The TI-83 Plus and the Numeracy Strategy

The National Numeracy Strategy, Framework for teaching mathematics: Years 7 to 9 was published in the spring of 2001 It is very pleasing to see that the framework recognises the importance of hand-held technology in the teaching of mathematics. In the framework document the graphics calculator is often referred to as the primary ICT resource for mathematical activities, in advance of spreadsheets and databases. This will be welcome in many mathematics departments where access to computing facilities is difficult.

The supplement of examples in the Framework documents provides ideas showing that a graphics calculator can be used to achieve many of the teaching objectives in the teaching programmes of the Numeracy Strategy. The following examples develop nine of these ideas and provide a little more support than is offered in the Framework document. Many of the examples chosen are numerical or algebraic ones, using the very basic facilities of the TI-83 Plus or TI-83 calculator and working on the home screen rather than the graphing screen.

At the top of each page you will find a reference to the particular part of the Framework where the example may be found.

For this selection we have kept to examples which can be found in the Year 7 teaching programme: there are many more examples in the Year 8 and 9 programmes.

Activities

- **generating sequences**
- **drawing shapes**
- **ordering decimals**
- **rounding**
- **commutative and associative laws**
- **order of operations**
- **plotting a triangle**
- **reflecting in the Y axis**

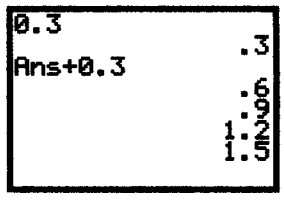
Strand:	Using and applying mathematics to solve problems
Topic:	Solving problems
Pupils should be taught to:	Solve word problems and investigate in a variety of contexts
Year:	7
Example:	Generate a sequence using the answer and table facilities

Activity - generating sequences

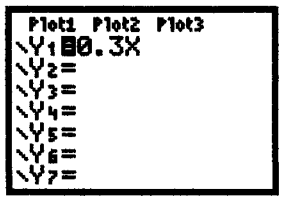
1) To generate, for example, the sequence of decimals starting with 0.3 and adding 0.3 using the answer facility:
Start on the home screen and press:

0.3 [ENTER]
[+] **0.3** [ENTER]
[ENTER] [ENTER] [ENTER] [ENTER] ...

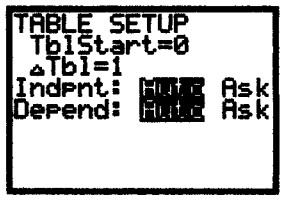
Before each press of [ENTER], guess what the next answer will be.



2) To generate the same sequence using the Table facility:
Press [Y=]. Clear any functions already on the Y= screen. Enter the function alongside Y1= by pressing **0.3** [X,T,Θ,n]

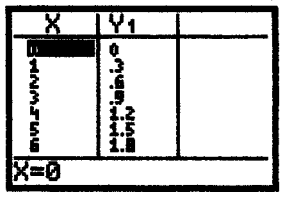


Check that the Table is set to the default values by pressing [2nd] [TBLSET] and, if necessary, changing the values to those shown here.



To see the values in the table press [2nd] [TABLE]
You can scroll through the sequence using the blue cursor key, [▼].

3) Use the two techniques to deal with questions such as:
What is 10 x 0.3?
What is 2.4 ÷ 0.3 and 2.4 ÷ 8?
Is 3 the same as 3.0?
Is 0.3 the same as .3?
What number is halfway between 0.3 and 0.6? Can you generate a sequence with the halfway values?



Notes and extensions

Try pressing **3** [ENTER] [+] **5** [ENTER] [ENTER] [ENTER] [ENTER] [ENTER]
to produce a sequence on the home screen.
Investigate how to produce this sequence using the Table facility.

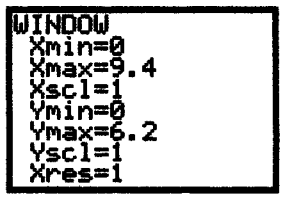
Set challenges to produce particular sequences such as:
the 37 times table 64,32, 16, 8. ... 1, 3, 9, 27, ...

Another way of producing sequences is to use the seq command from the List menu.
See **Calculator Maths: *Foundations Plus***, page 13.

Strand:	Using and applying mathematics to solve problems
Topic:	Solving problems
Pupils should be taught to:	Solve word problems and investigate in a variety of contexts
Year:	7
Example:	Use a graphics calculator to draw shapes.

