Secondary Mathematics with ICT

A pupil's entitlement to ICT in secondary mathematics
There are generally considered to be six major opportunities for learners to benefit from the use of ICT in mathematics: learning from feedback; observing patterns; seeing connections, developing visual imagery, exploring data and 'teaching' the computer.

Secondary Mathematics with ICT - learning from feedback

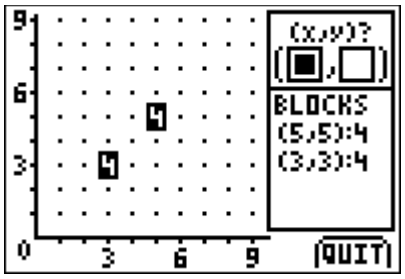
Feedback is the fundamental way in which ICT supports learners of mathematics. Through feedback learners notice patterns and see connections, explore, make mistakes and see the consequences of their decisions. Other opportunities offered by ICT to learners of mathematics include working with dynamic images; exploring data and teaching the computer which also supports the learner through various forms of feedback. The interactive facility of ICT allows students to receive feedback quickly on demand. Good ICT resources can provide feedback which is reliable, non-judgemental and impartial.

National Curriculum
Key Processes: Analysing

- Pupils should be able to take account of feedback and learn from mistakes.

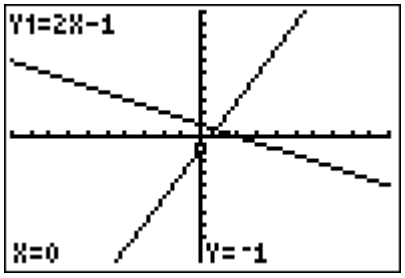
Using calculators
A basic example of learning from feedback with ICT is students adopting an exploratory approach through using trial and improvement to solve equations with calculators or using a spreadsheet.

Exploring a microworld
These Year 7 students used a small software program (or microworld) running on a handheld device to help develop their problem solving skills and practise their understanding of co-ordinates. The aim of the program was that they should try to find the Rhino hidden in a grid.



This example uses an application for Texas Instruments graphical calculators, a free download from http:\\education.ti.com

Exploring y=mx + c
A group of Year 10 students had the opportunity to obtain a good understanding of the connections between the equation for a straight line and its graph as they were able to generate many examples through varying the values of the constants and observing the effect on the graph. Access to graphical calculators made this activity easily accessible to the students without elaborate preparations by the teacher.



Progression idea

Modelling with still/moving images

The use of still or moving images to motivate a modelling activity extends the way in which feedback supports learning. Still images can be imported into most dynamic geometry packages and some graphing packages. In this example, Year 10 students used the images of their own basketball shots filmed in PE imported into a software package to introduce them to the equations of quadratic functions.

This example is included in the Teachers TV programme *Secondary Mathematics - Hard to Teach*. (http://www.teachers.tv/video/19119)

These students were using *The Geometer's Sketchpad* software. (www.keypress.com)

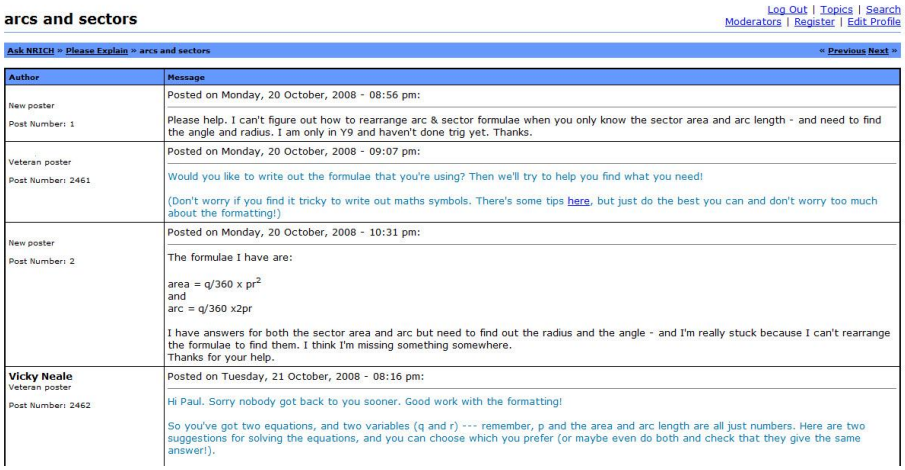
An alternative would be to use the video library within the *Coordinates and Graphing* tool from "The Mathematical Toolkit", a free piece of software that can be downloaded or run from the London Grid for Learning. (www.lgfl.net)

