optional membership of a working group being inspired by working with other colleagues on a specific project.
- Special rates at the annual conference
- Information about current legislation relating to your job.
- Tax deductible personal subscription, making it even better value

Additional benefits

The ATM is constantly looking to improve the benefits for members. Please visit www.atm.org.uk regularly for new details.

LINK: www.atm.org.uk/join/index.html