Integrating ICT into mathematics in Key Stage 3

Appropriate use of ICT can enhance the teaching and learning of mathematics in Key Stage 3. It is also an expectation of the National Curriculum that teachers will use ICT in teaching mathematics.

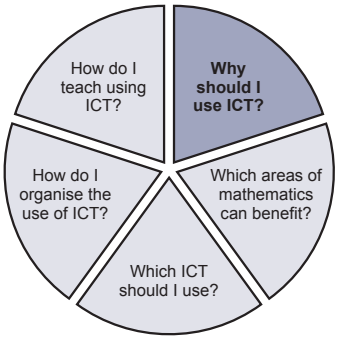
> *During the key stage, pupils should be taught the knowledge, skills and understanding through … tasks focused on using appropriate ICT [for example, spreadsheets, databases, geometry or graphic packages], using calculators correctly and efficiently, and knowing when it is not appropriate to use a particular form of technology.*
>
> *(National Curriculum programme of study: mathematics, Key Stage 3)*

Since Babbage developed the first calculating machine, computers have fundamentally influenced the development of mathematics … and mathematicians have fundamentally influenced the development of computer applications. As mathematics has developed through the use of computers so, too, has the use of computers altered mathematics teaching. Indeed, the use of ICT has a central place in the teaching of mathematics.

Computers offer powerful opportunities for pupils to explore mathematical ideas, to generalise, explain results and analyse situations, and to receive fast and reliable, and non-judgemental, feedback. Their use needs careful planning – not just of the organisation of hardware and appropriate software but also of activities that allow for off-computer mathematical thinking as well as on-computer exploration.

This document aims to help teachers to be aware of the different possibilities offered by ICT and to use ICT to enhance the teaching and learning of mathematics by addressing five interrelated key questions:

An appendix (page 17) lists where ICT is referred to in the supplement of examples of the *Framework for teaching mathematics: Years 7, 8 and 9*.



Why should I use ICT?

It is important to understand the opportunities that ICT offers and to be aware of the ways that it can enhance the teaching and learning of mathematics in Key Stage 3, before considering what ICT is available or how a particular piece of software might be used within a mathematics lesson.

ICT resources are not a panacea for all eventualities. In some situations they will be the best way to convey or consolidate a new concept, but not always. ICT needs to be planned carefully into departmental schemes of work so that pupils make good progress. Teachers can check whether the use of ICT is appropriate by asking whether it will:

- *allow pupils to investigate or be creative in ways not possible otherwise;*
- *give them access to information not otherwise readily available;*
- *engage them in the selection and interpretation of information;*
- *help them to think through and understand important ideas;*
- *enable them to see patterns or behaviours more clearly;*
- *add reliability or accuracy to measurements;*
- *enhance the quality of their presentations;*
- *save time, for example, spent on measuring, recording or writing.*

(Framework for teaching ICT capability: Years 7, 8 and 9, page 43)

There are three aspects of teaching and learning mathematics that might benefit from using ICT: pedagogy, mathematics and organisation.

Pedagogy

Will using ICT help me to teach mathematical facts, skills and concepts more effectively? Will using ICT help increase pupils' knowledge, give them an opportunity to practise and reinforce some mathematical skills, or improve their mathematical understanding?

Mathematics

Will using ICT help pupils to calculate results, produce relevant tables and draw graphs, or solve mathematical problems?

Organisation

Will using ICT help pupils to organise, present and refine their work and communicate their findings?

Pedagogy

Decisions about when and how ICT should be used to help teach mathematical facts, skills or concepts should be based on whether or not the ICT supports effective teaching of the lesson objectives. The use of ICT should allow the teacher or pupils to do something that would be more difficult without it, or to learn something more effectively or efficiently.

The National Council for Educational Technology in 1995 published *Mathematics and IT: a pupil's entitlement*, which listed six major ways in which ICT can provide opportunities for pupils learning mathematics.

Opportunities for exploiting the power of ICT

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

Observing patterns
The speed of computers and calculators enables students to produce many examples when exploring mathematical problems. This supports their observation of patterns and the making and justifying of generalisations.

Seeing connections
The computer enables formulae, tables of numbers and graphs to be linked readily. Changing one representation and seeing changes in the others helps students to understand the connections between them.

