



# Calculators as an aid,

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# Calculators as an aid, not an impediment,

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# Calculators as an aid, not an impediment, in maths teaching

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# Using a calculator is a skill to be taught

- Engineering and science students find advanced graphing calculators almost indispensable as tools for learning and for calculation.
- But before they get there, how do they learn to use and appreciate calculators properly?

# Using a calculator is a skill to be taught

- Engineering and science students find advanced graphing calculators almost indispensable as tools for learning and for calculation.
- But before they get there, how do they learn to use and appreciate calculators properly?
- In my experience, teaching Physics students, some got there the wrong way, or only by luck.
- So I want to talk about ways in which calculators can be an advantage, not an impediment, in teaching maths. Naturally, I shall mention HP calculators and emulators in particular.

# Using a calculator is a skill to be taught

- There are 3 important stages in mathematics teaching, at which calculators can be used as tools, but can instead be an impediment.
- These are:
  - First access to arithmetic
  - First experience of functions
  - First use of a graphing calculator
- A big problem is that no one mathematics teacher controls all these.

# Using a calculator is a skill to be taught

- School teachers of mathematics have a variety of approaches to calculators. A few even forbid calculators entirely.
- I have much sympathy with this.
- Children aged 5 to 8 or thereabouts, being introduced to the basics of numbers and arithmetic, need to understand what they are being taught. Those who have access to calculators can do arithmetic, but may not understand it!
- It is better to let them learn numbers from seeing mobile phones, but to teach so that calculators are not useful in lessons.
- *Question – should numbers on calculator be arranged like those on mobile phones?*

# Using a calculator is a skill to be taught

- Simple calculators should be introduced to help 5 to 8 year olds verify what they have learned, but if introduced too early they make understanding more difficult.
- An excellent example is that children with calculators know how to use the % key, but few understand it. One teacher suggested to me that makers of school calculators should not be allowed to provide a % key!
- Once + – x ÷ have been taught, calculators are an excellent tool for practice, using games, for example:
  - $12 = 3 \times 4$ ;  $56 = 7 \times 8$
  - + and  $\times$  are commutative, – and  $\div$  are not
  - $1/x$  and CHS (change sign) are their own inverses



# Using a calculator is a skill to teach

- Those teachers who approve of stack notation (RPN) on calculators can teach it at this age:
- $12 + 17 = 29$  is horizontal, or algebraic
- but

$$\begin{array}{r} 12 \\ 17 + \\ \hline 29 \end{array}$$

is vertical, or stack notation, the way addition really works.

# Using a calculator is a skill to teach

- If you have an HP33S available, or an emulator, you can see that it allows both methods to be learned – a significant HP ADVANTAGE.
- HP quality is also an HP advantage.

# Using a calculator is a skill to teach

- At ages about 9 to 14, school students learn about *functions*. Again it is important for them to understand the functions before they calculate values.
- So, again, it can be worth avoiding calculators, this time those with built-in functions.
- *Question: do teachers explain the names of functions? Why “ln”, why “sine”? Such questions can be tied in with the names on keys.*

# Using a calculator is a skill to teach

- One particular skill worth teaching is the use of precision.
- All teachers meet the student who insists on giving answers to 10 or more significant digits for no good reason
- *Question: how do we teach students to use an appropriate precision? This is one place where our friends who teach business maths are ahead. Two digits after the fraction mark and that's it!*

# Using a calculator is a skill to teach

- Squares and cubes, square roots and cube roots are a good starting point for teaching functions, then a calculator can be introduced as a wonderful tool for calculating them.
- *Question: are logs and antilogs necessary at this stage? I have with me a very inexpensive scientific calculator with trig functions, but not logs and antilogs. Would teachers like an HP quality calculator with arithmetic, roots/powers, and trigonometric functions only?*

# Using a calculator is a skill to teach

- Trigonometric functions can be taught with a non-graphing calculator, but once their cyclic properties are introduced, a graphing calculator can be a great help.
- This is the third stage at which calculators need to be introduced with care.
- If calculators have been introduced as tools (not as substitutes for thinking) at the first two stages, then students naturally go on to use graphing calculators as tools too.
- But many school boards forbid the use of these models in exams. Maybe the teacher will use a PC program with an overhead projector instead? This could be Mathematica™ or a calculator emulator. *Have we time for another demo?*

## Using a graphing calculator is a skill to learn

- This, finally, gets me back to where I began.
- If students have been taught to use calculators as tools, not as substitutes for thinking, then at this third stage they can learn for themselves to use graphing calculators, as tools to work and to understand.

## Using a graphing calculator is a skill to learn

- This, finally, gets me back to where I began.
- If students have been taught to use calculators as tools, not as substitutes for thinking, then at this third stage they can learn for themselves to use graphing calculators, as tools to work and to understand.
- HP provide a whole range of graphing and advanced graphing calculators for this.



# Choosing a calculator is a skill too



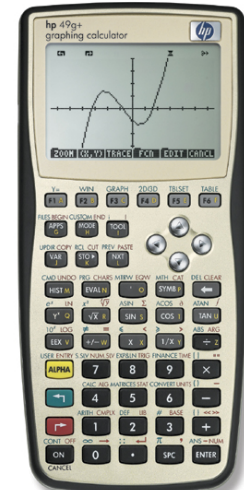
Scientific



Financial



Graphing



Advanced graphing

# HP calculator features

- Algebraic *and* stack notation available.
- The HP Solver.
- Units.
- Aplets on the HP39G+ and the HP40G.
- CAS (Computer Algebra System) on the HP40G, HP48GII, HP49G+.
- Fractions on the HP33S, HP39G+, HP40G, HP48GII, HP49G+.
- HP made the first scientific calculator and are not going to stop now.

## Using a graphing calculator is a skill to develop

- Let us see an example of an HP calculator feature – applets on the HP39G+.
- These allow teachers and students to develop their own tools.
- A simple example – the Trig Explorer built into the HP39G+.
- Many more applets are available on HP's web site and on others. I would like to emphasize the “Conic Plotter” and the “Residuals” applets on HP's web site in particular.

# Resources

- Because many professionals use HP calculators, many resources developed by them are available to students, and students can develop their own resources too.
- Applets have already been mentioned.
- HP's web site and others. Newsgroups. Clubs.
- Books and commercially sold programs.
- Dealers, and experienced users, whether in the college, lab, on the trading floor, at the survey site or elsewhere, even in space.

# Where next?

- If a student has well-developed calculator skills, he or she will go on to use the calculator in their professional life.
- Where could and should HP calculators go next? PDAs will not replace calculators for a long time, if at all.
- *Question: From the very first scientific calculator, HP have been innovators. What new or enhanced features do teachers and students expect from HP now?*

# Thank you





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