Primary Mathematics with ICT: A pupil's entitlement to ICT in primary mathematics

Becta in association with

There are generally considered to be five major opportunities for children to use ICT in learning mathematics: learning from feedback; observing patterns and seeing connections; exploring data; teaching the computer, and developing visual imagery.

Learning from feedback

The computer often provides fast and reliable feedback which is non-judgemental and impartial. This can encourage children to make their own conjectures and to test out and modify their ideas.

Observing patterns and seeing connections

The speed of computers and calculators encourages children to explore a greater number of examples of mathematical problems. This supports their observation of patterns and the making and justifying of generalisations. The computer enables formulae, tables of numbers and graphs to be linked readily. Changing one representation and seeing changes in the others helps children to understand the connections between them.

Exploring data

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

'Teaching' the computer

When children design an algorithm (a set of instructions) to make a computer achieve a particular result, they have to express their commands unambiguously and in the correct order; this makes their thinking explicit as they refine their ideas.

Developing visual imagery

Using a computer enables children to manipulate diagrams dynamically. This encourages them to predict the results and to visualise the geometry as they generate their own mental images.

Primary Mathematics with ICT – learning from feedback

Lengths and angles

Some Year 1 children were learning to use measures (lengths and angles) as they attempted to guide a floor robot around a prepared floor plan. The children took turns to program the robot, estimating the distance and angle of turn required to reach their target.

The activity provided continual feedback. Each movement of the robot helped them decide what to try next.

Roamer from Valiant http://www.valiant-technology.com or *Pippin or Pixie* from Swallow Systems http://www.swallow-systems.co.uk/ could be used with this activity.

Primary Framework for Mathematics Year 1:

Measuring

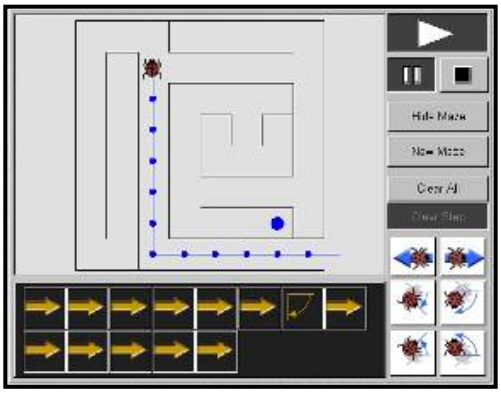
Estimate, measure, weigh and compare objects, choosing and using suitable uniform non-standard or standard units and measuring instruments (e.g. a lever balance, metre stick or measuring jug)

Understanding Shape

Identify objects that turn about a point (e.g. scissors) or about a line (e.g. a door); recognise and make whole, half and quarter turns

Visualise and use everyday language to describe the position of objects and direction and distance when moving them, for example when placing or moving objects on a game board

Progression idea

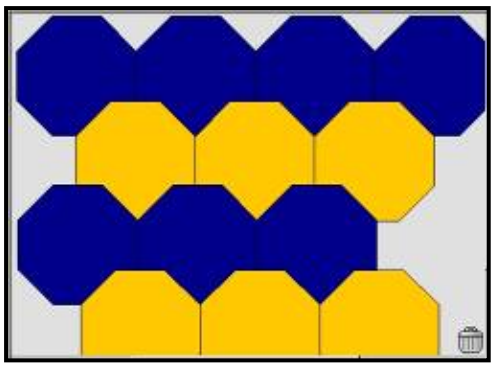


Older and more experienced children created, tried out, and revised plans to help '*Ladybug*' around a series of mazes using this online application from NLVM.

