

ICT in the primary mathematics classroom

Taken from www.ncetm.org.uk primary magazine issues

ICT in the classroom - sensors and data loggers

In this issue, we consider the use of sensors and detectors in mathematics through problem-solving scenarios. The contexts for the problems could be changed to suit children's interests, events in school or a curriculum theme, but in each the pupils will need to make decisions based on using and interpreting the data they collect.

Data logging involves using a device which records data from sensors, and either displays or feeds the collected data to a computer to be stored and represented. The data can be used to produce graphs and charts. Data loggers can capture and display data as it happens, collect data continuously or at regular intervals over longer periods of time. Everyday uses for data logging include weather stations and traffic flow systems. Some devices can respond to data, for example a movement or sound sensor could trigger an alarm or turn on a light when the data matches criteria.

Data loggers enable children to investigate their environment using their mathematical skills of understanding measures and data handling. Before these activities, it is valuable to observe children exploring the sensors in pairs or small groups to see and hear the "What if...?" and "How can I...?" questions they pose for themselves, and what mathematical language these resources promote.

The curtains

Curtains need to be chosen for a new sensory room, TV room or quiet room in the school or other local setting.

Ask the children to use light sensors to investigate which fabric the curtains should be made from to make it as dark as possible. They might think about colour and doubling or combining fabrics, or consider other factors such as price. The children will need to devise their own way of comparing the outcomes from different fabrics using the data from the device.



Ice cream

The PTA will be providing ice creams for the summer picnic. The ice cream will need to be scooped out in the kitchen, then brought round to people on trays outside.



Ask the children to use temperature sensors to investigate the best containers for preventing the ice cream melting too quickly e.g. cardboard cup, ceramic bowl or wafer cone. One advantage of using a sensor that takes regular measurements, is that the experiment is not affected by a thermometer being moved and handled. Try setting up a video camera to record the ice cream melting, then the whole class can observe and review the experiment together alongside the table or graph created from the data collected. Using the temperature sensors on frozen food provides an opportunity to explore negative numbers, and an introduction to calculating with them.

Shhh...

We will be recording advertisements in Literacy later this term.

Ask the children to use a sound sensor to investigate which is the quietest room in the school for recording the radio programme or podcast. Try taking readings at different times of the day or on different days of the week. Once children are familiar with the types of table and graph produced by the data logger on the computer, they can be given graphs without location information for them to reason about where the sensor might have been located.



Search and rescue

Someone has stolen an animal from the zoo. We know that it is sleeping in one of these bags. How can we recover the animal quickly without opening all the bags?



Recreate the scenario with a selection of bags. In one bag, place a toy animal made from a hot potato or heat pack. Ask the children to think about which sensor might allow us to detect an animal inside a bag without looking inside. One suggestion made by a Year 4 child thinking about this problem, was to put a sound sensor next to each bag to detect snoring! It is useful for children to investigate and discuss different methods although, with the warm toy, this scenario is obviously set up for use with temperature sensors. To know whether the temperature sensor can be used in this case, children need to think about these questions:

- can we use a temperature sensor to find something we cannot see?
- how sensitive is the temperature sensor?
- what materials and containers can it sense the heat through?

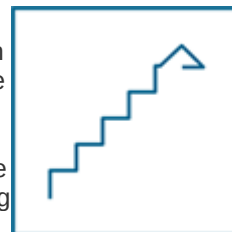
Rather than data handling, this activity provides opportunities to discuss and calculate differences in temperature.

ICT in the classroom - Computer Programming

In [Issue 33](#), we explored the mathematical possibilities of using programmable toys. These included engaging contexts such as storybooks and sports. In this issue, we take these ideas into the more abstract world of onscreen programming. To be able to do this, children will benefit from a reminder of the practical activities that support the beginnings of programming before launching into the abstract. It is therefore important to provide opportunities for them to work together on giving both verbal and written instructions to each other and also to programmable toys. They will need to be able to use the computer keyboard efficiently to enter the text for programs, so it is important that they have these skills. In addition, they will need an understanding of 'left' and 'right' and be able to measure angles using degrees. To consolidate or reinforce this you could consider using a physical obstacle course for either pupils themselves to be directed around or, for a robot.

LOGO is the mostly commonly used programming language in primary schools. It is used to control a turtle (an on-screen cursor) on a blank screen. There are many versions of LOGO available, they all have similar features but there are some differences in the commands. The commands used here will work in most versions of LOGO, but are written using MSW LOGO which can be freely downloaded from [Softtronix](#).

For an engaging activity that reinforces the concept of right angles, you could use this idea. Try making clear plastic mazes that stick over the computer screen. The children can then easily create their own mazes to challenge each other. They should draw the maze first on 1 cm squared paper by marking a pathway from the centre of the paper to one of the edges going through the middle of squares without diagonals. The walls of the maze can then be completed using some of the lines on the squared paper. The maze, not including the solution, should then be copied onto the clear plastic film using a marker pen and this is attached to the screen.



As an alternative, you could introduce the 'penup' (pu) and 'pendown' (pd) commands. The children could draw a show jumping or obstacle course onto the clear plastic film. The jumps are numbered so that the turtle, on the LOGO programme, can reach them in order and 'jump' over them.

Creating procedures involves generalisation of patterns – and real programming. Children will often discover the need for more efficient instructions as they find themselves writing the same instructions repeatedly. A discussion about a pattern such as this provides the opportunity to reveal the 'repeat' command. This pattern is made using 'repeat 5 [fd 20 rt 90 fd 20 lt 90]'.

This is a more efficient solution than typing in each line individually. More elegant programming involves teaching the turtle a new word. For example, the pattern above can be recreated any time using the command *stairs* if the computer is programmed to understand the new word. This new word is called a *procedure*. Every new procedure the turtle is taught opens with 'to' and is closed with 'end'.

```
to stairs
repeat 5 [fd 20 rt 90 fd 20 lt 90]
end
```

Once pupils have mastered the repeat command they can use circle commands to create spirograph-style patterns.



This pattern is created using `'repeat 9 [circle2 50 rt 45]'`. 'Circle2' is a procedure already written into MSW LOGO that draws a circle with the turtle at the edge. The number after 'circle2' refers to the size of the circle's radius.

Ask pupils to predict and investigate what happens when they change the blue numbers in the instruction.

Experimenting with changing the values in a command leads us nicely to exploring variables. A procedure with variables could, for example, allow children to quickly draw rectangles with any size length and width. For example, a rectangle could be created by programming this procedure:

```
to rectangle :length :width
repeat 2 [fd :length rt 90 fd :width rt 90]
end
```

If you then enter the command `'rectangle 60 20'` a rectangle with a 60-unit length and a 20-unit width would be created. This procedure is useful for reflection and discussion about the perimeter of rectangles, and how they can be calculated by doubling the sum of the length and width. Challenge pupils to use this procedure to create a set of rectangles that all have the same perimeter.

To provide a context for investigating number patterns try exploring the `'sound'` command to create a tune. Start with something familiar such as the first three notes of 'Three Blind Mice'. Can the pupils use trial and improvement to make those three notes by changing the values in the instruction `'sound [1000 1000]'`? Once they have identified the difference in the numbers that changes the pitch by one tone, children can continue the pattern to create a whole scale of notes and use them to make their own music.

Children with more experience can make a simple 'programming language' for younger, less experienced pupils by using procedures. The children designing the commands can create a poster to be displayed near the work station that communicates what each command does:

'F' will make the turtle go forwards 10 units

```
to f
fd 10
end
```

'B' will make the turtle go backwards 10 units

```
to b
bk 10
end
```

'L' will make the turtle turn 90 degrees to the left

```
to l
lt 90
end
```

'R' will make the turtle turn 90 degrees to the right

```
to r
rt 90
end
```

'J' will make the turtle jump forward 10 units

```
to j
pu
fd 10
pd
end
```

These one-letter commands can make controlling the screen turtle accessible to the youngest children in school if they are familiar with symbolic stickers that go over the appropriate letters on the computer keyboard when they are using the program. Interest can be added to the activity by putting a simple

pictorial map on a clear plastic sheet over the display. Encourage children to use positional language to describe how the turtle can get from one place to another on the map.

