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Calculators as Learning Tools in Mathematics Lessons

by Mary BJ Clark and the Equals editorial team

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In the last issue of Equals, (Vol. 4 No. 3) the editorial team put forward four reasons for using calculators as learning tools and promised to give more detailed descriptions of classroom scenes exemplifying these reasons.

The reasons we gave were:

- the calculator has a role as a learning tool to help the exploration of number and to encourage private and personal reflection on how numbers behave. The calculator, as an electronic gadget, is motivating for children.
- the calculator enables work with realistic data.
- the calculator provides access to learning so that children who are slow and/or inaccurate with calculation are not held back when the main teaching objective is not the calculation itself.
- children need to learn to how to be efficient users of calculators as the use of this tool will be required in their everyday lives.

Now we fulfil the promise and look more closely at each of these in the context of classroom activities with examples to illustrate each of the categories:

Reason **The calculator has a role as a learning tool to help the exploration of number and to encourage private and personal reflection on how numbers behave. The calculator, as an electronic gadget, is motivating for children**

Example 1

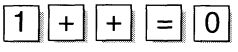
Eight Year 9 boys in a residential EBD secondary school make up the class. The Guessing Game is explained to them. The class is divided into two groups of four and a calculator provided for each group. The game is that the organizer in the group (the one with the calculator) will announce "a hard sum", that is, to combine two numbers by addition, subtraction, multiplication or division. He may choose, for example, 239 x 47 or 6721 - 4936 or, even more daring, 5.92 ÷ 3.17.

While the organizer (who changes every five or six rounds) performs the operation on the calculator the rest of the group estimate the result. Estimates are announced and the organizer reads out the calculator display. The winner of the round, gaining one point, is the one who has guess is nearest to the calculator result. All players must agree which is the nearest guess and this involves much discussion during which further understanding of place value, the size of numbers and, of course, estimation is developed. The game also develops confidence as neither group has to appeal to the teacher. They all make their own estimates and the organizer also creates his own result for himself with the help of the calculator.

It can happen that a wrong button is pressed and the teacher may then have to join in the discussion, but this did not happen on the occasion described. It is however important for the teacher to listen to the discussion in order to assess the level of understanding of number attained by each member of the group. Indeed, the game is a remarkably useful indicator for the teacher of the progress of the pupils in their understanding of number and of strategies used by them to make their estimates.

Example 2

This time the class is a Year I class in an infant school and the children are taught to use the constant on the four function calculators that the school has available. Stephan types the following sequence of key presses into his calculator:



and then follows the teacher's instruction to keep pressing the equals button. He is intrigued to find that the calculator can now count.

Each child in the class is challenged to fill in a graduated strip of paper as a number line to 100, if possible, using the calculator to help them identify which number should come next. When their current number knowledge has been exhausted they turn to the calculator for support in extending their learning of the counting sequence.

Example 3

The game *Down in the* Pit is introduced to a Year 4 class as the teacher writes the numbers 1 to 20 on a flip

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chart and randomly chooses three numbers to be ringed. A calculator designed for use on the overhead projector is used and the children invited to choose a number. This number is then repeatedly added. As long as the numbers thus displayed on the calculator do not include any of the three ringed numbers the class wins. Otherwise they 'go down the pit' and lose that game!

The game reinforces knowledge of multiples. Strategies such as avoiding choosing 2 when there is an even number ringed develop. Prime numbers can be introduced by ringing three prime numbers on the list. Children quickly grow to appreciate that a ringed number will then only be obtained if they choose 1 or one of the ringed numbers.

Example 4

Further ideas for using calculators to help children develop their understanding of how numbers behave are included in the centre spread in this issue. Most of these activities rely on the use of a simple four function calculator. The exception to this is the activity entitled *Answer and Execute* for which a graphic calculator is required. The activity has been presented in a format which fits with graphic calculators with the buttons Ans and Exe but if the calculators available to you have buttons labelled Ans and Enter these will be just as suitable. The use of graphic calculators has often been limited to older and more able pupils but they have much to offer those who find mathematics difficult as the calculation and its answer are displayed simultaneously on the screen so results can be reflected upon in the context of the original calculation and errors traced more easily.

Reason **The calculator enables work with realistic data**

Example 1

In the previous issue of *Equals* (Vol. 4 No. 3) the article *Who Wants to be a Millionaire?* presented a range of purchases that could be made for $500,000,000. The calculator allows such information to be checked and the activity extended so that pupils create comparisons of their own.

Example 2

Scientific calculators can be used to develop understanding of standard form. Data such as distances of planets from the earth, the diameters of microscopic organisms and international comparisons of funds etc. provide contexts for such exploration of different ways of expressing numbers.

Reason **The calculator provides access to learning so that children who are slow and/or inaccurate with calculation are not held back when the main teaching objective is not the calculation itself.**

Example 1

If the main teaching objective of a lesson is to provide an opportunity for pupils to understand that there is a relationship between circumferences and diameters of circles such that the circumference of a circle is always roughly three times as large as its diameter it is counter productive to waste time getting pupils to divide circumference measurements by diameter measurements. Difficulties with division would mask the discovery of the amazing circle relationships. The calculator releases pupils so that they can appreciate the relationship.