Activity - drawing shapes

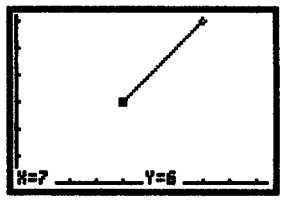
1) Press [WINDOW] and create a friendly graphing window: the values shown here ensure that pixels have integer values.



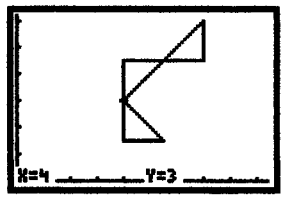
2) Direct drawing can be done on the Graphing screen. Press [GRAPH] and then [2nd] [DRAW] **2** to choose **Line(** from the menu.

Use the blue cursor keys to move to the point where the line will start and press [ENTER].

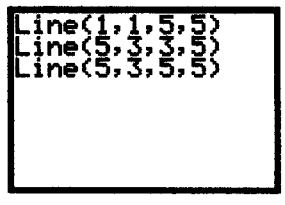
Move to the point where the line will end and press [ENTER] again. Watch the coordinates at the bottom of the screen to make sure the end points are where you want them to be.
Continue moving and pressing [ENTER] until the shape is complete.



To clear the drawing press [2nd] [DRAW] **1** to choose **ClrDraw** from the menu.



3) Indirect drawing can be done by entering commands on the home screen. Press [2nd] [QUIT] to go to the home screen.
Press [2nd] [DRAW] **2** to choose **Line(** from the menu and then complete the command by entering the coordinates of the end points, separated by commas.



What shape is produced by the commands shown here? Enter a fourth line to complete the symmetrical shape.

Notes and extensions

Points can be plotted directly or indirectly on the screen by pressing [2nd] [DRAW] [▶] **1** to choose **Pt-On(** from the Draw Points menu.

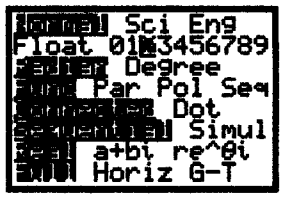
Direct drawing is more fun than indirect – the difficulty is then to ensure that students are using the coordinates at the bottom of the screen, rather than just producing the drawing by eye. There are lots of activities in **Calculator Maths: *Algebra*** (pages 16-19) which retain the fun aspect, while shifting attention to the coordinates.

A third way of drawing shapes involves specifying coordinates as two lists and then drawing a scatterplot or line graph. This is a particularly powerful idea and opens up the possibility of transforming the shape. For details see **Calculator Maths: *Shape*** (pages 36-39).

Strand:	Numbers and the number system
Topic:	Place value, ordering and rounding.
Pupils should be taught to:	Compare and order decimals
Year:	7
Example:	Use a graphical calculator to generate random numbers lying between 0 and 1, with a maximum of 2 d.p. Arrange the numbers in order.

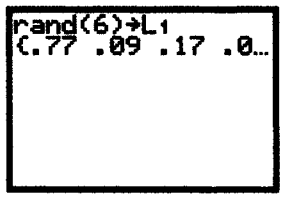
Activity - ordering decimals

1) Set up the calculator
Press [MODE] and fix the calculator to display 2 decimal places.

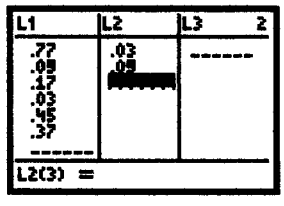


If necessary clear lists L1 to L3. Various methods e.g.enter on the home screen **ClrList L1, L2,L3** by pressing
[STAT] **4** [2nd] [L1] [,] [2nd] [L2] [,] [2nd] [L3] [ENTER]

2) Produce 6 random numbers between 0 and 1 and store them in L1.
Press [MATH] [◄] **1** [(] **6** [)] [STO▶] [2nd] [L1] [ENTER]
Note that **rand** is in the MATH PRB menu.

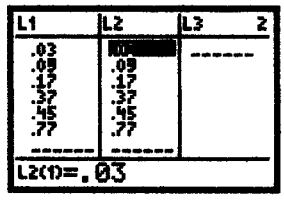


3) Go to the list screen and enter the six numbers in L2 in ascending order.
Press [STAT] **1** [▶] **.03** [ENTER] **.24** [ENTER] etc.



If necessary edit what you have entered in L2 by overtyping or using the [DEL] or [2nd] [INS] keys.