ICT in the classroom - Database Projects

In this issue, we explore how children can use online databases to search for items to match criteria. We also look at creating databases where items can be sorted for a purpose. Large real databases are available to search through internet sites, such as those that advertise items for sale. In [Issue 29](#) we shared ideas for using many online databases. Here we take one of those ideas and expand it into a project that covers a range of data handling objectives and concepts.

Databases can be created either on paper or a computer and are used to collect and organise data. Database software often enables children to quickly create graphs of the information and can calculate statistics such as the mean average and range of the data.

In order for children to understand this method of organising data it is useful for them to investigate what they can find out from an existing database. Younger children will usually need to use a database prepared particularly for children. Those with more experience, and adequate reading and comprehension skills, can use real databases designed for adults to find particular items like homes and cars.

Homes can be searched for under categories including:

- property type
- outside space
- price
- number of bedrooms
- location.

Cars can be searched for under categories including:

- make and model
- fuel type
- age
- price
- mileage
- engine size
- colour
- number of doors.

Try suggesting some questions that can be solved using a property or car sales website such as:

what is the most common (the mode) price of properties within a mile of our school? or, which car registered in 2011 has the highest mileage?

Maybe the children will be able to work together to find information that helps them investigate and solve more complicated problems such as:

how much more does a four-bedroom property cost than a three-bedroom property? or, does car colour make a difference to the price?

Encourage the children to draw conclusions and identify further questions to ask.

If each child designs their own property or vehicle and completes a data file then the class has created a new resource to search. This process involves identifying what data to collect in the file and how it will be recorded. Through this, the children use and develop skills of selecting and organising relevant data. Paper copies of the data files can be sorted by the children's criteria into a catalogue or file.

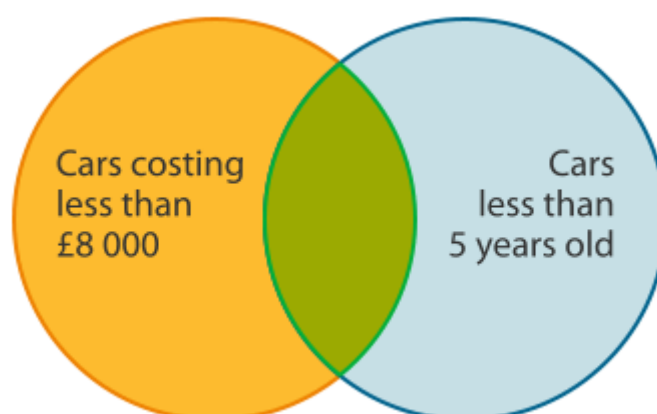
Once you have your own database, or the children are comfortable using one that has been already created, the class can get into the business of solving problems based on the scenario of supporting customers. The engagement of the children can be enhanced through the range of ways that 'customers' bring them their requirements of a car or home. Try phone messages, letters, emails, and any adults that you can convince to role play being a customer to visit the business.

'Customers' should use the precise language of logic including 'and', 'or' and 'not'. Children will need to talk together to decide which is the most relevant product for the customer if none of them exactly match the criteria. They use communication and reasoning skills to explain why that product is the best match. If appropriate, the children can produce a written report of their recommendations, referring to the data they have used, otherwise consider asking them to record a message for the customer.

If children are not familiar with matching objects to criteria in this way you might wish to share the CBBC activity [Beat the Boss](#), which involves the scenario of choosing aspects of footwear or a bicycle to meet the customers' needs.

If you decide to use the online databases as inspiration, but create your own databases using cards, this provides children with an understanding of how the entries are sorted by their criteria. It may be interesting and useful to use a Venn or Carroll diagram such as these:

	< £200 000	Not < £200 000
Garage		
No Garage		



Encourage children to compare their experience of using and creating computer and paper-based databases. Which is easier to search, create, amend, etc?

A project like this can provide excellent work for displaying and celebrating children's mathematics. Consider including printed data files, children's written recommendations, recordings of their messages or speech bubbles quoting their ideas, photographs of the children collaborating or role playing, and any sorting diagrams produced.

ICT in the classroom - Spreadsheets for Number and Algebra

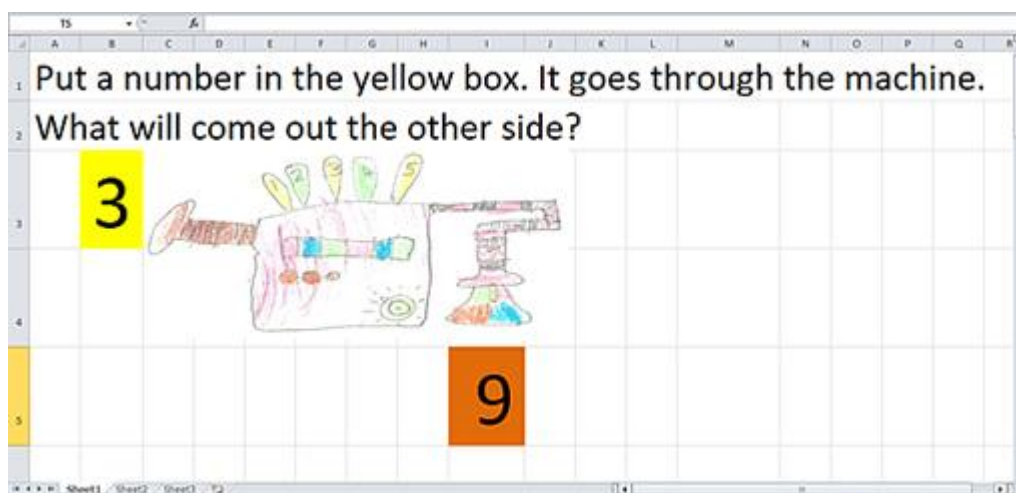
“Children display a tremendous intellectual curiosity about number patterns. Computer spreadsheets provide a vehicle for students to express that curiosity, allowing them to explore number patterns algebraically while the computer performs the tedious calculations.”

Spreadsheets, Patterns, and Algebraic Thinking by Ploger, Klingler & Rooney (1997)

Spreadsheets can quickly and easily be made and used again and again in class. Here we look at some of these spreadsheets and the learning and thinking they encourage.

Function machines

The simplest applications of spreadsheets are function machines, empty box problems, or problems where we need to work out the operation. In the example below, a child has designed their own machine which has been scanned into the computer. This also gave her a sense of ownership of the mathematics. The orange box contains $=B3+6$, although it could have been $=B3*3$. Children can try different numbers in the yellow box until they can put forward an idea for what the machine might do. The machine gives them a structure for making a generalisation, e.g. “The orange box number is six more than the yellow box number.” They can quickly predict and test their ideas.



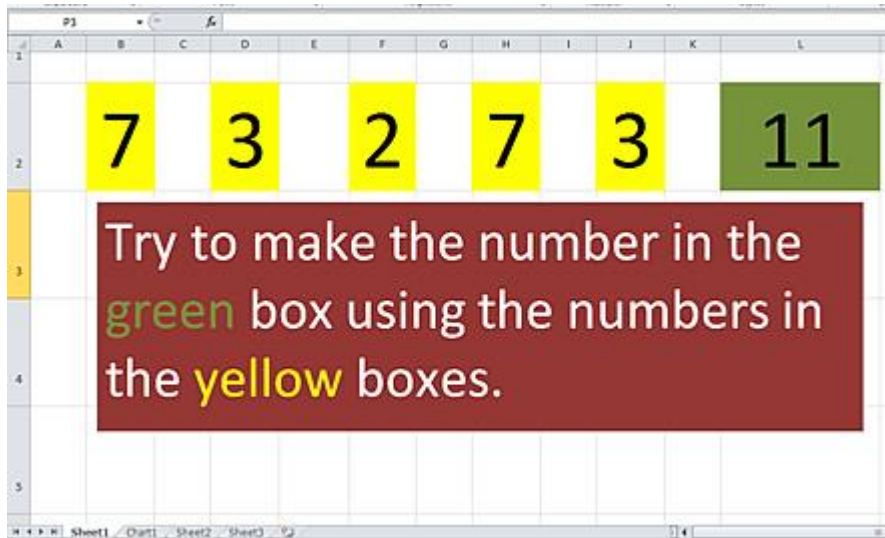
Allow children to play with the spreadsheet and explore “What if...” questions such as:

- what if I put my name in the yellow box, would I get three names in the orange box?
- what if I put a really big number in the yellow box?
- what if I put nothing in the yellow box? Is that the same as ‘0’?
- what if I put a negative or decimal number in the yellow box?
- what if I change the number in the orange box instead?