Example 2

Division on a calculator allows exploration and appreciation of recurring decimals.

Example 3

As a lesson in becoming familiar with and consolidating learning about the behaviour of powers of numbers the calculator allows access to the exploration number patterns created in the end digits of successive powers of numbers, for example

$2^0 = 1$
$2^1 = 2$
$2^2 = 4$
$2^3 = 8$
$2^4 = 16$
$2^5 = 32$
$2^6 = 64$

Reason **Children need to learn to how to be efficient users of calculators as the use of this tool will be required in their everyday lives.**

Example 1

Examples of when calculators will be necessary for efficient calculation include:

-checking the size of a bill

-calculating compound interest for a mortgage

-costing holidays

-checking bank statements

-VAT calculations

-costing offers including percentage reductions

-interpreting the calculator display when doing money calculations.

Editorial team

Give and Take

A game for two or more players

Each player enters a six-digit number into their calculator and makes a note of their number on a piece of paper.

- First player asks of any other player

  "Have you any 3's(say) in your number?!'

  If the answer is "Yes" then that player asks

  "What does the 3 stand for?"

- The first player then adds that number (or numbers!) to their display

  example

  if the 3 stood for 300 then 300 is added to the display.

- The other player subtracts that number from their display.

  If there were other 3's in the first player's display they receive similar treatment.

The next player then takes their turn.

- The game continues until

  either

  one player reaches 1 000 000 (for a six digit starter number)

  or

  all players except one have a zero display.

Even and Odd

Two players toss for Odd or **Even.**

Each of the numbers 0 - 9 inclusive must be used once only and the operations + −, x, and ÷ can be used.

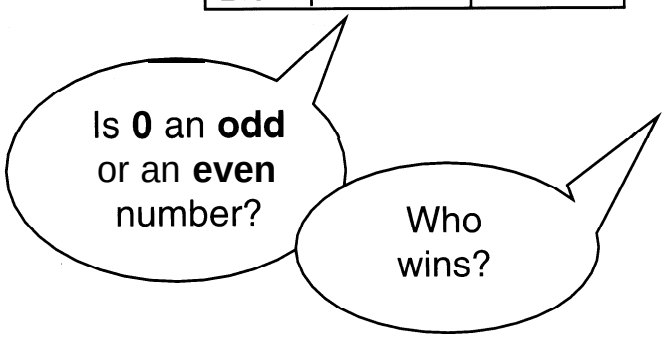
Players take turns to put a number into the calculator.

The **"Even"** player aims to make the calculator display an **even** number at the end of the game.

Example:

"Odd" starts and presses key 3

Player	Keys	Display
Even	+ 5	8
Odd	- 4	2
Even	+ 2	4
Odd	+ 7	11
Even	X 6	66
Odd	- 9	57
Even	X 8	456
Odd	- 9	447
Even	X 0	0



Make One

You will need nine number cards 1 - 9.

- Set a number between 10 and 100 on your calculator.
- Shuffle the number cards and put them in a pile face down.
- Pick a card. You are allowed to use this number key and the **+, −,** x, **÷, =** keys only.
- Aim to display 1, or as near to 1 as you can get, on your calculator and keep a record (no more than 20 key presses allowed!).

Example:

Starting number

Key press	Displa y
	24
2	2
2	22
=	2
2	2
	1

This game can be played by one person only or by a group, comparing their methods.

The aim can be changed, for example, make a big number over 1 000.

Answer and Execute !

1. Use a graphic calculator to find out what this set of key presses does:

   0 EXE ANS + 1 EXE EXE EXE EXE .

   - Write down the list of numbers you made.
   - Write about the list of numbers and explain what is special about it.

2. Try this sequence:

   3 EXE ANS + 4 EXE EXE EXE EXE...

   - Write down the list of numbers you made.
   - What happened this time?

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3. Now choose some numbers of your own so that you can find out more about the lists of numbers you make when you press

   number EXE ANS + number EXE EXE EXE...

   - Write down your number lists each time.
   - Explain anything you have noticed.

4. Choosing your own numbers find out about lists of numbers you make when you press

   number EXE ANS - number EXE EXE EXE...

   - Write about what you discover.

5. Choosing your own numbers find out about lists of numbers you make when you press

   number EXE number ANS EXE EXE EXE...

   - Write about what you discover.

Four Key Game

1 Using the keys 3 5 + = each player displays 20 different numbers.

The first to finish this stage of the game gets 5 points.

2 Players then compare lists crossing out all numbers that appear on more than one list.
Players score 2 points for each remaining number.

3 Players then challenge any number which they do not believe can be made.
The challenger is awarded 3 points for a correct challenge.

Variations: Use keys 3 5 - = or 3 4 X = or the players' own choice.