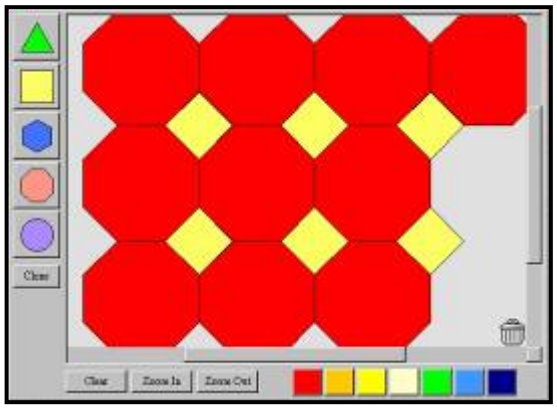
http://nlvm.usu.edu/en/nav/frames_asid_141_g_1_t_3.html?open=activities&from=grade_g_1.html

Tiling patterns

Various software packages can be used to create a motif and then copy and translate it on the screen to design a tiling pattern.



These Year 5 children found that in their first attempt using the tiling software the tiles overlapped.



They decided to add another shaped tile so that there were no gaps or overlaps.

Primary Framework for Mathematics Year 5:

Understanding Shape

Complete patterns with up to two lines of symmetry; draw the position of a shape after a reflection or translation

Using and applying mathematics

Explore patterns, properties and relationships and propose a general statement involving numbers or shapes; identify examples for which the statement is true or false

Progression idea

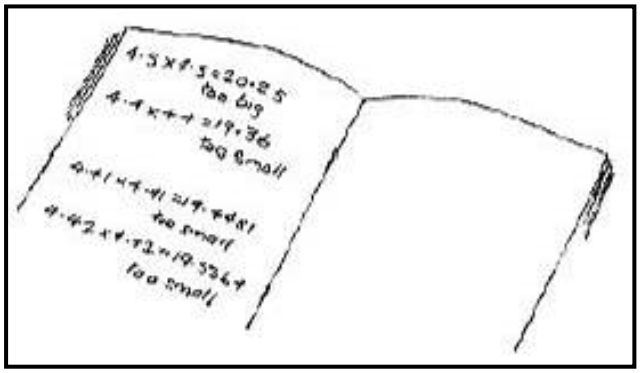
Children in Year 5 used the *Area* interactive teaching program to explore shapes with different numbers of lines of symmetry. You can view the lesson plan for this activity and watch a video snippet http://samples.lgfl.org.uk/primary/main.html by selecting Year 5: Mathematics: Symmetry.

The *Tesselations* software can be downloaded from NLVM http://nlvm.usu.edu/en/nav/frames_asid_163_g_3_t_3.html

The *Area* interactive teaching program can be downloaded from The Standards Site http://www.standards.dfes.gov.uk/primary/teachingresources/mathematics/nns_itps/area/

Square Roots

A Year 5 class was working on decimals and developing skills of mathematical reasoning. Two children wanted to know which number could be multiplied by itself to give 20. They knew that 4 was too small and 5 was too big, so 4.5 was their first approximation.



The process was not as simple as the child's exercise book suggests. The teacher needed to help the children to find a number that was more than 4.4 and less than 4.5 and this improved their understanding of place value.

ICT provides excellent support for trial and improvement methods, enabling pupils to obtain results that are both quick and accurate. Calculators or spreadsheets could be used with this activity.

Primary Framework for Mathematics Year 5:

Calculating

Use efficient written methods to add and subtract whole numbers and decimals with up to two places

Use a calculator to solve problems, including those involving decimals

Using and applying mathematics

Solve one-step and two-step problems involving whole numbers and decimals and all four operations, choosing and using appropriate calculation strategies, including calculator use

Primary Mathematics with ICT – observing patterns

Number grids

Software is available which allows children to draw grids of numbers and shade multiples quickly and easily. Two Year 5 children were using the software to help their understanding of relationships between numbers.

Teacher: *Which times tables make columns on the 8-grid?*

Children: *The 4 times table gives 2 columns.*

Teacher: *Why's that?*

Children: *It's because 8 is the end number and 4 is half of 8.*

1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24
25	26	27	28	29	30	31	32
33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48

From this starting point the teacher went on to ask about other multiples. Then she asked about different grids. Later still, the emphasis was on diagonal patterns.