The likelihood of children changing the number in the orange box means that it is always wise to have an extra copy of the spreadsheet stored on the computer to open when formulas are accidentally removed.

Practising addition and subtraction facts

This spreadsheet provides five random numbers between 1 and 8, and a target number between 11 and 20. The yellow boxes contain $=INT((RAND()*8)+1)$ and the green box contains $=INT((RAND()*10)+11)$. New numbers appear each time **shift + f9** are pressed.

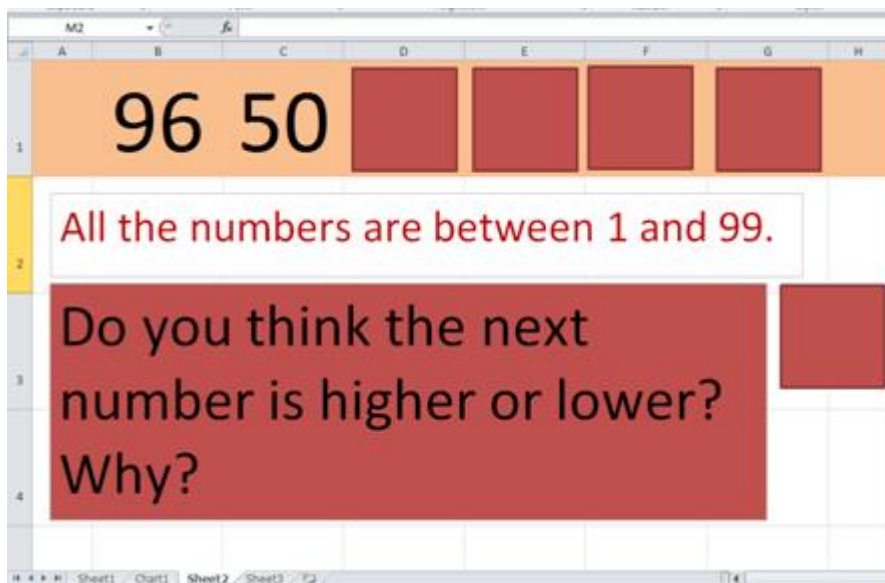


As well as giving children an opportunity to practise addition and subtraction facts through this activity, use questions and group talk to encourage problem solving, reasoning and communication. Try:

- what other numbers would you like to have? Why?
- are there any other ways to make the target with these numbers?
- how are you sure that it isn't possible to make the target with these numbers?
- is it easier to make lower or higher numbers?
- is it easier to make odd or even numbers?
- is it always / sometimes / never possible to use all the numbers?

Comparing and ordering numbers

This spreadsheet is created by entering `=INT(RANDBETWEEN(1,99))` into six cells. This generates whole numbers between 1 and 99. Each number, except for the first, is hidden behind a shape. The children can discuss and vote for whether they think the next number will be higher or lower. Model reasoning with statements such as "There are ** numbers higher, but only ** numbers lower, so I think it is more likely to be higher." Reveal the numbers under the shapes one at a time and provide an opportunity for children to discuss that the most likely outcome is not always the one that comes up.



Problem solving with money

To complement a garden centre role play area, or similar class theme, ask children to explore the cost of

buying combinations of different items on a spreadsheet. The cells in column M all follow the format $=H2*K2$ to enable both the price and the number of items to be changed. Ask:

- how much would it cost to buy a pair of gloves and a watering can?
- how much money would I need to buy three packets of seeds and a trowel?
- which two items can you buy for less than 30p? Are there any others?
- can you make the total exactly 50p? Are there any other ways?
- how much money do you think we would need to spend to start a new garden? Why?
- what if the price of seeds went up to 7p per packet?

Our Garden Centre													
1													
2	plant pots		10 p	buy	1	=	10 p						
3	seeds		5 p	buy	3	=	15 p						
4	gloves		20 p	buy	1	=	20 p						
5	trowel		15 p	buy	1	=	15 p						
6	watering can		25 p	buy	1	=	25 p						
7	TOTAL						=	85 p					

Print some completed spreadsheets to decorate the role play area, or for children to use as receipts.

To allow exploration of economic issues more realistically, children will ideally use more accurate prices as soon as they are able to interpret the values involved. Shopping websites are available for children to investigate the real prices of items, from which they can create their own spreadsheets. The ability to experiment with different combinations of purchases makes the spreadsheet a problem solving tool for real situations, such as planning a planting scheme for a school allotment, or the entertainments and refreshments for an end of Year 6 party.

ICT in the classroom - Spreadsheets for Probability and Data Handling

"... researchers believe that spreadsheets offer the potential to encourage students to explore and express mathematical ideas that they are likely to use when solving problems. The spreadsheets can help students move from specific examples to generalized relationships. According to Sharp (2003), one of the beauties of using spreadsheets is that it is possible to set up calculations, change some cell values and look at the effect on the results immediately. Today, it is clear that educational research supports the use of spreadsheets both in teacher education and K-12 classrooms."

[The Turkish Online Journal of Educational Technology](#)
– April 2011, volume 10 Issue 2

The NCETM has established an ICT group and commissioned Keele University to work with them. The National Centre microsite, [Using ICT and Digital Technologies for Teaching Mathematics](#), links to a set of seven skill zones for the use of ICT in Mathematics, including [Zone 5 – Spreadsheets for Mathematics](#).

Zone 5 - Spreadsheets for Mathematics

Although designed for use in commerce, spreadsheets can be used in a wide variety of ways to support mathematics teachers. They can be as useful in teaching situations, where mathematical concepts can be modelled, as in day-to-day administration.

- a. Managing cells, formulae, series, charts; statistical operations (including filters, pivot tables, frequency counts, histograms and tables)
- b. Making a spreadsheet interactive with slider bars, conditional statements and self-checking methods
- c. Knowing when Excel goes wrong, or does not quite get it right!
- d. Handling large datasets; selecting columns of data
- e. Converting data pasted from website when necessary using "Text to Columns"
- f. Sorting data; filtering data

In this issue, we look at some ideas that can be quickly prepared using a spreadsheet to develop understanding of probability and data handling.

■ Probability

Firstly, simulate a set of random data, where each of the outcomes is equally likely e.g. dice throws. Enter `=INT((RAND()*5)+1)` into a cell, then copy it into as many cells as you wish. Each cell now contains the outcome of one throw of the die. The saved spreadsheet will display a different random sequence each time it is opened. It is not as much fun as generating the data with real dice, but does allow a large number of outcomes to be collected quickly. Children can use the data to create frequency tables and graphs, and compare with their own collected data. Combined sets of data can be put together to look at how close the outcomes are to 1 in 6. Two dice can be simulated by having two columns of random numbers and a third where the outcomes are added together.

■ Line Graphs

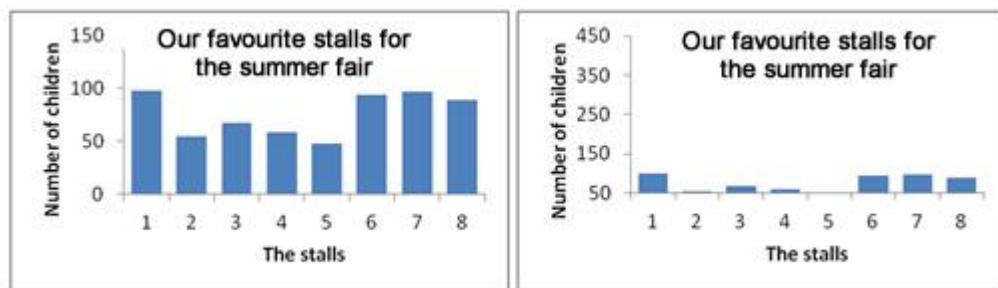
A similar method can be used to create a random line graph, which can be used to inspire line graph stories. Common themes for talking about a line graph through story are: 'A day in the life', 'The water level of the school pond' or 'The temperature in our classroom'.