Exploring 'Black Box' functions

Such activities are applicable to the full range of attainment and level of mathematics. For example, Year 7 students explored the outcomes of using the square root button for a variety of inputs.

Feedback from online support

Online support for students can take the form of email dialogue, responses to students work through a virtual learning environment and websites.



arcs and sectors

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Ask NRICH » Please Explain » arcs and sectors « Previous Next »

Author	Message
New poster Post Number: 1	Posted on Monday, 20 October, 2008 - 08:56 pm: Please help. I can't figure out how to rearrange arc & sector formulae when you only know the sector area and arc length - and need to find the angle and radius. I am only in Y9 and haven't done trig yet. Thanks.
Veteran poster Post Number: 2461	Posted on Monday, 20 October, 2008 - 09:07 pm: Would you like to write out the formulae that you're using? Then we'll try to help you find what you need! (Don't worry if you find it tricky to write out maths symbols. There's some tips here, but just do the best you can and don't worry too much about the formatting!)
New poster Post Number: 2	Posted on Monday, 20 October, 2008 - 10:31 pm: The formulae I have are: area = q/360 x pr^2 and arc = q/360 x2pr I have answers for both the sector area and arc but need to find out the radius and the angle - and I'm really stuck because I can't rearrange the formulae to find them. I think I'm missing something somewhere. Thanks for your help.
Vicky Neale Veteran poster Post Number: 2462	Posted on Tuesday, 21 October, 2008 - 08:16 pm: Hi Paul. Sorry nobody got back to you sooner. Good work with the formatting! So you've got two equations, and two variables (q and r) --- remember, p and the area and arc length are all just numbers. Here are two suggestions for solving the equations, and you can choose which you prefer (or maybe even do both and check that they give the same answer!).

The AskNrich website provides opportunities for students to discuss mathematics with others.

Secondary Mathematics with ICT – observing patterns

The speed of computers and calculators enables students to produce many examples when exploring mathematical problems. This supports their observation of patterns and the making and justifying of generalisations based on the facility to look at sufficient cases.

National Curriculum
Key Processes: Analysing

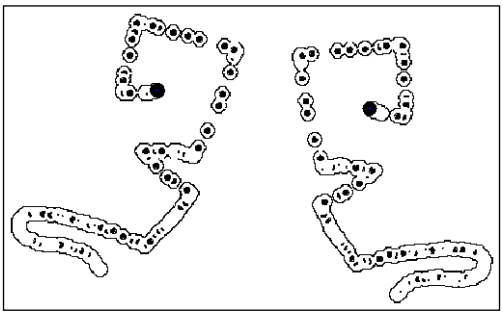
- Pupils should be able to explore the effects of *varying values* and looking for invariance and covariance. *This involves changing values to explore a situation, including the use of ICT.*

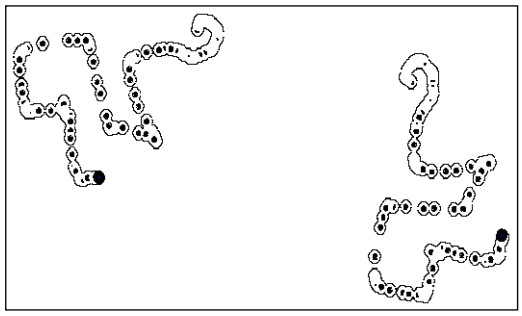
Key Processes: Interpreting and evaluating