1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21	22	23	24
25	26	27	28	29	30
31	32	33	34	35	36
37	38	39	40	41	42

Children: *7 works on the 6-grid.*

Teacher: *Why's that?*

Children: *It's always 1 more than the number of columns.*

Being able to draw many grids of different sizes and shade the multiples quickly helped the children to see the patterns and understand why they worked.

Primary Framework for Mathematics Year 5:

Using and applying mathematics

Explore patterns, properties and relationships and propose a general statement involving numbers

Knowing and using number facts

Recall quickly multiplication facts up to 10 × 10

Identify pairs of factors of two-digit whole numbers and find common multiples (e.g. for 6 and 9)

You could use *Number Grid* for this activity. *Number Grid* is an interactive teaching program (ITP) which generates a 100 square. You can hide or highlight rows and columns. The prime numbers and multiples can also be highlighted.

The program can be downloaded from The Standards Site

http://www.standards.dfes.gov.uk/primary/teachingresources/mathematics/nns_itps/number_grid/

Extension idea

Two Year 5 children were using their calculators to explore the patterns in the 11 times table.

Children: *The hundreds and the units always add up to the tens.*

Teacher: *Oh, I see. Does this always work?*

The children continued the pattern.

Children: It *goes wrong*

The teacher wanted the children to understand the pattern and why it breaks down.

Teacher: *Why do you think the pattern worked in the first place? Can you make up any other numbers which are divisible by 11? When does the pattern break down? Can you find any other places where it breaks down?*

Calculators or spreadsheets could be used with this activity. Alternatively, you could use the Multiplication Grid interactive teaching program http://www.standards.dfes.gov.uk/primary/teachingresources/mathematics/nns_itps/multiplication_grid/

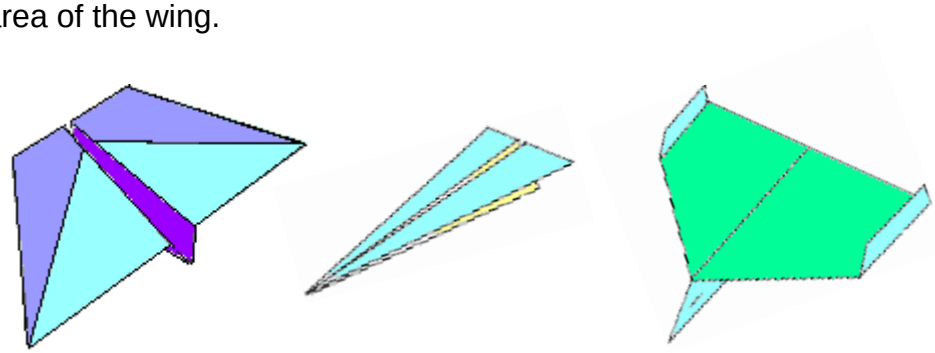
You can view a video snippet of how one teacher used this program http://samples.lgfl.org.uk/primary/main.html selecting Year 5: Mathematics: Multiplication.

When children can see many examples quickly, they are likely to observe patterns and notice where they break down. This may enable them to explain what is happening. The children learn to make generalisations and justify them.

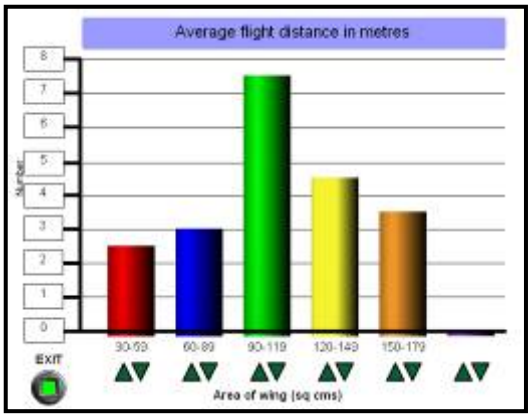
Primary Mathematics with ICT – exploring data

Paper planes

A Year 6 class experimented with paper planes. Each child made one and then they were all flown three times to see which travelled furthest. The children's task was to determine how to make a model that would fly as far as possible and so they decided to measure the length of each plane, the height of the tail, the wing-span and the area of the wing.