A random shape line graph is created by entering `=INT((RAND()*100)+50)` into 10 or more cells in a column on the spreadsheet. Select the column and create a line graph of the data. So that the children are not distracted by the list of values, the list of numbers can be covered over with a solid shape rather than looking at the shape of the graph. The shape can also be moved aside when the values are wanted. Each time Shift and F9 is pressed, the screen will refresh and the graph will change.

Following these random data activities, some children may want to explore the functions used to make the list of random numbers. **INT** stands for 'integer', a whole number, and **RAND** stands for 'random'. Explore what happens to the set of random numbers when the values are changed.

■ Investigating scale

The way in which axis scale influences how a graph might be interpreted can be seen quickly through creating more than one graph using the same data. Click on the vertical axis to change the scale, including minimum and maximum numbers. If the example below was to do with activities at the school fair and the fifth activity was playing games, the right hand graph could be used to suggest that nobody wants to play any of the games at the school fair, which from looking at the graph on the left is not correct and could be considered as a misrepresentation of the data.



This is particularly effective when the data has come from a problem that the children have an investment in, and they have collected it themselves. Ask children to try different scales for their data using the

spreadsheet, and perhaps to use an inappropriate scale on their graph deliberately to help them convince others of their argument.

ICT in the classroom - Digital cameras and mathematics outside the classroom

In [Issue 26](#) of the Primary Magazine, we challenged you to find [10 things to photograph](#) over the summer holidays in a mathematical scavenger hunt:

Mathematical Scavenger Hunt

- parallel lines
- a right angle
- a picture to go with the number '5'
- an object where you can see one line of symmetry
- an object with rotational symmetry
- a repeating pattern
- an object that weighs more than a ruler, but less than a shoe
- an object approximately one metre tall
- a ratio of 3 to 1
- a picture that shows that $2 \times 3 = 6$

This time we explore the possibilities of children using digital cameras in a similar way, as a vehicle to consolidate their understanding of mathematical concepts and develop reasoning skills.

Collecting mathematical photographs outside the classroom incorporates physical activity, unusual locations, and images 'owned' by pupils, which should support memory recall of the mathematics involved. It gives children opportunities to use and discuss mathematical vocabulary purposefully.

On a mathematical scavenger hunt, children can be challenged to collect pictures to go with any strand of mathematics that is relevant to their learning. The example here is of a hunt that covers a variety of strands at different levels, and could be used as a 'one-off' reinforcement or enrichment activity, or where the focus is on developing reasoning. A scavenger hunt on a particular mathematical area is very useful for starting a unit of work as it lends itself to reviewing previous learning and informal assessment, and provides pictures that can be referred to throughout the unit.

Give scavenger hunt lists to small groups or pairs of children and allow some time before they start collecting photographs for them to discuss where they might find matching images, and clarify any unfamiliar language. With younger children give the list verbally, one or two items at a time.

For some pictures, you might ask children to include some way of proving that the photograph matches the statement on the hunt. For example, "An object approximately one metre tall" might not look one metre tall in the picture, so the group will have to either justify why it does match the criteria, or photograph something next to the object to get a sense of scale.

Some practical considerations before starting the scavenger hunt outside of the classroom

Ensure all children and additional adults know about keeping safe, consideration for others around the school, time limits, how to work the cameras.

These pictures were all taken by groups of children to match items on the Scavenger Hunt example above.



Match each picture to one or more of the items on the scavenger hunt list. Consider what you could say to prove that the picture matches the item.

Once children have collected their pictures, upload them to be displayed on an interactive whiteboard. Each group can challenge the others to decide which statement they were matching. They discuss and decide which list item is depicted in the photo and why. Probably, some of the images will fulfil the criteria for more than one statement and this will allow children to debate different mathematical aspects of the picture, and the IWB enables the pictures to be annotated to support the argument. Reasoning can be a difficult task for children and you may want to display some choices of sentence stems to assist them in putting their thoughts into words, such as:

- "I think ... because ..."
- "I know ... so I know that ..."
- "I (dis)agree because ..."
- "It reminded me of ... so ..."

ICT in the classroom - Programmable toys and more

Problem solving with programmable toys incorporates estimating and measuring with number, length, angles and time, and offers opportunities to make links with other areas of learning, particularly literacy, design and technology and science. It's no surprise that in their report, [Digital Technologies – A new beginning](#), BECTA and the NCETM recommend that one of the features of interactive use of digital technologies should be writing "short computer programs, for example for movements of 'roamers' on the floor". Aspects of mathematics can be explored through robots at all ages and levels of development, in the primary school and beyond. Different types of programmable robot will be needed depending on whether the activity will require the robot turning angles other than 90 degrees, and on the accuracy needed.

Robots and storybooks

What if the three little pigs in the story of the same name were robots, or travelled on a robot, from one house to the next in their story? The 'costume' does not need to be elaborate, as long as it is clear which

way the character is facing. A pig could be made with a pink paper spiral for a tail and a pink paper circle for a snout attached to the rear and front of the robot.



Any story involving steps on a journey can be used in the same way, for example *Going on a Bear Hunt*, *The Gruffalo*, *The Very Lazy Ladybird* or *Big Blue Train*. If you are sure that the context will not cause confusion between forward and back, and up and down, the stories of *Jack and the Beanstalk* or *Rapunzel* could also be used. Each step in the journey that the character takes needs to be given a place in the classroom. The easiest way to show this is with a photocopy of the appropriate page from the storybook. Children can programme instructions into the robot and move along with it, using the prompts at each stop in the journey to tell the story. If the exploration with the robot is part of a class theme, then the props used for the journey of the story, and for dressing the roamer, could develop and use skills learnt through design and technology, together with opportunities for

exploring shape, estimating and measuring with a purpose.

The mathematical activity can be made more difficult through including the need for turns to get to the next stop on the journey, or needing to programme the whole sequence into the robot, with a wait command of a number of seconds at each stop.

Robots – numbers, measures and time

Make a number track using the programmable robot. Start by marking the front and back positions of the robot on a large sheet of paper, mark the space under the robot '0'. Move the robot forward one step, mark where the front of the robot reaches on the paper and mark '1' in the space under the robot. Continue to create a number track for the robot. If appropriate, the number track can also continue to the left to show negative numbers for moves that take the robot back beyond zero.

Create a time track by programming the robot to travel forwards in a straight line beside a piece of string for the longest distance possible in the space that you have. Ask the children to mark the point on the string that the robot is passing after 5, 10, 15 seconds.

Time how long the robot takes to do a full turn (360 degrees). Does it take half the time to do a $\frac{1}{2}$ turn? What about a $\frac{1}{4}$ turn? What other angles, or fractions of turn, could we estimate? Work out how long it would take the robot to get to somewhere in the classroom, school or further afield. Depending on the geography of your setting, it may be possible to find a real purpose for your robot by having it deliver messages between classrooms or the school office.



Robot sports

Robot synchronised swimming can create an exciting spectacle! If you can find a way to video the outcome from above, the resulting resource could be used to explore rotational symmetry and makes a wonderful film for celebrating mathematical work in assembly or to parents. Because the same sequence of instructions must be repeated for each robot there is a real reason for children to write their programme down. The programme can be as simple as a set of arrows, for example: $\uparrow \uparrow \rightarrow \downarrow \leftarrow \leftarrow$ written using whole words or sentences, or written in LOGO.



You may want to let children explore their own ways of communicating their sequences before suggesting how to make them clearer or more efficient.

Create a ski slalom for your robot with gates to travel through and time penalties, practising measures, angle and time along the way.

You could try 'robot curling'. Use more than one robot as 'stones' and the children should program their robots to move around a course that involves avoiding the 'stones'. Include strategies to block – older children may start speculating on the lengths of sides on a right-angled triangle as they try to avoid other stones.

For something that appeals to the dancers in your class, try robot figure skating. Agree on a scoring system that recognises intricate or challenging moves such as a 360 degree turn, skating backwards, zigzags or a figure of eight.