4) Check your ordering by sorting L1 into ascending order.
To enter **SortA(L1)** on the home screen press
[STAT] **2** [2nd] [L1] [)] [ENTER]
To return to the list screen press [STAT] **1**.



Notes and extensions

If you want the whole class to get the same random numbers, get them all to set the same random seed by entering e.g. **42–>rand**. If you want them to get different numbers they should choose their own random seed.

It is possible to put more numbers in list L1, but you then need to scroll up and down to see all the numbers.

Try sorting into descending order manually and then check using **SortD** (item 3 in the STAT menu).

There are various ways of changing the range of the random numbers:
e.g. **2rand(6)** produces numbers between 0 and 2.

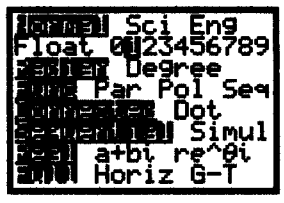
Set the Mode to show 3 d.p. and use **rand(6)/10** for values between 0 and 0.1.

Strand:	Numbers and the number system
Topic:	Place value, ordering and rounding
Pupils should be taught to:	Round numbers, including to a given number of decimal places.
Year:	7
Example:	Round decimals to 0 or 1 decimal places

Activity - rounding

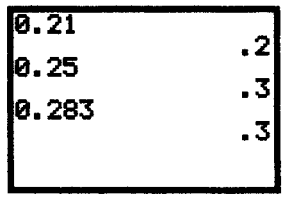
1) Use the Mode setting to make the calculator display answers to just one decimal place.

To do this press [MODE] [▼] [▶] [▶] [ENTER]

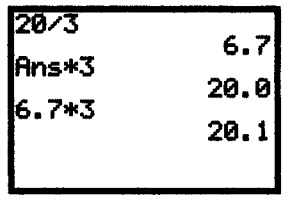


2) Guess what the calculator will display when you enter numbers such as 0.21, 0.25, 0.283 etc.

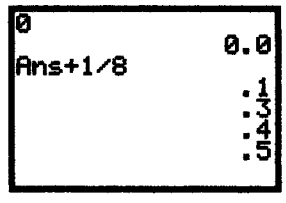
What do you expect to see when you enter expressions such as 1/4, 1/2, 3/4, 1/3, 2/3 etc?



3) Can you explain the apparent inconsistency shown on this screen?

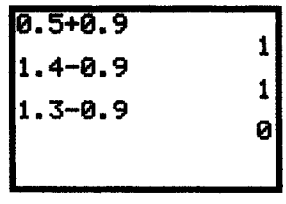


4) Try counting on in eighths, still rounding to one decimal place. Guess the next answer before you press [ENTER].



5) Use the Mode setting to make the calculator display answers with no decimal places. (Choose 0 in the second line of the Mode menu).

Repeat the above activities.



Notes and extensions

It is important to be clear that using the second line of the MODE menu causes the calculator to display the chosen number of decimal places. In the MATH NUM menu is a similar but subtly different facility. The command **round(20/3, 1)** for example, (with the MODE set back to **Float**) actually rounds the value to 1 d.p. in the calculator's memory, producing the value 6.7. You can see the difference if you now press [×] **3**: the answer is not 20 but 20.1.

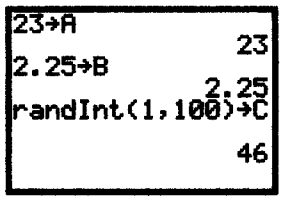
Many of the ideas above are taken from **Calculator Maths: Number** (pages 4-7).

Strand:	Algebra
Topic:	Equations, formulae and identities
Pupils should be taught to:	Know that algebraic operations follow the same conventions and order as arithmetic operations
Year:	7
Example:	Know that the commutative and associative laws apply to algebraic expressions as they do to arithmetic expressions

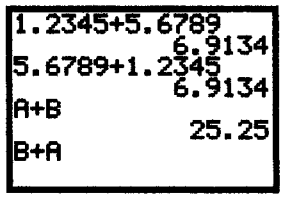
Activity - commutative and associative laws

1) Begin by storing any values into A, B and C.

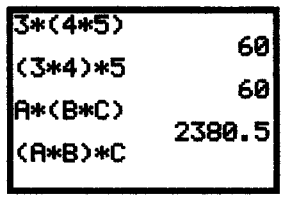
You can either choose your own values or get the calculator to choose numbers at random.
randInt is in the MATH PRB menu



2) Check the commutative law for addition and multiplication, firstly with arithmetic expressions and then with algebraic ones.



