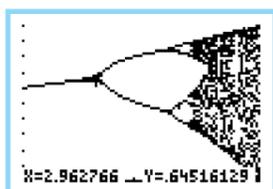


More than just a calculator

Later in the book, when chaos theory is being discussed, a short but deceptively powerful program is used to carry out thousands of calculations and produce what is often called a bifurcation diagram. Above is the skeleton program.

```
PROGRAM:BIFURC
:For(K,Xmin,Xmax
:,4X)
: 1→U
:For(N,1,80)
:KU(1-U)→U
:If N>30
:Pt-On(K,U)
:End:End
```

With suitably chosen window settings the calculator has to work hard but will produce diagrams such as that shown here. The book describes how the program can be used to delve deeper into the bifurcation diagram and investigate aspects of its self-similarity.



If you decide to try to teach through asking students to create short calculator programs (with or without the support of *30 Calculator Programs*), I would be very interested to hear how you get on. Please contact me at the e-mail address below.

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In this article Nevil Hopley writes about his approach to using pre-stored calculator programs to aid mathematics learning in the classroom.



You have graphical calculators and you want your students to use them to learn maths ... and not just graphs and statistics. What's the solution? Programs!

There are a host of programs and applications that are now available for the TI83+/84+ series of calculators, but only a few help to actually teach maths topics. Since 1993 I have been developing a collection of programs that allow students to teach themselves and these can now be obtained on-line at www.CalculatorSoftware.co.uk

There are many skills that students can learn through this sort of small software that cover aspects of shape, number, algebra and even logic. To use them requires no knowledge of how calculators are programmed or familiarity with the various inbuilt calculator commands. In many ways they are "switch-on-and-go" tools, great for use with secondary school students and even better for busy teachers.

The screen shots below show a small sample of the programs that are currently available.

The inspiration for these programs has come from many sources - old SMILE and Shell Centre programs for the BBC computer, current educational software for the PC, television game shows, suggestions from staff in my department and even a few ideas of my own!

Why did I take this approach? Handheld technology is now sufficiently widespread to be a viable platform for in-class use. Using pre-stored programs is often the easiest way for students and teachers to utilise the power of graphics calculators, compared to the time and skills required to master the built-in capabilities and syntax requirements of the basic calculator.

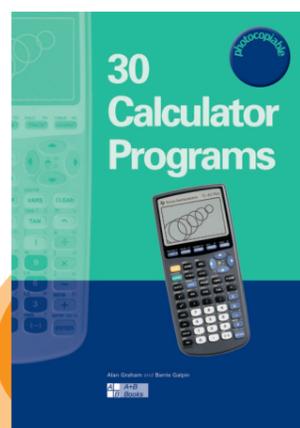
As a result of the demand by staff wanting to use these programs to deliver the courses that are offered at my school, we have several class sets of TI83+ Silver Editions. This enables the 13 maths staff to give students the opportunity to progress at their own rate through topics as varied as equation solving, index manipulations, and developing understanding of angles, to name a few.

So, why use programs?

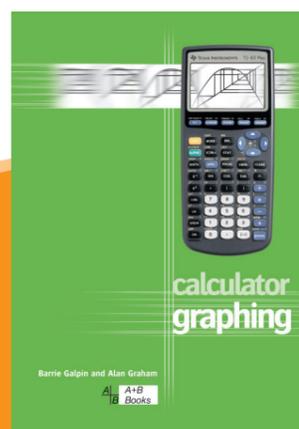
You won't properly discover the 'joy of short programs' until you try this approach out yourself and see how well it works with your own students. But potentially there are many advantages: here are some of them.

By creating their own short programs pupils can:

- ✓ use their maths in a purposeful way to achieve a meaningful goal,
- ✓ learn some useful programming skills,
- ✓ understand the way in which letters are used as variables,
- ✓ think logically and create programs for their own use and re-use,
- ✓ investigate concepts for themselves,
- ✓ apply maths to everyday problems and situations and across the curriculum,
- ✓ play games and generally have fun with maths,
- ✓ engage in mathematical modelling and gain a better understanding of what modelling is,
- ✓ experience success, motivation and a sense of personal empowerment.



30 Calculator Programs is one of a series of photocopiable books published by A+B Books.

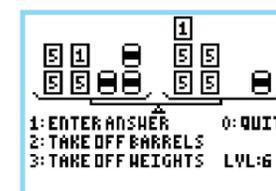


Calculator Graphing is one of a series of books for Post-16 students.