Research and CPD

In September 2010 the National Centre published a report on ICT in conjunction with BECTA, [Digital Technologies – a new beginning](#). The report offers a thorough consideration of the issues relating to ICT and mathematics, including:

“One of the features of interactive use of digital technologies in mathematics classrooms is that:

learners are engaged and actively involved in the exploration and making sense of mathematics (using digital technologies) through meaningful activities that make connections across all areas of mathematics.”

ICT in the classroom - Using Video and Animation



Creating video and animation can add an exciting dimension to mathematics lessons. Children can be creative and take ownership of their learning through producing films that are a product of their mathematical understanding.

Video and problem solving

A simple way to start is with worded problems. Interpreting what a problem is asking exactly, is a huge part of problem solving. Give small groups a word problem to consider, for example: “*Stuart and Rhys bought a*

packet of 45 bars of chocolate. They ate one fifth of them on Saturday. They ate a twelfth of the remaining bars on Sunday. How many bars did they have left?"



Ask the children to film themselves while they act out the problem, and then the solution. To share the problem-solving experience with the whole class, the group shows the first part of their video for the rest of the class and asks the others to write or say what they think the word problem was. After discussing what the word problem could be, they solve it and then watch the second part of the video, showing the solution, to check their answers.

The same strategy can be used for sharing logic puzzles, but with these problems the process of solving the problem is filmed as well as the context and the solution.

Here is an example:

Mr Young was interviewing five children to find out who had eaten the raffle prize, a beautiful cake, at the Christmas fair. This is what each child said:

Anya: "It wasn't Emily, it was definitely Bethan."

Bethan: "It wasn't Charlotte and it wasn't Emily."

Charlotte: "It wasn't Anya, it was Emily."

Dee: "It was Charlotte and it was Bethan."

Emily: "It was Dee, it wasn't Anya"

Each child told one lie and one truth. Who ate the cake?

One way to solve problems such as this, is to choose one of the children in the problem at a time as the child who ate the cake and see if that makes the statements correct. The children solving the problem could film what would happen for each of the options to play back when the class makes their choice.

Try setting up a camera, fly-on-the-wall style, to record individual children or groups working with mathematical apparatus or on a problem for review in a plenary. Ask *What was ...doing / learning? Why did you choose that ... method / equipment?* Be aware that you might want to review the video with the children concerned before sharing with the whole class, so it may not be available to use in the plenary of the lesson in which it was filmed.

Video and animation for exploring and sharing patterns

To explore repeating patterns, children can create and film their own repeating dance routine with a specific

number of steps. Watching the dance, children can consider all the questions usually associated with repeating patterns, such as *What will the next move be?*, *How many moves will the group have to do to get to the 4th jump?* and *If the dance continued, what would the 100th move be?* Discuss which questions we can check using the video, and which we will have to prove a different way. Similarly, children can create a pattern by being videoed stepping around a floor hundred square to a particular rule e.g. even numbers, starting on 3 adding five, for other children to guess the rule and continue the pattern.

Stop-frame animation can be used to show patterns of shapes or numbers extending and repeating. The children should start by creating a storyboard of the pattern they will film. Then all they need to do is create the first section of their storyboard with a practical resource or modelling material, fix the camera into position and film one second of each storyboard section before changing the scene to the next. The stop-frame animation can become more complex if the experience of the children allows. Consider creating a bank of videos for children to access to support their learning in different units.

Video for explanation and communication

Children can record explanations in mathematics as a documentary, news report or children's educational programme.

A news report in a mathematics lesson might go something like this:

Presenter
(Jessica): *Today, children in Class 5 found out that two even numbers added together will always make an even number. Phoebe is in the classroom with more information.*

Reporter
(Phoebe): *Yes, Jessica. Here in this classroom, this morning, children first tried out these calculations (holds up whiteboard) which suggested that the statement about addition was true. They then went further by using resources such as these (points to resources on the table) to prove that it was always true. Ethan and James were part of the group that made this discovery. James, tell me what happened.*

Interviewee
(James): *Well, we saw that all the even numbers we added together made even numbers so we wondered if that was always true.*

Interviewee
(Ethan): *We found out that even numbers always look like this (points to arrangements made with a resource) and can be made up by pairs of cubes. When we put any two even numbers together the answer can also be made with pairs of cubes (moves to groups of cubes together and points to the new group made) so that is even too.*

Reporter
(Phoebe): *Thank you. So it's true. Two even numbers added together will always make an even number.*

Although this type of role play can be carried out without filming the activity, the resource it produces can be used to celebrate mathematics work and reinforce concepts soon after the lesson, to remind children of previous learning when returning to the strand of mathematics later in the year and used with other classes and year groups to introduce concepts.

ICT in the classroom - Using email



Audience and purpose are essential for good quality data handling enquiry and effective problem solving can rarely be separated from effective reasoning, so an efficient communication tool such as email should probably have a place in mathematics education. Writing electronic messages can have its limitations for young children due to typing speed and a lack of experience of appropriate writing styles, but can add an engaging dimension to their mathematics learning.

Using email with mathematical problems

A good place to start is to find a context where children are not expected to continue extended conversations. The “Submit a Solution” facility on NRICH creates a safe environment for children to type their ideas about their mathematics into a computer and possibly have it published and commented on by someone outside school. Imagine the children’s reaction to reading:

“What fantastic work – I love the way you have begun to ask your own questions and explored things that interested you. You also worked very systematically to find all the possible combinations of totals on three dice, which is very helpful in answering this problem. It makes me wonder ... will a dice always have an opposite face, no matter how many faces it has?” (Response to a problem solved in the [October 2010 issue](#)).

For emailing within the class or school, consider children setting mathematical puzzles via email, sending solutions and thinking about what hints could be given. Try to develop a culture of: “I enjoyed this mathematical problem / puzzle, and thought you might too.” In the same way that many people often send pictures and jokes.

One possible plan is to email children in the class one brainteaser-style puzzle for each group. They solve the problem and send a reply. Then the children choose someone else in the class or school to forward the puzzle to. Give children sentence templates to help them phrase their answers with an explanation e.g.

- “I think ... because ...”
- “It can’t be ... because ...”
- “Some examples are ...”
- “... is ... and ... is ... so the answer must be ...”
- “I found the pattern ... so ...”

These could be copied onto card and stuck around the computer screen. Simply phrased statements could also be investigated in the same way, such as:

- the sum of three odd numbers is always odd.
- multiples of four must end in 0, 2, 4, 6 or 8.
- any odd number can be made by doubling a number and adding one.

Good places to find these types of problem are [NRICH](#), [brainbashers.com](#), and [primaryresources.co.uk](#).

If the problem is embedded in the text of the email there are limited opportunities to provide an image or model to support understanding the problem or templates to help with recording. Consider putting links into emails for external sites, for example, [this PDF file](#) from primaryresources.co.uk uses a caterpillar to help children with their work.

Using email with ‘real-life’ problems

Communicating by email can become particularly inspiring when used to role play in an authentic context. If the children have set up an ‘enterprise’, then an adult in the guise of ‘customers’ or ‘clients’ can contact them with relevant questions and requests. The children can respond with calculated cost of products and solve the required problems.

Ask permission from parents and other stakeholders for children to email them with short surveys for use in school. The children may be interested in formulating a questionnaire based on something that the school leadership team want to find out about, for example, provision for pupils travelling safely to and from school. Questioning language has to be more precise in a survey that will be completed remotely, and children will need to discuss and manage decisions about what people will answer and how they might answer it. The nature of this type of data collection is that some of the responses may not be complete, or returned in a format that the children can easily use.

Liaising with another school can provide further opportunities for 'real-life' mathematics in comparing data from different localities. The same survey can be carried out at both schools, e.g. traffic survey at a particular time of day, rainfall data collection, preferences in foods or activities. In comparing the data between the two schools, the pupils can see the teacher realistically modelling how to draw conclusions or form further questions because they know that the teacher does not already know the answers.

Short mathematical activities using email

[Transum](#) suggests using email in this quick starter activity:

In the first minute of the activity each person is to send an email to the teacher. The subject of the email must be "Number" and in the body of the email there must be a positive whole number (Natural Number). The winner is the person who emails the smallest number which nobody else has chosen.

Other lesson starter activities using email include asking students to type in the most:

- mathematical words beginning with the letter 'm'
- numbers in the 13 times table
- mathematical words which begin with the last letter of the previous word, beginning with the word 'subtract'
- famous mathematicians
- units of measurement
- things they have learned in maths this year.