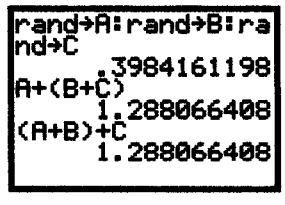
3) Check the associative law for addition and multiplication, firstly with arithmetic expressions and then with algebraic ones.



Notes and extensions

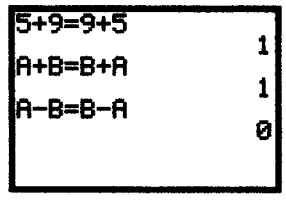
It is easy to try lots of different numbers stored in A, B and C using a semi-automated process as shown here.

The three expressions can be re-entered very easily by pressing [2nd] [ENTRY] three times.



Alternatively the expressions could be stored in a short program.

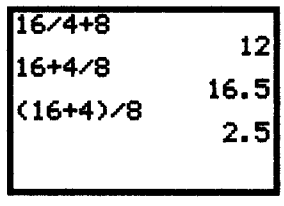
Another approach is to use the calculator's TEST menu. If the expression entered is true 1 is generated and a 0 if the expression is false. For more details see **Calculator Maths: *Algebra***, page 44.



Strand:	Calculations
Topic:	Number operations and relationships between them
Pupils should be taught to:	Know and use the order of operations, including brackets
Year:	7
Example:	Calculate with mixed operations, including with a calculator

Activity - order of operations

1) The graphics calculator is an excellent tool for investigating the effect of changing the order of operations and introducing brackets.



For example, the screen display shown here, viewed by means of a Viewscreen on an OHP, can provide the teacher with the basis for a very useful full-class discussion.

2) Alternatively pupils, working on individual calculators, may be asked to predict the result of keying in the following expression:
"Two... plus... three... times... four".

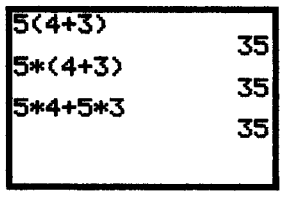
When they use the calculator, many will be suprised to find that the answer is **not** 20. And the need for brackets and the BODMAS rule become immediately clear.

3) The following exercise is based on one from **Calculator Maths: *Number***, page 10.

Insert brackets in the following sequence in order to achieve the desired output.

Sequence	Desired Output	Key sequence
7 + 3 x 5	50	
3 x 8 – 6	6	
-12 ÷ 2 – 6	3	
20 ÷ 10 ÷ 5	2	
16 + 4 x 2	40	

4) What mathematical rules does the screen display on the right illustrate?



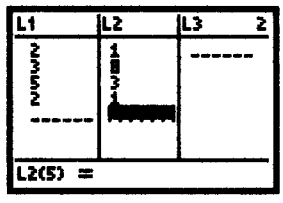
Notes and extensions

It is an easy step on the calculator to move on to generalisations: ask pupils to store whatever numbers they like in A, B and C. Then investigate whether A + B x C is ever the same as (A + B) x C and always the same as A + (B x C). Similarly is A(B+C) always the same as A x B + A x C?

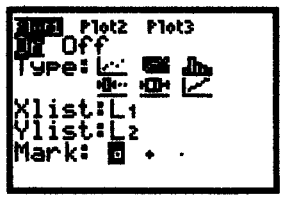
Strand:	Shape, Space and Measures
Topic:	Co-ordinates
Pupils should be taught to:	Use co-ordinates in all four quadrants
Year:	7
Example:	Read and plot points using co-ordinates in all four quadrants

Activity - plotting a triangle

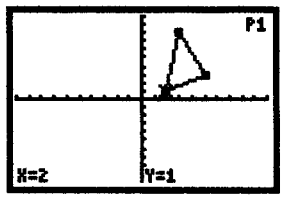
(1) Clear all the lists by pressing [2nd] [STAT PLOT] **4** [ENTER].
Press [STAT] **1** to enter the list screen.
Move the cursor to list L1; enter the values 2, 3, 5 and 2.
Move the cursor to list L2; enter the values 1, 8, 3 and 1.