Working with dynamic images
Students can use computers to manipulate diagrams dynamically. This encourages them to visualise the geometry as they generate their own mental images.

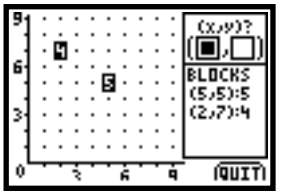
Exploring data
Computers enable students to work with real data which can be represented in a variety of ways. This supports interpretation and analysis.

'Teaching' the computer
When students design an algorithm (a set of instructions) to make a computer achieve a particular result, they are compelled to express their commands unambiguously and in the correct order; they make their thinking explicit as they refine their ideas.

Learning from feedback

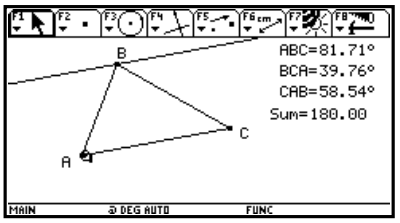
ICT encourages an exploratory approach to learning mathematics partly because it provides reliable feedback.

For example, Year 7 pupils can develop their problem-solving skills and practise their understanding of coordinates when trying to find the Rhino in a small computer game.



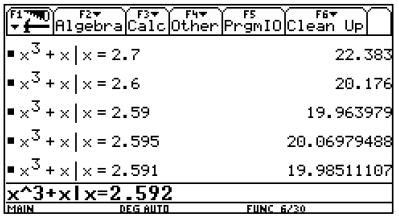
The continual nature of the feedback provided when a pupil manipulates an image in a dynamic geometry package helps to provide insight and encourage explanation.

For example, as Year 7 pupils drag a vertex of a triangle around the screen they may notice that although the sizes of the individual angles are changing, their sum remains constant.



The speed and reliability of the feedback allows pupils to use trial and improvement and iterative searches more efficiently.

For example, a Year 9 pupil might use a computer algebra system to solve the equation $x^3 + x = 20$ by trial and improvement.



Observing patterns

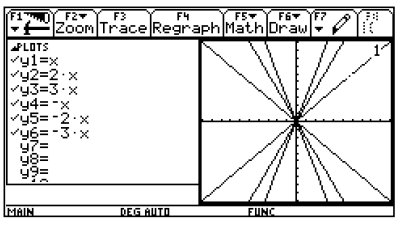
ICT allows pupils to generate many examples very quickly. This can remove the tedium of repetitive manual calculations and encourage pupils to focus on patterns and relationships.

For example, Year 8 pupils can use a spreadsheet to investigate the effect of multiplying and dividing any number by 0.01.

	C	A	B
1	Divide	Number	Multiply
2	600	6	0.06
3	1800	18	0.18
4	1200	12	0.12
5	2400	24	0.24
6	6700	67	0.67
7	13700	137	1.37
8	32400	324	3.24

The ability of many ICT resources to recalculate automatically can encourage pupils to explore a concept more effectively. Spreadsheets and graph plotters allow rapid recomputing of tables and graphs as a value or formula is changed.

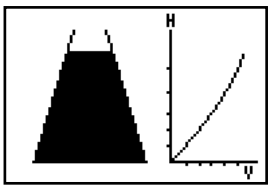
For example, Year 7 pupils can investigate the effect on a graph of changing the value of m in the function y = mx.



Seeing connections

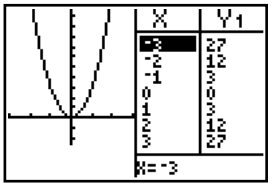
Using ICT can enable pupils to move easily between different representations of a relationship. This can emphasise the connections in mathematics and improve conceptual understanding.

For example, pupils in Year 9 might use a small computer program to investigate the depth of water against time when water steadily fills different shaped bottles.



Using a graphical calculator, spreadsheet or graph plotter can help pupils to understand functions and their graphs, as they can move between the algebraic, tabular and graphical representations of the same relationship.

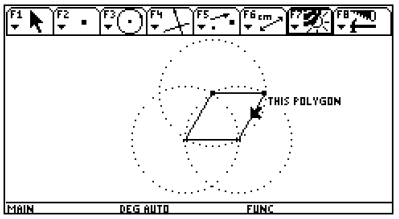
For example, pupils in Year 9 might use a graphical calculator to explore quadratic functions.