And finally...

If I send an emailed puzzle to five friends one day, and they each send the puzzle to five different friends on the next day, and the day after those friends send the puzzle to five further friends each; how many people have the puzzle? (Hint - Don't forget "I"). If the pattern continues, how many days will it take for over 10 000 people to have the puzzle?

ICT in the classroom - Using the internet for real data handling

The internet is a rich resource for investigating and analysing a wide range of real data that can be used for problem solving across the curriculum. There are also databases available to be searched under most themes imaginable.

An easy place to start is with the [CensusAtSchool project](#). The site has real data arranged under curriculum areas covering themes such as Victorian childhood, healthy eating, and environmental issues. The worksheets and teachers notes offer thought provoking questions and lines of enquiry, as well as opportunities to consider the accuracy and usefulness of data collected.

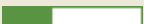
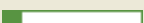
Sports are bursting with statistics, and one set of data that children might find interesting is that of Olympic Games results and world records. Some information on this theme is available through the [Centre for Innovation in Mathematics Teaching](#), where children can answer questions directly from the tables such as 'Who won the Men's Marathon at the 2000 Olympic Games?' or 'What was the time difference between first and second place in the Women's 100 metres?' They could otherwise create graphs to show the numbers of medals won by different countries in different years, considering trends over time.

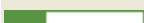
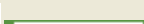
Rather than rely on datasets already collected, children can access information to make up their own that more precisely answers their own needs. Using a website such as [mySupermarket.co.uk](#), children can compare prices of foods from four different supermarkets to follow an enquiry linked to the budget for a class party, or pricing a recipe for food to make for the Christmas fair.

For a chance to both collect your own data, and then compare it with other datasets go to The Royal Society for the Protection of Birds (RSPB) [Big Schools' Birdwatch](#), which includes a facility online for making many different types of graph and chart with their sample data and participate in a nationwide data collection event. [Little Schools' Birdwatch](#) has resources dedicated to inspire three- to five-year-olds, or

for more in-depth information try the general [Birdwatch pages](#) for statistics about all the birds seen in last year's collection.

How about a holiday or hotel break? Sites such as tripadvisor.co.uk allow customers to rate their experiences of different holidays and hotels. These two summaries are from hotels in Leeds which both get an overall score of 4/5 from the reviews. Can the children argue persuasively which they think is the best hotel based on the statistics? Use this opportunity to discuss what 'average' means and how different averages might be used. Ask the children to present an argument for what average is the most important in choosing a hotel.

Show reviews by trip type and rating			
All reviews (229)	82% of travellers recommend		
	 229 reviews		
Business reviews (62)	Excellent		83
Couples reviews (89)	Very good		93
Family reviews (11)	Average		20
Friends getaway reviews (19)	Poor		21
Solo travel reviews (34)	Terrible		12

Show reviews by trip type and rating			
All reviews (64)	81% of travellers recommend		
	 64 reviews		
Business reviews (16)	Excellent		33
Couples reviews (35)	Very good		16
Family reviews (8)	Average		10
Friends getaway reviews (2)	Poor		3
Solo travel reviews (12)	Terrible		2

The [BBC Weather](#) site allows us to compare weather between regions or countries around the world. We can pose the question 'How accurate are the BBC weather forecasts for our town?' and compare the forecasts with data collected at school over a period of time. As winter approaches we might even be able to use this to introduce negative numbers in the context of temperature, and learn how to plot negative numbers on a graph.

Many organisations have databases available to customers and the public online. The [Royal Horticultural Society \(RHS\) Plant Selector](#) allows us to search through an enormous number of plants. Try working with children to find plants to put into a Carroll diagram. In the diagram below, the blue area represents an area of the school that is ready for planting. Fruit or herbs are to be planted at the front of the bed where they will be more easily harvested, and the left hand side of the bed is against a wall that provides some shade. The diagram could be completed on the screen either using photographs or text from the RHS website.

	Partial Shade	No Shade
Not edible		

Edible (fruit/herbs)		
----------------------	--	--

The children could make their own mini database for planning a garden or making a plant catalogue, choosing which statistics and information should be included and the order in which the entries will be arranged to help them be found easily.

Other online database ideas

Estate agency sites such as [Rightmove](#) can be used for sorting pictures of homes into an on-screen Venn diagram, choosing two categories to compare, such as more than two bedrooms, not more than £200 000, terraced, no garage etc. Perhaps you might develop the idea further by creating the children's own database of real or imagined homes to be used in mathematical role play.

Colchester Zoo has a [database of its animals](#) which can be browsed through by animal name, or searched for a particular feature. Try sorting animals by continent of origin, or whether they are carnivores or herbivores. Allow children to discuss and come up with their own ways of presenting the information about the animals that they find interesting.

The British Museum has a [database of its collections](#), where children can search for artefacts relating to a historical theme. Each file includes measurements of the object. Why not make your own class museum? Recreate objects to scale, consolidating measurement skills, and consider different ways of arranging the objects in the museum, for example, along a timeline, by the object's material, or by its use.

Often when the children access information on line they are searching a database. Exploit any opportunities that arise when the searches are not successful. Are the criteria available for the search useful, too many, too few, do the results match the search? How could the database / search engine be better designed? You might even consider using the organisations as an audience for the children's mathematics work by allowing them to contact the organisation with feedback about the websites and information about the enquiry they have undertaken.

ICT in the classroom - ICT to enhance the plenary

Whether embedded at strategic points within a lesson to review progress and move learning forward, or as the conclusion of a lesson to evaluate and consolidate, the plenary is a good opportunity to focus the children on the most important aspects of their learning and crystallise understanding. ICT can be used to make more efficient use of the limited time usually available for this part of the lesson.

Using the plenary for prepared group feedback can give purpose and an audience for the children. Unfortunately those who are not presenting can sometimes become passive or disengaged. This can be solved by the group not just feeding back, but challenging their class mates, which is particularly empowering for children working at a lower level. For example, in a differentiated problem solving lesson such as 'Lollipops' from [Problem Solving with EYFS, Key Stage 1 and Key Stage 2 children: Finding all Possibilities](#), the children can take photographs with a digital camera of the different ways of making 6p with coins. One feedback challenge could be for a group to show a photograph of the coins, with some covered, on an interactive whiteboard so that other children could decide what might be under the cover to make the total up to 6p, and if there are other possibilities:

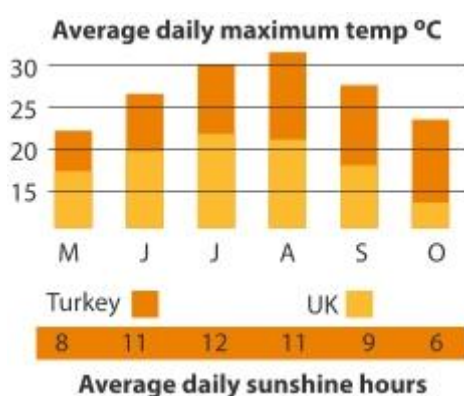


To encourage discussion about being systematic, a group could display their first three possibilities by having the photographs embedded in a presentation, then challenging the others to work out their pattern and decide what arrangement of coins comes next:



In either example, ICT can be used to quickly show a number of pieces of children's work, and allows an instant reveal of the solution which all the children can see. Taking this a step further, learning can be consolidated by a group preparing and video recording an explanation of a mathematical process or skill they have learned, with the purpose of it eventually being used with another class. This should involve high-level discussion about the steps needed to be successful in that aspect of mathematics. In the plenary, the whole class can review the video, suggesting improvements that would make the concept clearer. A collection of these videos would make an excellent resource to be used again and again. Examples of mathematical concept videos can be found online, which start children considering concise explanation and good use of mathematical vocabulary, images and resources. Try the BBC Learning Zone for clips such as [Numberline 0 to 1](#), showing ordered fractions by converting them to fractions with a common denominator.

