

Using calculators

OBJECTIVES

This module is for study by an individual teacher or group of teachers. It:

- discusses when it is and when it is not appropriate for pupils to use a calculator;
- considers the skills that pupils need to use a calculator effectively and efficiently;
- discusses the progression of calculator skills and the implications for teaching.

CONTENT

The module is in four parts.

- 1 The role of the calculator
- 2 Mental, written or calculator?
- 3 Progression in calculator skills
- 4 Summary

RESOURCES**Essential**

- Your personal file for inserting resource sheets and making notes as you work through the activities in this module
- A scientific calculator
- The *Framework for teaching mathematics: Years 7, 8 and 9*
- The resource sheets at the end of this module:
 - 2a How do you currently use calculators?
 - 2b Using a calculator
 - 2c Learning with a calculator
 - 2d Mental, written or calculator?
 - 2e Progression in calculator skills
 - 2f Teaching points for Year 7
 - 2g Summary and further action on Module 2

Optional

- 16 coloured counters, eight of one colour and eight of another (or use two different kinds of coins)

STUDY TIME

Allow approximately 90 minutes.

Part 1 The role of the calculator

- 1 This module is about the use of the calculator in Key Stage 3 mathematics lessons. During it, you will be considering the skills that pupils should be developing in Years 7, 8 and 9 and the kinds of activities that will help them to develop those skills.
- 2 Consider the three questions on **Resource 2a, How do you currently use calculators?** Use the resource sheet to make notes on the current position in your school.

Could the teaching of calculator skills in your school be more systematic? If so, working through this module should help you to achieve this, particularly in Year 7.
- 3 Read and fill in the table on **Resource 2b, Using a calculator.**

To what extent do your answers to the four statements correspond with your perspective on current practice in Resource 2a? If there are differences, jot down the three main ones to discuss later with your head of department.
- 4 The two main ways in which calculators can play a role in mathematics lessons are as a teaching or learning aid, and as a calculating aid. **Resource 2c, Learning with a calculator**, has some examples of calculator activities that can support learning. Try the first two activities, then consider and make notes on the accompanying questions.
- 5 The first two activities on Resource 2c are puzzles or investigations that pupils can work on independently or in pairs. Other activities are in the form of a game for two or more players. The third activity on Resource 2c, reproduced below, provides an example.

Four in a row: a game for two players

Each player needs about 8 counters in their own colour.

506	1426	217	837	1136	3266
4757	1809	1242	3082	341	112
77	496	3752	432	176	2201
1917	736	737	189	2576	1072
616	322	896	781	3976	497
469	1512	1736	2077	392	297

Take turns.

Choose a number from the playing board and two numbers from this list.

7 11 16 27 31 46 56 67 71

The player finds the product of the two numbers using a calculator. If it equals the chosen number, the player covers the number with a counter.

The winner is the first player to get four of their counters in a straight line.

Activities like those on Resource 2c can be presented to individual pupils or groups of pupils on a worksheet or to the whole class on an overhead projector transparency. They are just three of many different examples that can help to develop or practise calculation skills and ideas of number.

A further advantage is that where the calculator is used to check the accuracy of calculations, pupils can practise aspects of calculation without disturbing the teacher, freeing the teacher to observe or to provide direct teaching to selected small groups.

Part 2 Mental, written or calculator?

- 1 Work through the questions on **Resource 2d, Mental, written or calculator?**, deciding what kind of calculation to do.

You could use an exercise with questions similar to those on Resource 2d as an oral and mental starter to a mathematics lesson. This would reinforce for pupils the importance of selecting the most appropriate calculation method for a particular question.

In your personal file, plan an exercise along the same lines that you could give to a class of Key Stage 3 pupils in, say, the next month.

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- 2 Compare the recommendations below with your decisions on the questions on Resource 2d.

- 1 Mental

A simple test of divisibility confirms that the answer will be a whole number of pounds.

- 2 Mental

The convenience of the numbers here means the calculations are easily done mentally. Confirm the answers by checking that they total 420.

- 3 Calculator

A clear candidate for the calculator (although formal or informal written methods are appropriate). How can the calculator be used efficiently?

- 4 Mental (for some), calculator or written (for others)

Remember to estimate first (perhaps using $125 \times 8 = 1000$).

- 5 Calculator

A calculator can quickly help find the total number of minutes, but how best to convert to hours and minutes will need to be taught.

- 6 Mental

This should be seen as a mental calculation ('counting on': $1 \text{ h } 15 \text{ min} + 5 \text{ h } 20 \text{ min}$, assuming both times are in the same time zone).

- 7 Mental

The context demands an answer to the nearest whole number above so a mental method is appropriate. If $387 \div 51$ is attempted using a calculator, the result will need to be interpreted.