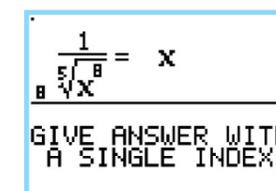
For further information about these and other books for the TI-83 and TI-84 families of calculators, please see the A+B Books website: www.AplusB.co.uk



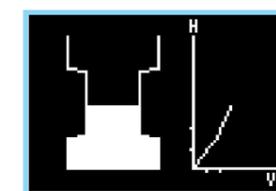
Grid Rush number challenge



Equations tutor



Indices tutor

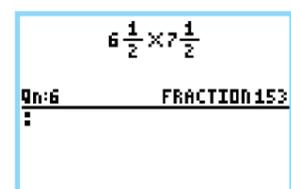


Jug-filling graph tutor

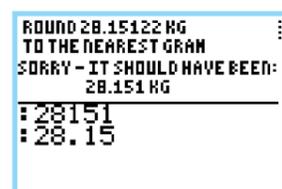
One particular program – the “Ultimate Non-Calculator Challenge” – presents students with varying levels of difficulty of calculations involving integers, fractions, decimals and percentages – yet they can’t use the calculator to solve them! With over 1200 distinct levels, there is a place for everyone to start – these are often the most industrious lessons for everyone. Each student is very keen to know how to complete their own question so that they still have a chance to score 100 per cent by the end.

We have used these programs with widespread success in our classrooms on a regular basis and as a main resource for delivering certain topics. This is an important status for such programs - they are not something that is done as well as textbook work, but often instead of normal routine work.

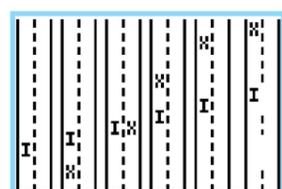
Many programs incorporate levels of difficulty that lead students to acquire sophisticated skills in a structured manner. Some have built-in timers so that they can try and beat the clock. All are intuitive and user-friendly to operate. The students enjoy using a different resource that’s not confined to an end-of-week, end-of-term, or “fun” lesson. They also love being able to put the programs onto their own calculators and to use them in their own time. And the teachers love seeing their students enthuse about the maths. Users of these programs in other schools across



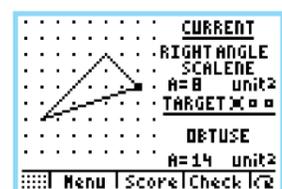
Ultimate Non-Calculator Challenge



Rounding tutor



Distance-Time graph animation



Pinboard Challenge

Scotland and England have reported the same experiences.

A Becta research study (<http://curriculum.becta.org.uk/docserver.php?docid=4445>) which assessed small software’s impact and usefulness in schools noted that, as the programs randomly generated questions, no two calculators presented the same problem. This led to the students discussing not what the answers were, but rather what the right method was. How often have you tried to achieve that whilst working from a textbook?

A school computer network requires IT Support staff and a set of calculators is no different. It is not required for staff to know how to program, but an appreciation of how the RAM and Archive memory operate is achieved through daily use.

With this understanding in place, the only regular maintenance required is the changing of batteries and possible re-sending of programs from one calculator to another as a result of a student resetting the memory.

Even so, if a calculator refuses to work in a lesson, it’s an isolated machine and can easily be exchanged for one that does work, allowing the work to continue. The problem can then be sorted out later. Can this quick swap be done with a PC or an iMac that isn’t behaving in a computer room?

The collection of programs continues to increase and ideas for new programs are always welcome. The non-threatening and, in many cases, the non-writing-in-a-jotter nature of the programs is one which students seem more than willing to engage with!

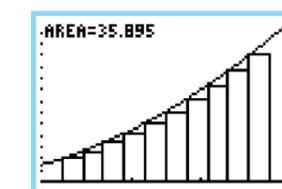
Nevil Hopley is Head of Mathematics at George Watson’s College, Edinburgh.



Car Wars (develops spatial logic)



Angles tutor



Integral Approximation



3D Viewer

Free samples of graphical calculator programs plus full program details and much more are all available online from www.CalculatorSoftware.co.uk

Puzzle Time

Why is this program called Hero?

Which calculator button could it replace?

Can you improve program Hero to make it more accurate and efficient?

You might consider the following:

- Does it work for all numbers?
- Should the loop be used more times?
- Is there a better way of controlling the loop, for example leaving the loop when the value of R is no longer changing?
- What about using a starting value other than 1 for R?

Can you create programs to replace other calculator buttons or menu items?

```
PROGRAM:HERO
:Prompt S
:1→R
:For(C,1,10)
:  .5(R+S)→R
:Disp R
:Pause
:End
```