The plenary offers the opportunity to bring a concept that is being rehearsed and consolidated into 'real-life' situations, so developing the skills of using and applying the mathematics. A visualiser is a type of document camera that will send images of anything placed on it directly to appear on screen. A similar effect can be produced using a video camera or webcam. With this resource, any page from a newspaper, sales brochure or takeaway menu can be immediately shared and annotated with the whole class to solve problems. Here are a couple of examples:



What is the average daily maximum temperature for the UK and Turkey in June?
 Discuss and explain what "average daily maximum temperature" might mean.
 In which month is there the biggest difference in temperature between the UK and Turkey?



I am going to order king prawn fried rice, chicken chow mein and a mushroom omelette. Which menu is the cheaper?

Objects can also be placed on the visualiser or captured through a video camera linked to the screen. Try numbers of objects to estimate or arrange into an array to make them easier to count. A selection of objects can be shown together for children to discuss how they could be sorted or to reason and explain which might be the odd one out.

Assessment for learning can be strengthened through thoughtful use of projecting children's work and examining it against success criteria. This will only work where evidence of the success criteria can be found through written work, for example, one part of success criteria in a lesson about measuring might be 'the measuring cylinder must be on a flat surface', clearly this will not be apparent in a child's book. However, a child's work about solving problems systematically or labelling a graph could be used and would be helpful in encouraging reflection from the class and consolidating learning in those areas. Plenaries are a great opportunity to celebrate success and progress in mathematics. Work selected to be analysed or photographs taken of children working successfully can be displayed in the classroom, after being shared, to develop confidence and promote positive attitudes to mathematics.

An IWB screen at the end of the lesson showing the learning objective and either traffic lights or smiley faces to enable pupils to drag their name to the relevant place, gives the teacher an opportunity to record pupils' self assessments easily.

ICT in the classroom

Collaborative problem solving using an interactive whiteboard

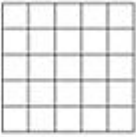
Mathematics is not always considered to be a social activity, but engaging children in collaborative problem solving can provide rich opportunities for reasoning, communicating and supporting each other's learning. An interactive whiteboard (IWB) can facilitate collaboration by giving children a shared point of focus, easily seen by the whole group. The IWB can simulate problem solving with practical equipment through the use of 'objects' that can be moved around the screen. Jottings can be made and diagrams annotated directly on to the screen. Listening in on conversations while children work collaboratively is probably the only way to accurately assess preliminary levels in reasoning and communicating.

To get started, try some puzzles from [Mathematical challenges for the more able in Key Stages 1 and 2](#). These can be easily converted into IWB files. If you wish to use a facility to help you to do this and to locate your files without any difficulty, you could use these [planning folders](#), which are linked to the primary framework blocks and units under the heading *Planning from the Framework*.

Activities like *Odds and evens*, below, from Year 4 Block D Unit 1, are ideal for introducing children to working together at the whiteboard. The graphics are simple.

Odds and evens

You need 13 counters or coins.



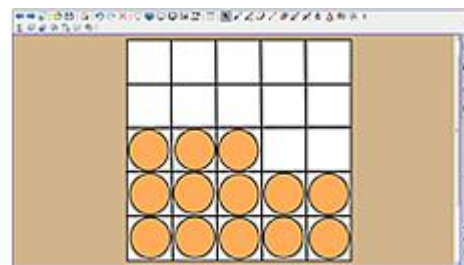
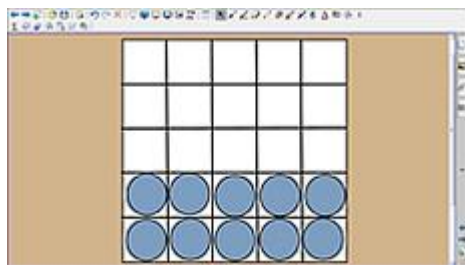
Draw a 5 by 5 grid.
Put counters on it.
You can put only one counter in each space.

- Place 13 counters.
Get an **odd** number of them in each row and column and the two main diagonals.
- Place 10 counters.
Get an **even** number of them in each row and column and the two main diagonals.

Teaching objectives
Solve mathematical problems or puzzles.
Recognise odd and even numbers.
Explain methods and reasoning.

43 Mathematical challenges Puzzles and problems for Years 3 and 4

Activity usage:
Slides 2 & 3 are as per the set problems.
Can pupils identify each row, column and the two main diagonals? What are the odd/even numbers of counters which would meet the problem's requirements?
Having found a solution are there alternatives? Are these different or rotations? Can a solution be found without fives, ones or fours in it?
What strategies are children using?



The problem can be accessed through trial and error initially, then by applying strategies and checking against a simple rule – the number of counters in a line must always be odd or even.

Another place to look for problems to solve collaboratively on screen is the NRICH website, where some of the problems, such as the Stage 1 puzzle [Chain of Changes](#) have an interactive feature.

There are many simulation software products intended for use in primary science that have mathematical problem solving aspects to them, for example a simulation that shows how different sizes of [parachute](#) behave, or where the children need to experiment through trial and improvement how much sun and water is needed for a plant to grow successfully at [KS1](#) or [KS2](#) levels.

Equally, problems such as making a screen turtle travel through a maze or creating a pentagon, can be solved as a group using a programming language.

When making your own interactive screens include moveable objects, space for jotting and calculations, and hidden clues or solutions that can be revealed by moving a panel. This problem-solving screen has a moveable frog to help children explore the problem practically.

Jottings
Use this space to do calculations or organise information

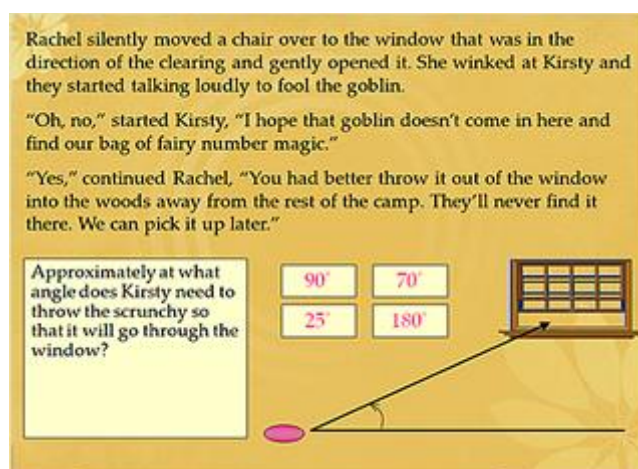
Move this box to reveal a hint.



Freddy Frog is 30 metres below sea level. He wants to climb 50 metres above sea level so that he can visit Batty Badger. Each hour he climbs 10 metres up but rolls back 5 metres. How long before he meets his friend?

Alternatively, presentation software such as PowerPoint can be a very effective way of presenting word problems. The children cannot move objects around the screen, but the presentation can introduce the

problem in stages and slides can include buttons to show multiple choice solutions, so that the children can enter their solution and be taken to a congratulations slide, or further support with models, images or hints. Worded problems can even be put together to form an adventure story as in the extract here:



Presentation software can also be used by children to create presentations showing the steps they have used to solve a problem which they can present to the class or a wider audience at, for example, an assembly.

For more open-ended problem solving requiring real-life data, for example planning a class party within a budget, working at the IWB allows easy access to the internet and information can be copied directly on to the problem solving screen. Other benefits of using ICT include the facility that the screen is easily reset if the group decides that they have reached a dead end, and work can be saved at different stages and stored for revisiting later or to continue investigations that go beyond a single lesson. The IWB can be both visually stimulating and support kinaesthetic exploration and learning through moving onscreen 'objects'. Using a microphone, children can also record verbal explanations with their work. The interactive whiteboard enables children to model a problem, work systematically and communicate ideas in an innovative way.

Younger children in particular may struggle with organising roles within a group, especially when only one child can interact with the board at a time. Allow thinking time for the children and keep all children involved with solving the problem by providing individual whiteboard slates and pens so that they can try out ideas on their own or in pairs before bringing them to the group. Initially, it might be necessary to structure children's groups while they are developing their speaking and listening skills, with rigid rules about taking turns at the IWB. Some groups may be able to work effectively by nominating a scribe at the board who is not allowed to write up or try out their own ideas until everyone else has had their say.

ICT in the classroom

Audio Recordings

Incorporating recorded sound into mathematics enables children to independently engage with the mathematics no matter how fluent their literacy skills. It can facilitate children hearing mathematical vocabulary in context, and using mathematical vocabulary purposefully.