- 8 Calculator, written or mental

Most are likely to prefer a calculator or written approach. Noting the equivalence to $31.2 \div 12$ would allow some to tackle it mentally.

Key Stage 3 pupils should not be over-reliant on calculators. They should be able to recognise when it is more appropriate to use mental methods, with or without jottings, and they should be able to use written methods accurately and efficiently. Make some notes in your personal file on what you might need to do to help pupils to do this.

Part 3 Progression in calculator skills

1 Read **Resource 2e**, **Progression in calculator skills**.

2 The Key Stage 2 National Curriculum tests have shown that a significant number of pupils entering Year 7 may not have developed the technical skills necessary to use a calculator efficiently, although the position is improving slowly.

One of the factors that not all pupils may appreciate by the end of Key Stage 2 is the difference between the 'answer' as displayed in the calculator display, and the 'answer' that should be recorded.

Work through the questions on **Resource 2f**, **Teaching points for Year 7**.

3 Compare your answers to the questions on **Resource 2f** with those below.

	Display	Written answer	Teaching points
1	15.6	£15.60	Note the need to write the zero for 60p in the written answer ...
2	0.8	£0.80 or 80p	... and the zero for 80p.
3	9.14 or 914	9.14 m or 914 cm	The units must be the same. Enter $8.47 + 0.67$ for an answer in m, or $847 + 67$ for an answer in cm.
4	0.09 or 9	9 cm	Enter $1.03 - 0.94$ for an answer in m, or $103 - 94$ for an answer in cm.
5	4.95 or 495	£4.95	The calculation should be done mentally. If a calculator is used, enter 8p as 0.08, or £5.03 as 503.
6	1237 or 1.237	1237 g or 1.237 kg	Enter $1500 - 263$ by changing both to g, or $1.5 - 0.263$ by changing both to kg.
7	0.185	18.5p or 19p to nearest p	Discuss what to do about digits beyond the second decimal place ...
8	2.266666	£2.27 to nearest p	... and how to round to two decimal places.

In your personal file, plan some questions to ask Year 7 pupils that would allow you to draw attention to similar teaching points.

4 Look at the objectives identified under 'Calculator methods' and 'Checking results' in the teaching programmes for Years 7, 8 and 9, Framework section 3, pages 6–13. Look at the corresponding examples in the supplement, Framework section 4, pages 108–111.

Think about how you could make the teaching of calculator skills more explicit in your planning and teaching of Key Stage 3 lessons. Jot down your ideas in your personal file.

5 Key Stage 3 pupils will also benefit from learning how to use a graphical calculator – this should not be restricted to the most able pupils. There are several examples of activities in different contexts, including solving problems, in the Framework supplement of examples. Examples include:

- using a large screen to follow the steps of a calculation and to explore patterns in calculations and sequences;
- beginning to explore straight-line graphs and the relationship between the values of x and y ;
- solving problems involving coordinates and shapes.

Look for examples of the use of graphical calculators by browsing through the supplement of examples, Framework section 4. Focus in particular on number and algebra. In your personal file, make a note of any example that would be useful to explore with the classes that you teach.

Part 4 Summary

1 Some important principles in the use of calculators are:

- Pupils need regular opportunities to practise and extend their mental skills, since the ability to estimate the result of a calculation by approximating and calculating mentally is key to the successful use of a calculator.
- Calculator skills need to be taught systematically. Pupils will not learn these technical skills merely by ‘being allowed’ to use calculators.
- Pupils should be encouraged to use the most appropriate method for a calculation and should always ask themselves first: ‘Can I do this in my head?’
- Skilful use of a calculator depends on:
 - a good understanding of the number system, including place value and rounding;
 - a good knowledge of units of measurement, and the ability to convert one unit to another mentally.
- Calculators are more than calculating aids. They can also support the teaching and learning of different aspects of mathematics.

2 Look back over the notes you have made during this module. Have you identified the most important things that you may need to consider and adopt when you are planning and teaching?

Use **Resource 2g, Summary and further action on Module 2**, to list key points you have learned, points to follow up in further study, modifications you will make to your planning or teaching, and the main points to discuss with your head of department.

Resource 2a How do you currently use calculators?

How often do you *expect* pupils to use a calculator (as opposed to 'letting' pupils use a calculator)?

How do you *teach* calculator skills?

How do you ensure that pupils use an appropriate method of calculation (mental, written or calculator)?

Resource 2b Using a calculator

Do you agree or disagree with the statements below?

	Agree	Disagree
A calculator can be used as a teaching tool to develop understanding of concepts as well as being a calculation tool.		
Calculator skills need to be taught systematically.		
Poor calculator skills currently hinder some pupils.		
Pupils should be taught to recognise when it is appropriate to use a calculator and when it is more appropriate to use a mental or written method for a calculation.		
There should be times when pupils are asked to put their calculators away and to work without them.		