Working with dynamic images

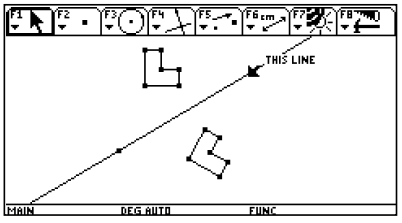
Much of geometry, particularly transformational geometry, is concerned with movement. Manipulating diagrams dynamically generates many examples that can help pupils to make conjectures and explore what changes and what stays the same. This can help pupils to develop their skills of geometrical reasoning.

For example, pupils in Year 8 can learn about the properties of a rhombus by using a dynamic geometry package to construct and manipulate one. They can then compare their different methods of construction.



Dynamic geometry allows pupils to see transformations that might be difficult to visualise. This can be useful when exploring loci or when learning about reflection, rotation and enlargement.

For example, pupils in Year 7 can develop their understanding of the effects of reflecting a shape in different mirror lines.



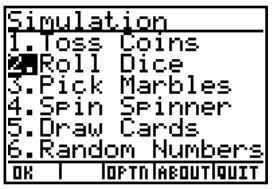
Working with dynamic images can also stimulate pupils' mental imagery.

Exploring data

Through ICT, teachers and pupils can access large amounts of data quickly. Secondary sources of data are vital in giving real-life contexts for mathematics, and the Internet and CD-ROMs provide useful ways of accessing such information which can then be analysed.

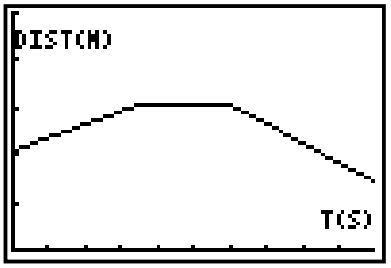
ICT can be used to generate experimental data through running simulations. Such simulations can encourage pupils to make conjectures and generalisations based on experimental evidence.

For example, Year 8 pupils might use probability simulations on a graphical calculator to estimate probabilities based on experimental data.



ICT can provide an easy way of collecting real data for analysis in mathematics lessons.

For example, using a graphical calculator and a motion sensor, pupils in Years 7 and 8 can collect 'live' data and produce distance–time graphs. These graphs can be interpreted by referring back to the movements that produced them; in this way pupils' understanding of real-life graphs and their skills of graphical interpretation can improve.



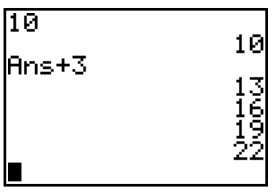
In the ICT curriculum, pupils in Years 7 and 8 explore the effects of random number generation in a spreadsheet model to generate test data and to simulate the rolling of a dice. They also use Logo to explore the rolling dice simulation.

'Teaching' the computer

The opportunity for pupils to 'teach' the computer can arise in many situations. For example, when pupils define a procedure in Logo to make the turtle draw a hexagon, or use a formula in a spreadsheet, or construct a parallelogram in a dynamic geometry package, they are defining a set of instructions to make the computer perform a particular action and effectively beginning to model particular behaviours or develop a set of rules.

Teaching the computer encourages pupils to formalise their mathematical thinking, define conditions, sequence actions and express their ideas clearly. When the computer carries out the instructions it has been given, pupils need to observe the effect, and may then need to refine and improve the procedure they taught the computer. This essentially helps them to develop their skills of algebraic thinking.

For example, pupils in Year 7 may use a graphical calculator to generate the terms of a sequence and identify the term-to-term definition of it.



Mathematics

Pupils can use ICT as a tool to perform calculations, draw graphs and help solve problems. The most obvious example of ICT being used in this way is when pupils use a calculator to carry out more difficult numerical calculations. However, pupils may use a spreadsheet, computer algebra system or graphical calculator to solve a problem by trial and improvement or iterative methods. They may use a graphical calculator or graph plotter to solve an equation graphically rather than algebraically. Pupils can use the comprehensive statistical features of a graphical calculator to carry out a statistical analysis of data that they have collected. Constructing a figure in a dynamic geometry package may help a pupil to understand, solve and then prove a geometrical problem. When pupils are using ICT as a tool to find things out, solve problems or help them to understand what is happening, then it is often helping them to develop their skills in using and applying mathematics.