- Pupils should be able to be aware of the strength of empirical *evidence* and appreciate the difference between evidence and proof. *This includes evidence gathered when using ICT to explore cases.*

Generalising about transformations

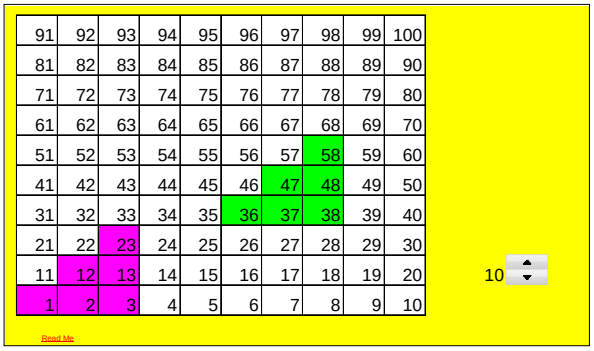
In a geometric context, Year 7 students dragged a point around the screen and watched the movements of a second point. They made conjectures about the geometric relationships between the pairs of points and added geometric construction lines and performed transformations to confirm or refute their thinking.





Number grids

There are various software packages which allow many examples to be explored quickly so that learners can observe patterns in their results. This process will help them to explain what is happening. Some year 8 learners used a simple number grid which could be redrawn by increasing or decreasing the counter. They explored the sums of the numbers within the shaded shape for different grids.



91	92	93	94	95	96	97	98	99	100
81	82	83	84	85	86	87	88	89	90
71	72	73	74	75	76	77	78	79	80
61	62	63	64	65	66	67	68	69	70
51	52	53	54	55	56	57	58	59	60
41	42	43	44	45	46	47	48	49	50
31	32	33	34	35	36	37	38	39	40
21	22	23	24	25	26	27	28	29	30
11	12	13	14	15	16	17	18	19	20
1	2	3	4	5	6	7	8	9	10

10

Read Me

This example of uses the *Number grid*, a free downloadable Excel resource from the Flexcel project.
http://www.maths-it.org.uk/index.php

Progression idea

Generalising algebraically

Year 9 students entered values for *p* and *q* to support them to work out how each of the values in the cells of a number grid was related. The speed with which the examples are generated encouraged the students to make and test conjectures and they made generalisations in words, and then using algebra.

p=	q=
1	2

3	2	4
8	2	4
7	4	-1

This example is taken from the National Strategies *Using ICT to address 'hard to teach' concepts in mathematics project* and can be downloaded from the DCSF standards site.

http://nationalstrategies.standards.dcsf.gov.uk/

Secondary Mathematics with ICT – seeing connections

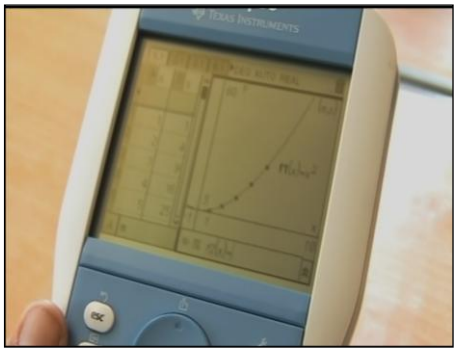
The computer enables formulae, tables of numbers and graphs to be linked readily. Changing one representation and seeing changes in the others helps students to understand the connections between them. Within a spreadsheet an algebraic formula can be used to generate a table of numbers and this can then be graphed. Alternatively, graphing software or a graphic calculator allows the graph to be drawn directly from the formula and values can be traced. Working through a medium which enables pupils to switch effortlessly between these representations enhances their conceptual development.