Through these activities, consider how sound stimulates thinking and learning in a different way to the visual and kinaesthetic, and what experiences children need to have had, to visualise and apply what they hear.

Small devices which can record 10 or 30 seconds of sound can be purchased from education resource retailers, or some novelty items, found in high street stores and supermarkets, can also record small

amounts of speech. You can also use the new facility in the Learning Journal in your NCETM Personal Learning Space if the children are able to sit near your computer or a laptop.

Sorting and matching

Provide opportunities for children to sometimes experiment individually, and other times collaboratively, to match objects, pictures, symbols, and even other recorded sounds or words, to a recorded mathematical word, and collect the set together in a tin. Alternatively, encourage reasoning and negotiating meaning through taking objects, pictures and symbols one at a time out of a tin and asking 'What do you think is recorded on the button?' This is particularly engaging and empowering for pupils when they have created their own recordings for sorting by their own criteria and can lead the activity themselves.

Giving precise mathematical instructions

Adults and children can both be involved in recording instructions for others to use. Try creating a 'treasure hunt' using recordable buttons hidden around the learning environment. Each button gives clues to where the next button is located. This could be early positional language such as 'look under the sand tray', to 'find the button located at co-ordinates (2, 3) on your map' or 'find the next button at 2m West, 1.5m North'. Time limits built into recording devices can be used to encourage concise and precise instructions when children are recording their own instructions.

Collaborative problem solving

Audio recordings can support collaborative problem solving by allowing all participants access to the problem, or clues, simultaneously. Individual clues to an ordering problem can be recorded onto different devices. Each child, or pair, listens to one piece of information. Because they receive the information aurally, there is greater necessity to summarise and prioritise the information relayed to the group, instead of reading it aloud with its original phrasing from a piece of paper. Encourage children to listen to the clue more than once to identify what might be important to solving the problem.

Try this example in the context of rebuilding an accidentally destroyed shop display before the manager gets back. The four items on the display were a set of pens, a skipping rope, an elephant statue, and a teddy bear. What order were they arranged on the shelf?

- the set of 24 gel pens in a plastic case was next to the large, grumpy teddy bear
- the elephant statue was faded on one side because it was on the end of the shelf, next to a window
- the pink, extra long skipping rope was not on the end of the shelf, and it was to the left of the teddy bear.

Solution: elephant statue, skipping rope, teddy, pen set.

Giving a purpose for problem solving

Messages can be pre-recorded onto mobile phones and answer machines to direct or encourage mathematical thought in role play situations and areas. Enterprise style contexts, a type of engaging "real-life" problem solving opportunity where the children work together to develop and market products or services at an appropriate level for their development, can be further enhanced by the children receiving telephone message orders from "real" customers. It's even richer if the message gives the criteria the children need to meet to satisfy the customers needs and asks them to recommend the most suitable product or develop a product to meet the need.

Patterns and sequences

To explore pattern through pitch, volume, rhythm or number, provide children with recorded sounds to sequence. Give the children reasoning sentence stems such as "I think the pattern is ... because ..." to support them in explaining the sequences and patterns they have made. Encourage children to continue given patterns and create their own.

ICT in the classroom

Code breaking - with calculators

The Calculator Code

 The exciting context of secret messages, codes and espionage inspires this use of ICT for Key Stage 2 pupils.

The calculator can be used to encode parts of text using calculations to spell words upside down on the screen. 0 becomes O, 1 is I, 3 is E, 4 is h, 5 is S, 6 is g, 7 is L, and 8 is B. So 'globe' can be made by entering 38076 and turning the calculator upside down, or by entering 19038×2 to achieve the same result.

This concept can be presented to children at three levels. At a basic level, children can start to break prewritten codes. This helps them to become more familiar with calculator operations and interpreting the screen, while increasing their understanding of the necessity for accurate use. Usefully, code breaking is self-checking – if the process has been carried out correctly, real words appear!

Try breaking this code with a standard school calculator and consider what calculator or mathematical skills are needed or developed to solve the puzzle:

7700 +18 hurt 1000 - 486 91 x 7 on the 15428 ÷ 2, 2 ÷ 4 $\sqrt{1156}$ had to 3 788.04 ÷ 0.01. $857^2 + 3$
602 said "6.9606 ÷ 9" and gave him 56.63×100 to 6 + (3788x100).

Much more mathematical thought is required for writing these codes than breaking them. The concept could be introduced as a problem solving activity linked to finding different possibilities and sorting. First, set the children the task of recording which letters can be made on an upside-down calculator. They can work collaboratively to discover the words that can be made with those letters and will soon discover that the word needs to be entered backwards to make it correct when the calculator is turned. Encourage them to use a systematic approach to collecting and arranging lists of words that can be encoded, include opportunities for sorting using their own criteria and explaining their reasoning for doing this in their particular way.

With the set of words, start recording and sharing different calculations that could be answered to make some of them. Groups of children might decide on one particular function to apply to every word to create their code. You could restrict the function to multiplying by a number from 1 to 10 for example, if the function code is x4 then 'hog', which is made from 604, would become 2416 in the coded message. This gives other groups the chance to try to break the code using their knowledge of multiples of different numbers or inversions. Can the children predict any problems with using a x10 or ÷10 function code?

Depending on the children's experience, this is an excellent opportunity to encourage the use of the calculator memory for calculations that involve more than one step, including brackets. For multi-step quick problems to solve, try displaying the calculations in a picture clue, for example, $(41 \times 25) + 67^2$ displayed inside the outline of a snake, or $(4 \div (101 - 96)) \times 0.1$ inside a ghost. It's fun to observe how creative the children can be with their own calculator code picture clues!

One of the most powerful uses of the calculator in the primary classroom is for developing an understanding of the inverse calculations or missing number problems.

Calculator code breaking can give us an exciting purpose for solving problems. Why not try this example with a spy scenario...

You have intercepted a message. You've just started to destroy it when you realise that it needs to be replaced in the spy's pocket so that he does not know that you have broken the code! The decoded message reads. "Meet Bob at the Globe Theatre."
Work out the original coded message so you can recreate it and fool the spy!



If you are feeling inspired by code breaking you should find the article [The Secret World of Codes and Code Breaking](#) interesting. The [NRICH Code Breaker](#) resource is worth exploring, it includes an on-screen interactive code breaker, ideal for collaborative problem solving.

ICT in the classroom

Interactive whiteboard technology

Taking inspiration from archaeology, this idea introduces activities that can be shared with children at many different levels. Covering aspects of measures, data handling and co-ordinates, it is perfect for a mini-project that crosses over from Block C to Block D of the Primary Framework. There are also opportunities for cross-curricular links with history and literacy.

Here's what to do...

Set up an interactive whiteboard page with a soil or sand background colour. Insert images of objects onto the background, fixing the objects in place, then paint over the whole page in a similar colour to the background. This becomes a patch of ground which archaeologists believe is filled with important artefacts. These artefacts, too fragile to be moved, must be revealed and catalogued before the site is covered over for future generations.



Allow children to start exploring the 'site' in a small group, with soft paintbrushes in place of the board eraser. Direct children towards considering what information should be catalogued about the artefacts. What information is needed for historians to understand the objects and the site? How can we let future archaeologists know where to find objects once they have been reburied? Depending on the age and experience of the children, choose suitable measures of length, decide how to divide up the site using grid lines and plot co-ordinates of objects. Collect information about the frequency of different materials or objects found, creating a database of artefacts. Once the site is covered over, use information from the database to make representations of the discoveries, draw conclusions about the site making reference to the data, and finally use records of position to check that the artefacts can be rediscovered.

Ideally make the activities richer through cross-curricular links to historical periods being studied in class. Otherwise, try inspiring interesting science-fiction genre writing by using unusual objects on a far-away planet, or drawing together a character portrait in literacy linked to the artefacts.

Although using real objects and a sand tray has many benefits, using the interactive whiteboard enables sharing a variety of images with the whole class, which should encourage collaborative reasoning and explanation with reference to the images. Using ICT enables resetting the images for testing children's ideas and allows the teacher to control the variables e.g. size, number and orientation of objects, to match their stage of development. Some children may need the experience of discovering and discussing objects in a sand tray first.