To what extent do your answers to the four statements correspond with your perspective on current practice in Resource 2a?

If there are differences, jot down the three main ones to discuss later with your head of department.

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Resource 2c Learning with a calculator

1 MISSING OPERATIONS

Each circle represents a missing operation.

Find out what it is.

1 $(37 \bigcirc 21) \bigcirc 223 = 1000$

2 $(756 \bigcirc 18) \bigcirc 29 = 1218$

3 $27 \bigcirc (36 \bigcirc 18) = 675$

4 $31 \bigcirc (87 \bigcirc 19) = 2108$

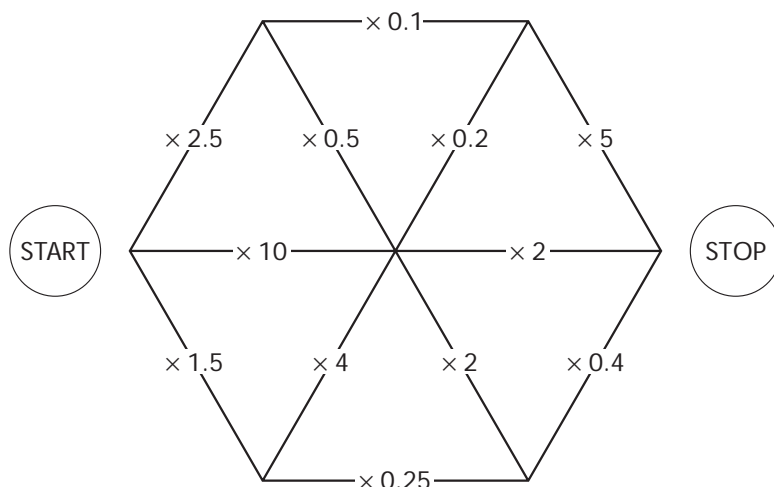
When you have solved these problems, consider these questions. Use the space below to make notes.

- 1 Could problems like this be used with Key Stage 3 pupils?
- 2 What technical skills in using calculators would they need?
- 3 What mathematical skills and understanding could they develop through working on the problems?
- 4 Could you present these or similar problems to the whole class on an overhead projector?
- 5 How could you adapt the problems to make them easier for less able pupils? Or more challenging for more able pupils?

Notes:

2 MAZE

Try this puzzle. Start with 1 in your calculator display.



Choose a route from START to STOP.

You may go along each line only once.

Multiply the number in your display by the number on the line.

The aim is to finish with 5 in your display.

When you have solved this puzzle, consider these questions. Use the space below to make notes.

- 1 Could the puzzle be used with Key Stage 3 pupils?
- 2 What technical skills in using calculators would they need?
- 3 What mathematical skills and understanding could they develop through working on the puzzle?
- 4 Could you present the puzzle to the whole class on an overhead projector?
- 5 How could you adapt the puzzle so that it could be played as a game by two players?
- 6 How could you adapt the puzzle to make it easier for less able pupils? Or more challenging for more able pupils?

Notes:

3 FOUR IN A ROW

This is an example of a game for two players. If you wish, you could find a partner and try playing the game.

Each player needs about 8 counters in their own colour (or you could use two different kinds of coins).

506	1426	217	837	1136	3266
4757	1809	1242	3082	341	112
77	496	3752	432	176	2201
1917	736	737	189	2576	1072
616	322	896	781	3976	497
469	1512	1736	2077	392	297

Rules

Take turns.

Choose a number from the playing board and point it out. Then choose two numbers from this list.

7 11 16 27 31 46 56 67 71

Find the product of the two numbers using a calculator. If it equals your chosen number, cover the number with a counter.

The winner is the first player to get four of their counters in a straight line in any direction, horizontal, vertical or diagonal.

If you have a chance to play *Four in a row*, consider these questions. Use the space below to make notes.

- 1 What mathematical skills and understanding could Key Stage 3 pupils develop through playing this game?
- 2 Could you present the game to the whole class on an overhead projector?
- 3 How could you adapt the puzzle to give pupils experience of working with different kinds of numbers (e.g. decimals with one or two places, positive and negative numbers, fractions)?

Notes:

Resource 2d Mental, written or calculator?

Work through these questions. For each question decide which method of calculation a Key Stage 3 pupil might use, and which method a teacher like yourself would use – mental method, written method, or calculator method?