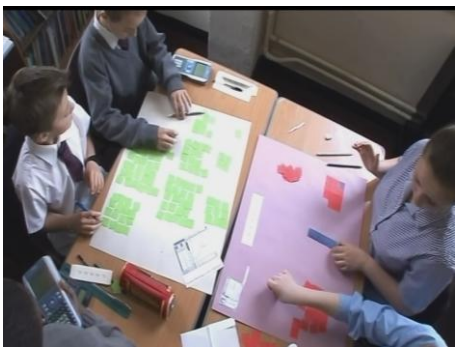
National Curriculum
Key Processes: Analysing

- Pupils should be able to make *connections* within mathematics. *For example, realising that an equation, a table of values and a line on a graph can all represent the same thing or understanding that an intersection between two lines on a graph can represent the solution to a problem.*

Connections between formulae, tables of numbers and graphs

Using a handheld device, Year 9 students entered data, plotted graphs and matched functions for a given quadratic number sequence based on a growing pattern made from square tiles.

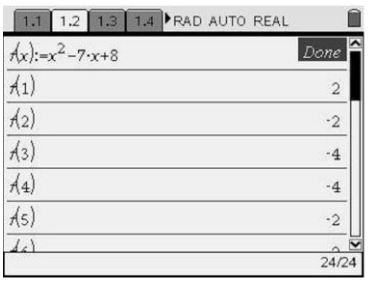


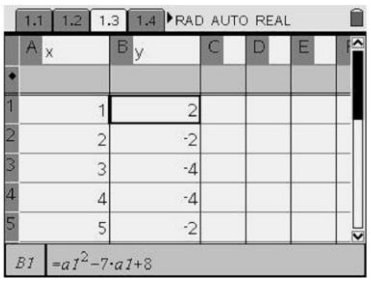


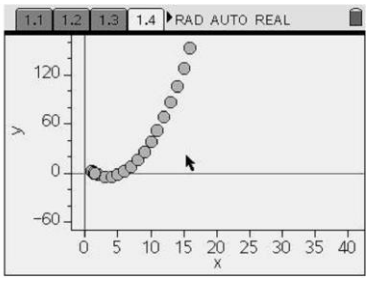
This example of students using the TI-Nspire handheld is included in the Teachers TV programme *Hard to Teach - Secondary Maths Using ICT*. (http://www.teachers.tv/video/29853)

Progression idea

Year 10 students made explicit links between a trial and improvement strategy to find the roots of a quadratic equation alongside the graphical representation of this by plotting a scattergraph of their trials and seeing how the points got closer to the x-axis.







Secondary Mathematics with ICT – working with dynamic images

Students can use computers to manipulate diagrams dynamically. This encourages them to visualise diagrams or graphs as they develop the capability to generate their own mental images.
The facility with which a figure produced by geometric construction can be manipulated generates many examples and encouraging the students to notice 'what changes and what remains the same' enables them' to formulate and test their conjectures.

National Curriculum
Key Processes: Analysing

- Pupils should be able to visualise and work with dynamic images.

Using dynamic number lines

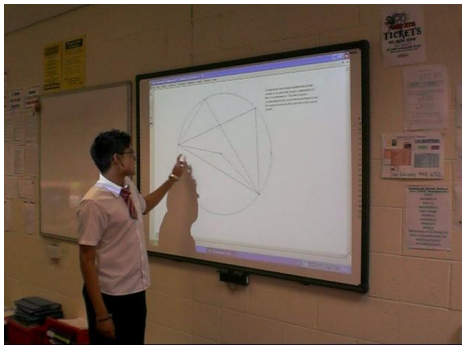
These Year 7 students used a dynamic number line to understand the meaning of variables. As they dragged the point ***n*** along the number line, the position of point *a* changed, according to the previously defined relationship.

This example used the *Number line tool* from "The Mathematical Toolkit", a free piece of software that can be downloaded or run from the London Grid for Learning. (www.lgfl.net).

The same example can be designed in most dynamic geometry software packages.

Using dynamic geometry software

Some Year 9 students explored a circle theorem by constructing an appropriate dynamic figure and used geometrical reasoning to make conclusions and reported them to others.