The children recorded all the results in a database and they attempted to identify the important variables. Some were easy to spot; others were more complicated.



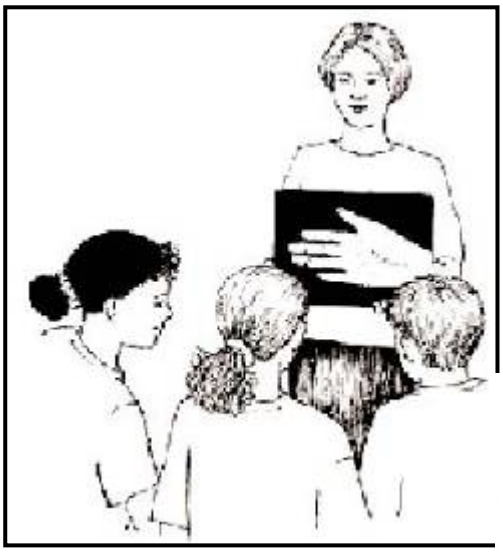
Sorting and finding averages helped and various graphs were also useful.

The children also discussed whether their test was fair and some were able to see the necessity of changing one variable at a time.

Using a computer enables children to work with real data and represent it in a variety of ways. They can take their first steps in mathematical modelling by deciding what experiments to do, which data to record and how to interpret the data.

Progression idea

A Year 6 teacher wanted to introduce scattergraphs to her most able group while working on collecting, representing and interpreting data. She started by talking to the whole class.



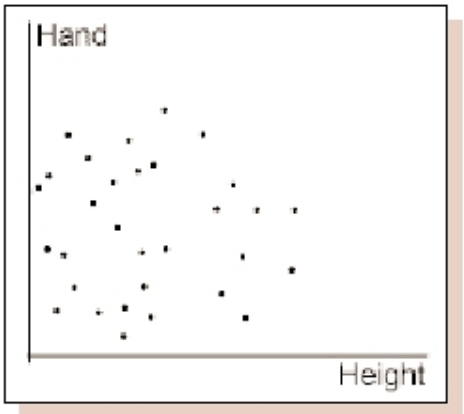
"I met a giant yesterday. He was so tall that my tape measure was not long enough to measure him. But I did manage to get a photograph of his hand."

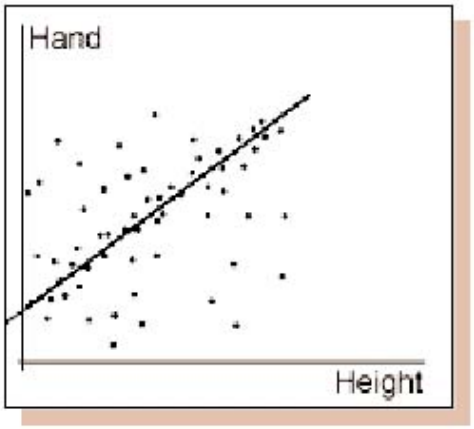
The teacher held up an enlarged photocopy of her own hand and asked the children how tall they thought the giant was.

	A	B	C
		Height (cm)	*Hand (cm)*
1	Siva	120	8
2	Helen	114	9
3	Peter	129	11
32	Roberta	156	10

The group measured the heights of all the children and some teachers too. They also measured their hands and recorded the data in a spreadsheet.

The children produced and examined the spreadsheet's scattergraph but no trends were obvious.





Teacher: *Sometimes things become clearer when there's more data. Why don't we ask the other Year 6 classes to take part in our survey?*

The data from the other classes was added to the spreadsheet and a new scattergraph was produced.

The teacher explained what was meant by a line of best fit and the children drew it by eye onto a print-out.

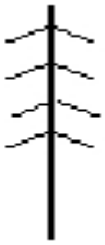
Then they used the line to estimate the giant's height.

Primary Mathematics with ICT – teaching the computer

An algorithm is a set of instructions. People often use mathematical algorithms, such as a learnt method for multiplying large numbers, but devising algorithms is less common.

Logo trees

Children can develop mathematical reasoning by teaching algorithms to the computer.