		Method a pupil might use	Method a teacher might use
1	Three friends shared £411. How much did each friend get?		
2	John owns 420 CDs. The ratio of his classical to pop CDs is 3 : 4. How many of each type of CD does John own?		
3	Rashida travelled 532 miles last month for work. She is paid 35p a mile for the first 250 miles and 20p a mile for the remainder. How much will she be paid?		
4	$6250 \div 125 =$		
5	A turkey needs to be cooked for 40 minutes per kilogram, plus 20 minutes. For how long would you cook a turkey that weighs 5.2 kg?		
6	A ferry leaves Hull at 22:45 and arrives in Rotterdam at 05:20 the next day. How long did the journey take?		
7	372 pupils and 15 adults are going on an outing. How many 51-seater coaches will they need?		
8	The mass of an object is 0.312 kg. Its volume is 0.12 m^3 . Density is mass divided by volume. What is the density of the object?		

Resource 2e Progression in calculator skills

To ensure good continuity and progression in pupils' learning, Key Stage 3 teachers need to be aware of the progression in calculator skills from Year 5 through to Key Stage 3.

The calculator skills that most pupils in Years 5 and 6 are expected to develop are as follows. Pupils should learn to:

- use a calculator to perform a one-step problem and interpret the result;
Most pupils will have little difficulty with entering a one-step calculation such as 4.5×27 . However, when they are solving word problems, when it is not always obvious which values and what operations to use, they may misinterpret the question and enter the wrong calculation.
- key in and interpret money and measurement calculations;
Interpreting the results of money calculations often causes difficulties; for example, recognising whether the answer is in pence or pounds and interpreting the result of a division calculation.
- recognise rounding errors – for example, recognise 2.9999999 as 3;
Pupils need to make sense of problems and realise when answers are likely to have been rounded.
- use division to enter a fraction such as $\frac{3}{8}$, recognising the display of 0.375 as the decimal equivalent;
- recognise recurring decimals, such as 0.3333333, and know that this is equivalent to $\frac{1}{3}$;
Pupils need to recognise that not all digits may recur in a decimal, as in $1 \div 6 = 0.16666666$.
- recognise negative numbers and use the sign-change key if appropriate;
Pupils may miss the minus sign that indicates a negative number, which is usually on the extreme left of the display.
- carry out calculations with more than one step, such as $8 \times (37 + 58)$, or $\frac{3}{8}$ of 980;
Pupils need to be familiar with the order of operations so that they select the correct sequence of operations in calculations involving more than one step.
- clear the display before starting a calculation;
Pupils are less likely to make errors if they clear the display before starting a new calculation.
- correct a wrong entry by using the CLEAR ENTRY key;
Most Key Stage 2 pupils will clear the display and repeat the calculation if they think that they made an error. They also need to learn how and when to use the CE key.
- have a feel for the size of an answer and check it appropriately, for example, by carrying out the inverse operation.
This is the most important skill – errors in entering values often lead to nonsensical answers!

These skills need to be consolidated, reinforced and built upon throughout Key Stage 3. In summary, by the end of Key Stage 3 most pupils should know:

- the order in which to use the keys for calculations involving more than one step;
- how to carry out calculations involving percentages without using the percentage key;

- how to enter numbers and interpret the display when the numbers represent money, metric measurements, units of time or fractions;
- how to carry out calculations involving mixed units of time (e.g. hours and minutes, or minutes and seconds);
- when and how to use facilities such as the memory, brackets, the square-root and cube-root keys, the sign-change key, the fraction key, the constant facility;
- how to select from the display the number of figures appropriate to the context of a calculation.

Resource 2f Teaching points for Year 7

Use your calculator to answer the questions in the table below. Complete the columns headed 'Display' and 'Written answer'. Leave the column headed 'Teaching points' blank at this stage.

	Question	Display	Written answer	Teaching points
1	$£6.25 + £9.35 =$			
2	$£3.52 - £2.72 =$			
3	$8.47 \text{ m} + 67 \text{ cm} =$			
4	$1.03 \text{ m} - 94 \text{ cm} =$			
5	$£5.03 - 8\text{p} =$			
6	$1.5 \text{ kg} - 263 \text{ g}$			
7	50 pens cost £9.25. What does 1 pen cost?			
8	Washing machine liquid costs £3.40 for 1.5 litres. What is the cost of 1 litre?			

Now go back and complete the column headed 'Teaching points'.

Jot down what points you could draw out by asking Year 7 pupils to do a few examples of this kind. For example, for the first question, you could ask pupils to note the need to write the zero for 60p. You could also remind them to include the £ sign in their answer, but not a p for pence.

Resource 2g Summary and further action on Module 2

Look back over the notes you have made during this module. Identify the most important things to consider and modify in your planning and teaching.

List two or three key points that you have learned.

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List two or three points to follow up in further study.

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List two or three modifications that you will make to your planning or teaching.

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List the most important points that you want to discuss with your head of department, or any further actions you will take as a result of completing this module.

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