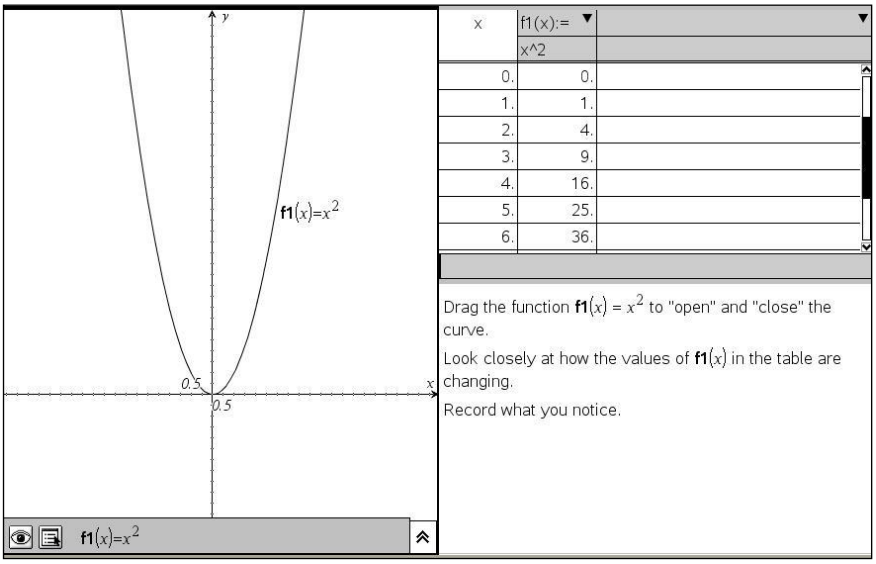
This is shown in the Teachers TV programme *Hard to Teach - Secondary Maths Using ICT*.
(http://www.teachers.tv/video/29853)

Progression idea

Students could use a dynamic number line to explore when two different functions share the same values of x and y. For example, for which values of x are the values of y the same for the functions $y = 2x$ and $y = x^2$?

Exploring graphs dynamically

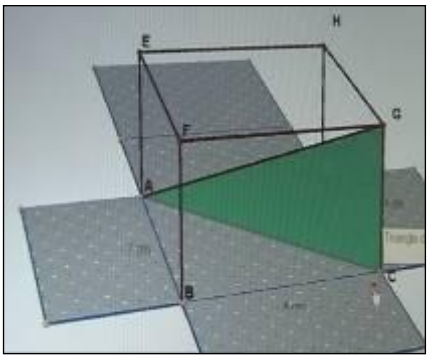
These Year 10 students used a new software development which enabled the graph of a function to be dragged, allowing them to simultaneously observe changes in its parameters.



This example uses TI-Nspire software or handheld. (http://www.ti-nspire.com)

Exploring 3D shapes dynamically

A group of Year 10 students manipulated 3-D images of cuboids to enable them to solve Pythagoras problems in 3-D by unwrapping nets and constructing the 2-D shapes. This supported them in devising a solution strategy for traditional problems solved by paper and pencil.

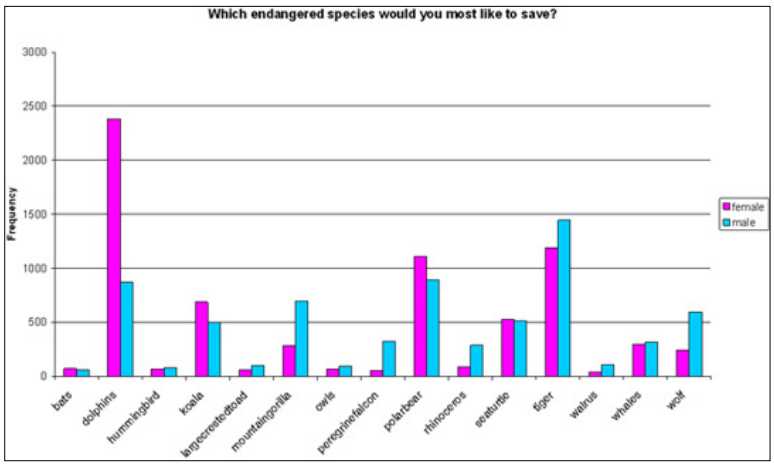


This example is shown in the Teachers TV programme *Hard to Teach - Secondary Maths Using ICT*. (http://www.teachers.tv/video/29853)

Secondary mathematics with ICT - exploring data

Computers enable students to work with real data which can be represented in a variety of ways. This supports interpretation and analysis.