Clearly, ICT can be a powerful and efficient tool, but if pupils are to use the facilities it offers constructively and efficiently then they need to be taught the technical skills required. For example, in order to use a calculator effectively, pupils in Key Stage 3 need to learn:

- how to select from the display the number of figures appropriate to the context of the calculation;
- how to enter numbers and interpret the display when the numbers represent money, metric measurements, units of time or fractions;
- the order in which to use the keys for calculations involving more than one step;
- how to use facilities such as the memory, brackets, the square root and cube root keys, the sign change key, the fraction key, and so on.

Similarly, pupils need to be taught how to use the facilities and functions of a spreadsheet, graph plotting package, computer algebra system, dynamic geometry package or graphical calculator if they are to use them effectively to help solve mathematical problems. Mathematics lessons can therefore help pupils to develop their ICT skills by providing new contexts in which to apply those skills.

It is also important that pupils use the appropriate functions of the ICT they are using. When using a spreadsheet, for example, teachers need to check that pupils are using formulae when displaying the results of calculations rather than simply entering the results as numbers. Calculators and mental methods could be used to verify results.

Pupils need to learn to choose the appropriate ICT tools to help them solve mathematical problems, but they also need to learn when it is not appropriate to use ICT. For example, it is important that they learn to avoid using ICT for routine tasks that can be carried out more effectively through mental methods or with pencil and paper. Examples include:

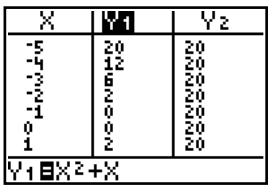
- using a calculator or spreadsheet for a straightforward, single calculation;

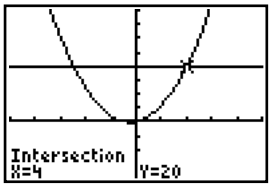
- using a calculator or spreadsheet for a sequence of calculations if mental and written skills are not being developed and consolidated elsewhere;
- using a graphical calculator to draw a graph when a sketch would be more appropriate.

Organisation

ICT provides a medium through which pupils can choose how to organise and present their work. Pupils may choose to use a wordprocessor to produce a report of a mathematical investigation that they have carried out. They may decide to use a spreadsheet to organise the results of a statistical enquiry, choosing the graphical representations that are most appropriate. Indeed, a very powerful feature of ICT is that it offers pupils the opportunity to represent problems and their solutions mathematically in a variety of forms.

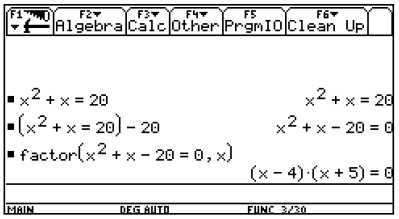
For example, some pupils in Year 9 may choose to solve the quadratic equation $x^2 + x = 20$ with a table of values, via a spreadsheet or graphical calculator.



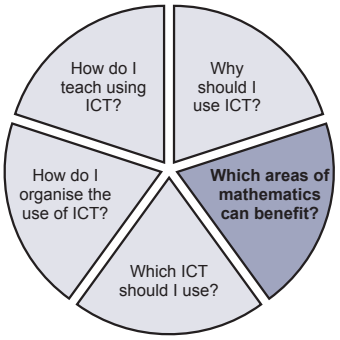


Other pupils may choose to present their solutions graphically, via a graph plotter or a graphical calculator.

A few pupils may choose to present their solution algebraically.



ICT can encourage discussion in mathematics through pupils comparing and discussing the different ways they have solved a problem. This in turn will help to improve their written communication skills.

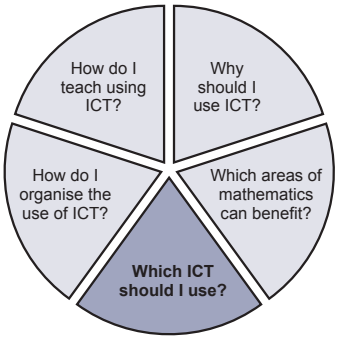


Which areas of mathematics can benefit?