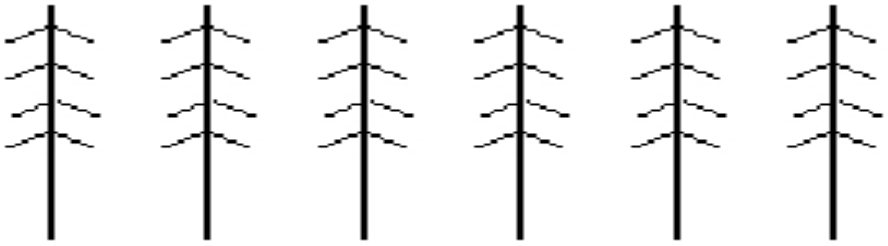


Two girls (Years 3 and 4) used Logo to draw a tree using the commands: forward (fd); back (bk) and right turn (rt) followed by the number of degrees the turtle should turn. Then they wanted to teach the turtle to draw their tree.

They found they could save time by writing a procedure to draw a pair of branches and using it several times.

```
to tree

fd 70 bk 40

branches fd 10

branches fd 10

branches fd 10

branches fd 10

end
```

Later the girls used this procedure to draw an 'avenue' of trees. At first they found it hard to work out how to move the turtle to the right place to draw each of the trees.



When they had finished, the children had taught the computer several new words and, whenever they typed 'avenue', the turtle followed their instructions and the complete picture was drawn on the screen.

The value of using ICT for this activity is that the computer always obeys the precise instructions it has been given. It waits patiently, it has no expectations of its user, it offers instant feedback and it is uncritical of failure.

The children very quickly understood the need to express their commands unambiguously and in the correct order.

Primary Framework for Mathematics Year 3:

Understanding Shape

Read and record the vocabulary of position, direction and movement

Draw right angles and identify right angles in 2-D shapes; compare angles with a right angle; recognise that a straight line is equivalent to two right angles

Using and applying mathematics

Describe and explain methods, choices and solutions to puzzles and problems, orally and in writing, using pictures and diagrams

Year 4:

Understanding Shape

Recognise horizontal and vertical lines; use the eight compass points to describe direction

Know that angles are measured in degrees and that one whole turn is 360°

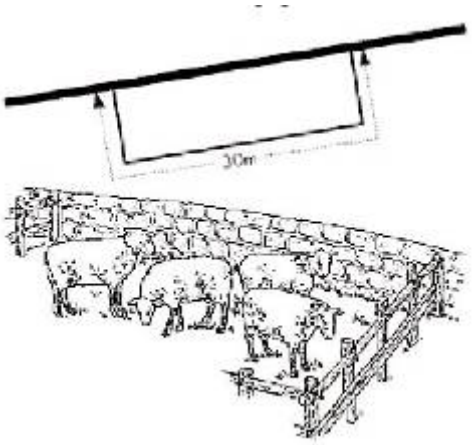
Using and applying mathematics

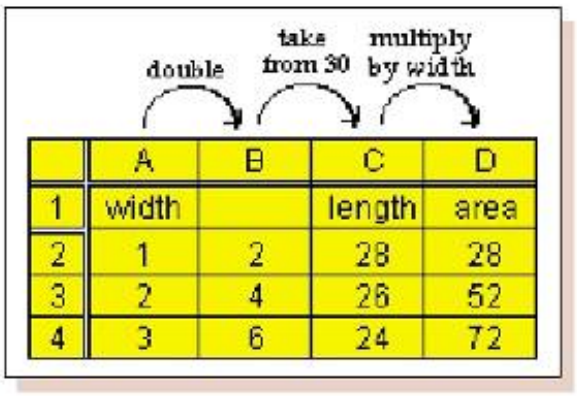
Represent a puzzle or problem using number sentences, statements or diagrams; use these to solve the problem; present and interpret the solution in the context of the problem