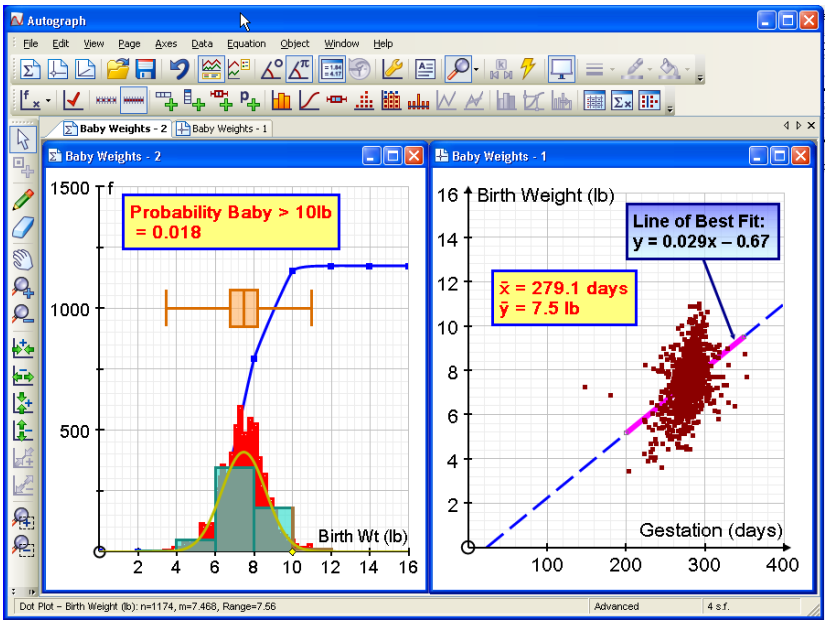
Some Year 7 students had recently taken part in an online survey, one of the questions of which required them to decide which endangered species they would most like to save. They were then able to compare and contrast their views with students from another part of the country using a range of graphs and statistical calculations.



The survey was part of the free Census at School project.

www.censusatschool.ntu.ac.uk

Students can also use existing databases to gain access to much larger sets of data. For example, these Y10 students used a database of 1174 babies to explore the distribution of baby weights, and, after creating a range of standard diagrams, measured the probability of a baby over 10 lbs. They then investigated the relationship between gestation length and baby weight.

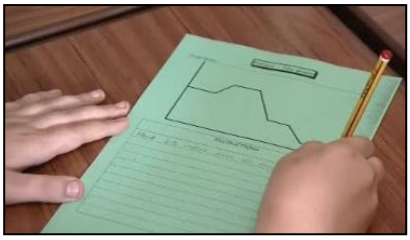


The database is freely available from

http://www.tsm-resources.com/useful-files.html

Using a motion detector

Year 9 Students planned a "walk" to match a given distance time graph and then tested their plan using the motion detector and a whole class display.



This example of a motion detector being used is shown in the Teachers TV programme *New Maths Technology - In the Classroom*. (http://www.teachers.tv/video/154)

Progression idea

Students could use real data with computers which means that a cross-curricular approach is feasible. For example, students tested the distance travelled when cars rolled down slopes which contributed to their understanding of concepts from the science curriculum..These children were engaged in the process of mathematical modelling while they were handling data. They decided what experiment to do, which data to record and how to use the data.