Clearly, ICT can be used advantageously in most areas of mathematics, but the following areas particularly benefit from the opportunities it offers.

- Applying mathematics and solving problems
- Place value, ordering and rounding
- Equations, formulae and identities
- Sequences, functions and graphs
- Geometrical reasoning: lines, angles and shapes
- Transformations
- Coordinates
- Construction and loci
- Handling data

The appendix lists where ICT is referred to in the supplement of examples section of the mathematics Framework.



Which ICT should I use?

There are many types of software available for teaching and learning mathematics. Most have already been referred to in pages 2–8.

- **Generic software**: spreadsheets (and databases)
- **Content-free, mathematics-specific software**: graph plotters, dynamic geometry, computer algebra systems
- **Programming languages**: Logo (and Basic)
- **Content-specific software**: usually aimed at particular mathematics content
- **Graphical calculators**
- **Information resources**: Internet, CD-ROMs, data files

The specific features and most common uses of these different types are described below.

Generic software: spreadsheets

Spreadsheets allow users to sort and carry out a vast range of calculations on lists and arrays of numbers. The data contained in the spreadsheet can also be represented in various graphs and charts. There are a number of uses for spreadsheets in mathematics in Key Stage 3:

- generating and exploring number patterns and sequences;
- solving simple optimisation and number problems;
- developing an appreciation for the concept of a variable;
- constructing and exploring functions, including equivalence of functions;
- analysing data and statistics.

It is important to note that the notation used for constructing mathematical functions is often different to mathematical conventions. Also, some mathematical graphs and diagrams are difficult to produce correctly.

Content-free, mathematics-specific software

Content-free, mathematics-specific software is particularly useful in teaching and learning mathematics in Key Stage 3.

Graph plotters

Graph-plotting packages allow users to plot and explore the graphs of a range of mathematical functions. Many graph plotters also have features

that enable users to carry out geometric transformations on the functions and graphs and plot data sets. There are particular uses for graph plotters in mathematics in Key Stage 3:

- exploring functions and graphs;
- plotting real data and constructing mathematical models.

Dynamic geometry

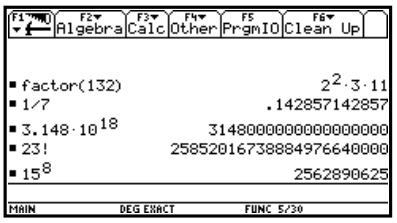
Dynamic geometry software allows pupils to explore and learn geometrical facts through experimentation and observation. Pupils can construct figures on the screen and then explore them dynamically. When an independent point or line is dragged with the mouse, all dependent constructions remain intact. They can be used to understand what stays the same and what changes under different conditions. They can motivate pupils to explain and prove. Dynamic geometry software can be used in a variety of ways in Key Stage 3:

- exploring and learning about the properties of shapes;
- studying geometric relationships and learning geometrical facts;
- transforming shapes;
- working with dynamic images to make and test hypotheses about properties of shapes;
- making and exploring geometric constructions;
- constructing and exploring loci.

Computer algebra systems

Computer algebra systems are tools that automate algebraic computation. This includes simplifying and factorising expressions and solving equations.

A particularly powerful feature for teaching and learning mathematics in Key Stage 3 is the ability to deal with exact arithmetic of integers, fractions and decimals to a very high precision.



Although most often used with older pupils, there are some useful ways in which computer algebra can be used in mathematics in Key Stage 3:

- calculating with large numbers, including indices and factorials;
- exploring fractions and decimals, including patterns in recurring decimals;
- exploring patterns in number and algebra;
- learning about algebraic equivalence;
- developing skills of algebraic manipulation and solving equations.

Programming languages

There are a number of areas of the Key Stage 3 mathematics curriculum where it may be appropriate for pupils to write short procedures to 'teach' the computer. Pupils may use Logo, Basic or the programming language of a graphical calculator. Pupils will develop programming skills in defining macros in spreadsheets and in dynamic geometry packages.