(2) Press [2nd] [STAT PLOT] to see the StatPlot screen. If any of the plots are set to 'ON', press **4** [ENTER] to turn all plots off.
Press [2nd] [STAT PLOT] again; press **1** to select **Plot1** and choose the settings shown opposite.



(3) Press [ZOOM] **6** to display the triangle with standard axes.
Press [TRACE] and use [▶] and [◀] to move around the vertices (i.e. corners) of the triangle. Write down the co-ordinates of the three vertices.



(4) How do the numbers entered in L1 and L2 match the co-ordinates you found in part (3)?
Why are there four pairs of values in L1 and L2 and only three pairs of co-ordinates?
Experiment by entering different numbers in L1 and L2 and see the effect on the triangle.

Notes and extensions

This activity will enable pupils to practise using co-ordinates with positive and negative numbers. They can investigate questions like:

- how can I display a point in each quadrant of the screen?
- how can I create an equilateral triangle?
- how can I create a square or rectangle?
- how can I draw my initials on the screen?
- What will happen if I change the sequence of numbers in lists L1 and L2?

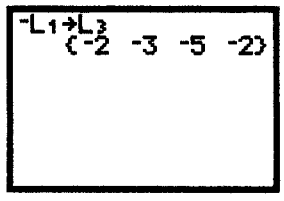
It is possible and easy to transform the shape – see next activity.

Strand:	Shape, Space and Measures
Topic:	Reflections and Combinations of Transformations
Pupils should be taught to:	Recognise and visualise transformations and symmetries
Year:	7
Example:	Understand reflection as a transformation of a shape in which points are mapped to images in a mirror line or axis of reflection.

Activity - reflecting in the Y axis

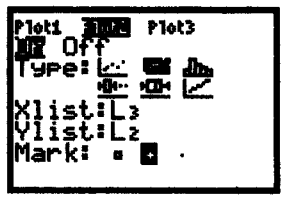
(1) Set up the calculator to draw a triangle using the technique in the previous activity.

(2) Now find the negative of the values in L1 and store them in L3.
From the home screen press:
[(-)] [2nd] [L1] [STO▶] [2nd] [L3] [ENTER]



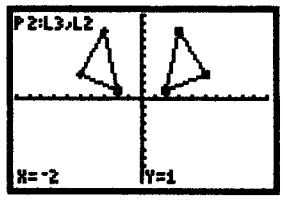
Press [STAT] **1** to see the new values in L3.
Spend a few moments understanding where the new values in L3 have come from.

(3) Press [2nd] [STAT PLOT] and choose **Plot2** by pressing **2**.
Choose the settings shown opposite.



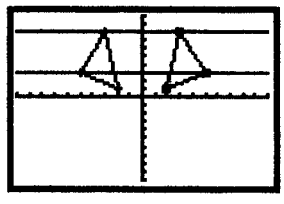
Press [GRAPH] to see the triangle reflected in the Y axis.

Press [TRACE] [▼], and write down the coordinates of the new triangle.



Notes and extensions

- Pupils can use the Horizontal command from the Draw menu to see that the line joining each point to its image is at right angles to the mirror line.
- They can confirm from the coordinates that the image is the same distance to the left of the mirror as the original is to the right of it.
- By changing one of the vertices of the original triangle to lie on the Y axis, they can confirm that points on the mirror line do not change their position after reflection.
- By reflecting the image triangle in the Y axis (using **-L3 -> L4**) they can confirm that a reflection which maps A to A' also maps A' to A.
- They can investigate how to reflect in the X axis, using a similar approach (i.e. using **-L2 -> L5**).



Course Evaluation

We would very much welcome your responses, anonymous or named, to the following questions about the course.

1. Overall

Were your personal aims and expectations satisfied?

2. Best bits

Which features of the course did you find most helpful?

3. Worst bits

Which features of the course did you find least helpful?

4 Confidence

Are you more confident with using a graphics calculator as a result of taking this course? Tick one box.

Less confident	☐
About the same	☐
More confident	☐
Much more confident	☐

5 Recommend the course?

What would you tell someone else thinking about coming on a future course?

6 Topics covered

Here are some of the themes that may have been covered on this course:

(i) Lists and statistical plots,
(ii) Graphs,
(iii) Algebra,
(iv) Handling data,
(v) Coordinates and transformations,
(vi) Use of CBR to produce distance/time graphs,
(viii) Into the classroom

Which if any of these would you leave out

What additional topic, if any, would you like to have been included.

7 Any other comments?

Name (optional)