Biggest sheep pen

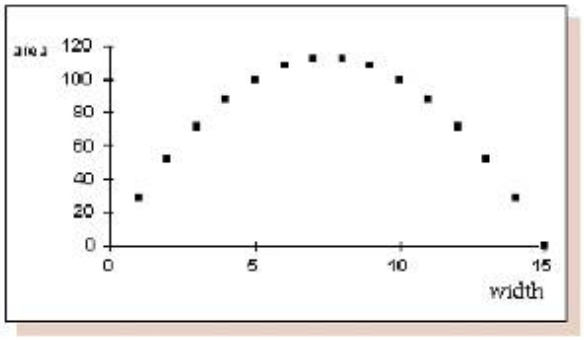
Jacqui and Pinder were in a Year 6 class which was very familiar with spreadsheets and their graphs.

The teacher wanted to introduce them to algebra and so they were set the task of finding the biggest rectangular sheep pen they could make with 30 metres of fencing against a wall.





	A	B	C	D
1	width		length	area
2	1	2	28	28
3	2	4	26	52
4	3	6	24	72



They entered some results in their spreadsheet manually. They calculated the lengths by doubling the widths (column B) and subtracting from 30 (column C). Then they multiplied the lengths by the widths to find the areas (column D).

They realised that they needed many more rows in their spreadsheet and so they taught the spreadsheet some formulas in order to generate the numbers they required.

Jacqui was not sure how to double but Pinder suggested trying =A2*2 in cell B2. Finding a formula for column C was harder. It took a while before the children hit upon =30-B2 for cell C2. The last column was easier (=A2*C2).

Later they graphed the width against the area to help their exploration.

Using the spreadsheet provided an important reason for the children to struggle with formal algebraic language and find the formulas. The spreadsheet also enabled them to break the problem down into more manageable steps.

Primary Framework for Mathematics Year 6:

Measuring

Calculate the perimeter and area of rectilinear shapes

Using and applying mathematics

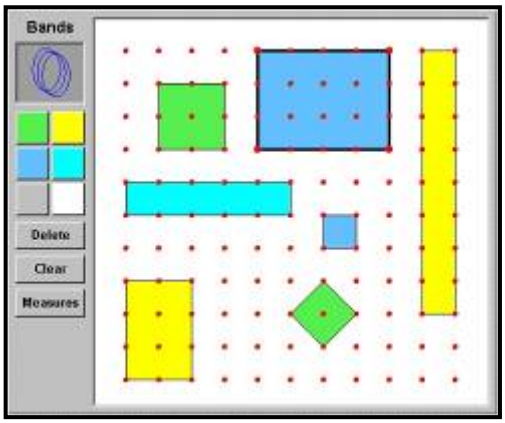
Represent and interpret sequences, patterns and relationships involving numbers and shapes; suggest and test hypotheses; construct and use simple expressions and formulae in words then symbols

Primary Mathematics with ICT – developing visual imagery

Stretching and enlarging

Some Year 2 children were using an interactive *Geoboard* program to make simple two-dimensional shapes and then distort them in various mathematical ways.

The children stretched their shapes horizontally or vertically by using the computer's mouse.



Then the teacher discussed the various shapes with them.

"Which of these rectangles looks most like a door, or a window, or a book, or a TV screen?"

"How could you make a square?"

Progression idea

Later, the children used clip-art with a paint package as they wanted to draw a family of giants. They used the mouse to change the dimensions of the image.

"They're too fat."

"They're not getting taller."

The children were shown where to click the mouse and the teacher talked about enlargement:

"The giant grows properly now."

"All the parts get bigger and the shape doesn't change."

Children can use computer software to explore shapes by moving them. This encourages them to form their own mental images and visualise the geometry.

Primary Framework for Mathematics Year 2:

Using and applying mathematics

Describe patterns and relationships involving shapes, make predictions and test these with examples

Understanding shape

Visualise common 2-D shapes; identify shapes from pictures of them in different positions and orientations; sort, make and describe shapes, referring to their properties

You can download an online Geoboard program from NLVM http://nlvm.usu.edu/en/nav/frames_asid_277_g_1_t_3.html?open=activities&from=grade_g_1.html.