Logo

Logo is a powerful computer programming language that is easily accessible to pupils. Programming in Logo uses simple everyday words. Logo can be 'taught' to do new things by defining new words (procedures). The most recognisable feature of Logo is the microworld of turtle geometry, where pupils can explore angle, shape and space by programming turtle movement around the screen. Logo can be used to explore and develop understanding of other areas of mathematics, including number and algebra; it can also be used to develop and test mathematical models, and to set up and manage control, monitoring and modelling activities. Logo can be used in a variety of ways in Key Stage 3:

- exploring and learning about the properties of shapes;
- generating number patterns and sequences;
- developing the concept of a function;
- developing simple programming skills.

Content-specific software

This is usually aimed at particular mathematics content. Although much of the software is written for desktop and laptop computers, programs (applications) are now being developed which run on graphical calculators. 'Small' software usually takes the form of games or puzzles which involve pupils practising a particular mathematical skill or using some mathematical knowledge. Pupils often have the choice of playing these games against each other or against the computer. Some small software is more open and presents an environment that pupils can explore and investigate. Some small software is written so that it can be used interactively by teachers, as well as by groups of pupils. A number of useful mathematics applications can be downloaded from the Internet and stored for future use. Small software can be used within many areas of the Key Stage 3 mathematics curriculum.

Graphical calculators

A typical graphical calculator has almost the same power and functionality as the classroom computers of 15 years ago. They are equipped with a range of content-free, mathematics-specific software

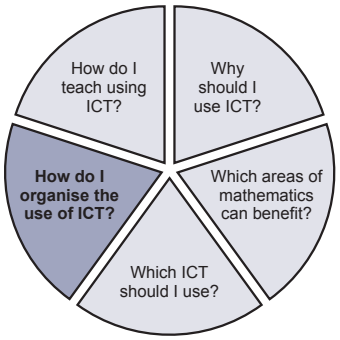
including an advanced calculator, graph plotter, basic drawing tools and advanced statistical features. Pupils can use them to generate numerical sequences by a range of methods, manipulate lists of numbers, use and manipulate algebraic variables, and use a range of algebraic and graphical analysis tools. Some graphical calculators include computer algebra systems and dynamic geometry software. A few have flash-ROM which acts as a 'hard disk' as it enables application software to be downloaded from the Internet. A few graphical calculators can be connected to data-logging devices such as a motion sensor, which provides an easy way of collecting real data that can then be analysed.

The display from teachers' models of graphical calculators can be projected via an OHP panel on to a whiteboard so that they can be used for whole-class interactive teaching. Data and programs can be exchanged easily between similar calculators and a computer. An obvious advantage of graphical calculators is that they are portable and can be used anywhere inside and outside the classroom. Other advantages are that they are reliable, easy to keep secure, and inexpensive. Graphical calculators can be used extensively in Key Stage 3 mathematics:

- generating sequences and exploring patterns in number and algebra;
- exploring and analysing functions and graphs;
- exploring relationships expressed in tables, as functions and as graphs;
- using algebraic variables;
- plotting real data and constructing mathematical models;
- analysing statistics;
- collecting real data using a data-logger, which can then be analysed;
- developing simple programming skills;
- using small software.

Information resources

Secondary sources of data yield real-life contexts for mathematics. The Internet and CD-ROMs provide useful ways of accessing such information. Some data sets are included on the CD-ROM provided as part of the *Interacting with mathematics in Key Stage 3: Year 8 handling data mini-pack*.



How do I organise the use of ICT?

A number of decisions need to be made when planning to use ICT.

- How will I organise the ICT equipment? Will I use one computer or graphical calculator projected on to a whiteboard, one standalone computer, a suite of computers, or a class set of graphical calculators?
- How will the pupils be grouped? Will they work as a whole class, in small groups, in pairs or individually?
- How will the ICT be used? Will it be accessible to the pupils, or just controlled by me?

Sometimes the answers to these questions will be dictated by the availability of hardware and software: for example, whether the computer suite is available or whether the mathematics classroom has access to a standalone computer. However, whichever way the ICT is being used, pupils also need space to work with pencil and paper while they are using the computer or graphical calculator.

It is important that the organisation of the ICT and the groupings of pupils reflect the reason why the ICT is being used.

Working with the whole class

A graphical calculator or computer can be projected on to a whiteboard to support interactive teaching. This may be useful to:

- introduce, review or demonstrate a new mathematical fact, skill or concept;
- practise or consolidate previously learned mathematical facts;
- introduce a question, puzzle or problem which pupils then work on either with or without access to ICT;
- observe a simulation or discuss some data that have been collected;
- share pupils' work.