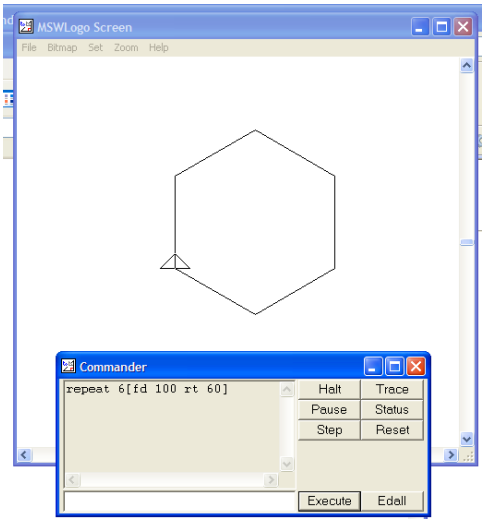
Secondary mathematics with ICT – 'teaching' the computer

When students design an algorithm (a set of instructions) to make a computer achieve a particular result they must express themselves unambiguously and in the correct order. They are beginning to model particular behaviours or develop a set of rules. This engagement with a 'formal system' sets up the opportunity for developing a mathematical habit of mind, to develop their skills of algebraic thinking.

'Teaching the computer' encourages students to formalise their mathematical thinking, define conditions, sequence actions and express their ideas clearly. When the computer carries out the instructions it has been given, students need to observe the effect, and may then need to refine and improve the procedure they taught the computer

Logo

For example, when Year 7 students devised a simple Logo program to draw a hexagon, they needed to decide on the sequence of actions carried out by the 'turtle' and the angle turned.

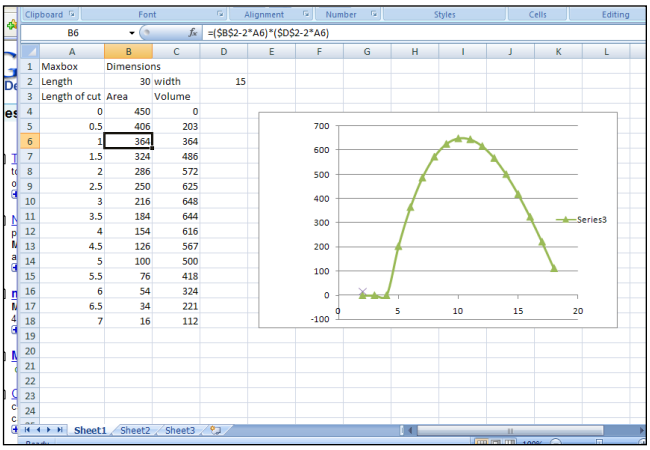


MSW Logo is a free software package available from http://www.softronix.com

They also needed to use the correct 'syntax'. This is not just a technical matter; it gave the students an opportunity to engage in a 'formal' system for a real purpose – to draw a shape. In this context students were also able to be creative, pursued their own goals and developed a sense of authorship and personal authority.

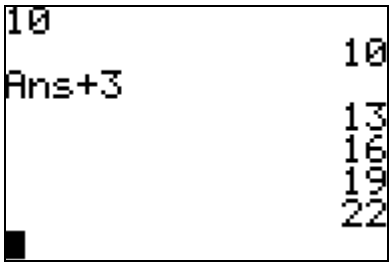
Spreadsheet formulae

The opportunity to 'teach a computer' arises whenever students use formulae in a spreadsheet. It is important, in this context, that students are given the opportunity to do this for themselves. For example, these year 10 students taught a spreadsheet to display the volume of a box, in the Maxbox investigation, which assisted their understanding of symbolic representations.



Programming graphical calculators

Most graphical calculators have a programming facility which is easily accessible. For example, some Year 8 students produced a range of programs from simple ones which carried out basic calculations automatically to ones which could generate random numbers or sequences. In doing so they generalised and expressed their ideas in a formal language.



Progression idea

Students could build on the logo procedures for drawing a hexagon to try to tessellate them. By trying out the procedures and 'debugging' them, they engage with a rich mathematical environment, working with geometry, algebra and logic. They see the consequences of their decisions in an environment where investigation and feedback support their learning.