Working with small groups, pairs, individuals

Sometimes all groups of pupils in the class will need access to the ICT while they are working. This will be particularly important if they are learning a new mathematical fact, skill or concept. If a suite of computers or a set of graphical calculators is available, it may be possible for all

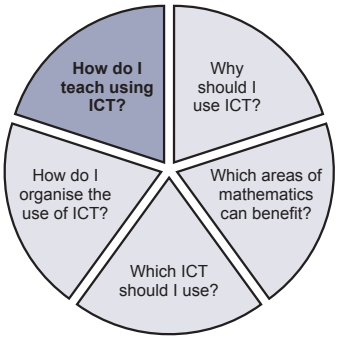
pupils to have access to the ICT at the same time. If only one standalone computer is available, pupils may have to take turns to access the ICT.

In some situations, the ICT may be used to support pupils who are struggling to grasp a particular concept or who need further practice with a mathematical skill. In others, the ICT may be used to provide extra challenge for higher-attaining pupils. However, it is important that all pupils have equal opportunity to use ICT as part of their mathematical learning.

Small groups of pupils may particularly benefit from using ICT to:

- investigate and explore a mathematical problem or situation;
- practise or consolidate previously learned mathematical facts;
- research and find information;
- collect and analyse data;
- use a simulation;
- solve a problem;
- organise and present their work.

As well as having access to ICT as part of a planned activity, pupils also need spontaneous access to ICT resources that they may want to use at any time. For example, a pupil may decide in a lesson that a spreadsheet or graph plotter might help them to solve the problem that they are working on. Although this is harder to prepare for, it will encourage pupils to see ICT as being an integral part of mathematical learning. Graphical calculators are particularly useful here because of their portability and functionality.



How do I teach using ICT?

Teaching with ICT is no different from teaching without ICT. A high proportion of each lesson where ICT is being used should be direct teaching, often of the whole class, but also of groups and individuals.

Good direct teaching is achieved by balancing different teaching strategies:

- *Directing and telling …*
- *Demonstrating and modelling …*
- *Explaining and illustrating …*
- *Questioning and discussing …*
- *Exploring and investigating …*
- *Consolidating and embedding …*
- *Reflecting and evaluating …*
- *Summarising and reminding …*

(Framework for teaching mathematics: Years 7, 8 and 9, section 1, pages 26–27)

If pupils are to gain maximum benefits from using ICT in mathematics, teachers need to be aware of the following.

- Practical activities and work with pencil and paper usually need to take place alongside the work on the computer or graphical calculator.
- Pupils can use ICT to generate large amounts of data. They need to be taught to find, organise and use the information that is fit for a clearly defined purpose.
- Pupils can use ICT unthinkingly, pressing button after button to move rapidly from one screen to the next. They need to be encouraged to focus on what they see and to ask questions such as ‘Why did that happen?’ or ‘What would happen if…?’.
- Feedback provided by ICT can lead pupils to make generalisations based on experimental evidence. It is important that pupils are encouraged to reflect on what they see, evaluate the evidence, make predictions and explain their conclusions. Teaching with ICT should focus on observation, explanation and proof.

Appendix: ICT in the mathematics Framework

This section lists references to ICT in the supplement of examples in the *Framework for teaching mathematics: Years 7, 8 and 9*.

Using and applying mathematics to solve problems

ICT resource	Teaching objective	Page ref:
Graphical calculator, Logo, dynamic geometry software, spreadsheet	Solve word problems and investigate in a range of contexts	10–15, 18–19
Calculator	Suggest extensions to problems, conjecture and generalise	32

Numbers and the number system

ICT resource	Teaching objective	Page ref:
Calculator, spreadsheet	Multiply and divide numbers by powers of 10	38–39
Graphical calculator, small software	Compare and order decimals	40–41
Calculator	Round numbers, including to a given number of decimal places or significant figures	45, 47
Calculator, graphical calculator	Order, add, subtract, multiply and divide positive and negative numbers	48–49, 51
Calculator	Recognise and use multiples, factors and primes; use tests of divisibility	53
Calculator, ICT	Recognise squares, cubes and corresponding roots	56–57, 59
Small software	Use fraction notation to describe a proportion of a shape	60
Calculator	Convert fractions to decimals	65
Calculator	Calculate percentages	72–73
Graphical calculator, graph plotter, spreadsheet	Solve problems involving proportion	79
Calculator	Consolidate understanding of multiplication and division; know how to use the laws of arithmetic	83–85
Calculator	Know and use the order of operations	86–87
Spreadsheet	Consolidate and extend mental methods of calculation	92
Calculator	Make and justify estimates and approximations	102–103
Calculator	Use the facilities of a calculator	108–109
Calculator	Use checking procedures	110–111

Algebra

ICT resource	Teaching objective	Page ref:
Calculator, spreadsheet	Understand and use inverse operations	114–115
Graphical calculator, spreadsheet	Simplify or transform algebraic expressions	117, 119, 121
Graphical calculator, graph plotter	Solve a pair of simultaneous linear equations	129
Calculator, graphical calculator, graph plotter, spreadsheet	Use systematic trial and improvement methods and ICT tools to find solutions to non-linear equations	133, 135
Graphical calculator, graph plotter	Set up and use equations to solve problems involving direct proportion	137
Computer programming, graphical calculator, spreadsheet	Use formulae from mathematics and other subjects	138–139, 142–143
Computer programming, graphical calculator	Generate and describe sequences	144–145
Computer programming, graphical calculator, spreadsheet	Generate terms of a sequence	148–151
Graphical calculator, spreadsheet	Express functions and represent mappings	161, 163
Graphical calculator, graph plotter	Generate points and plot graphs of functions	164–167, 169, 171
Graphical calculator and data-logger, Internet	Construct functions arising from real-life problems, and plot and interpret their corresponding graphs	172–174

Shape, space and measures

ICT resource	Teaching objective	Page ref:
Dynamic geometry, Logo	Identify properties of angles and parallel and perpendicular lines, and use these properties to solve problems	180–181, 183
Calculator, computer tiling software, dynamic geometry, Logo, spreadsheet	Identify and use the geometric properties of triangles, quadrilaterals and other polygons to solve problems; explain and justify inferences and deductions using mathematical reasoning	184–185, 188–189
Dynamic geometry	Identify and use the properties of circles	195, 197
Dynamic geometry, Logo	Recognise and visualise transformations and symmetries of shapes (reflection, rotation, enlargement)	202–206, 208, 210, 215
Graphical calculator	Use coordinates in all four quadrants	218
Dynamic geometry	Construct lines, angles and shapes	221
Logo	Find simple loci, both by reasoning and by using ICT	225–227
Calculator	Know and use the formula for the circumference of a circle	235
Spreadsheet	Solve problems involving lengths, perimeters, areas and volumes in 2-D and 3-D shapes	241
Calculator, graphical calculator, spreadsheet	Begin to use sine, cosine and tangent to solve problems	243, 245, 247

Handling data

ICT resource	Teaching objective	Page ref:
CD-ROM, computer database, graphical calculator and data-logger, Internet	Decide which data to collect and identify possible sources	250–251
CD-ROM, computer database, graphical calculator and data-logger, Internet	Collect and record data from primary and secondary sources	255
Calculator, graphical calculator, spreadsheet	Calculate statistics from data, using ICT as appropriate	256–261
Calculator, graphical calculator and data-logger, spreadsheet	Construct graphs and diagrams to represent data, on paper and using ICT	262–265, 267
Graphical calculator and data-logger, spreadsheet	Interpret diagrams and graphs, and draw inferences	268–269
Spreadsheet, presentation software, wordprocessor	Communicate methods and results	272–273, 275
Internet, programming, small software	Compare experimental and theoretical probabilities	284–285

References and further reading

Framework for teaching mathematics: Years 7, 8 and 9 (DfES 0020/2001)

Framework for teaching ICT capability: Years 7, 8 and 9 (DfES 0321/2002)

Interacting with mathematics in Key Stage 3: Year 8 handling data mini-pack (DfES 0216/2002)

Mathematics and IT: a pupil's entitlement (NCET 1995)

National Curriculum programme of study: mathematics, Key Stage 3 (QCA/99/460)

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