Unit 6

Using calculators in Key Stage 3

Unit 6

Using calculators in Key Stage 3

Objectives

- To review the use of calculators within departments
- To look at progression in calculator skills
- To explore the features of different types of calculators
- To contribute to a school policy on calculator use

Suggested use and organisation

- All schools; meetings of subject departments where calculators are used or likely to be used.
- This unit builds on the whole-school training units. It also provides information that will support the departmental follow-up in unit 9.
- It may be useful for a member of the mathematics department to lead or work with each department on this unit.

Resources

- OHTs 6.0–6.5
- Handouts 6.1 (one per pair), 6.2 (one each) and 1.4 or 4.3 (teachers should bring their own copies)
- Calculators – at least one basic (arithmetic logic) and one scientific (algebraic logic) calculator between two participants; consider asking teachers to use models which are unfamiliar to them
- A copy of the mathematics department or school policy on the use of calculators in Key Stage 3 (if available)

Session outline — 75 minutes

The role of the calculator Considering the place of calculators and choosing the most appropriate calculation method	Talk, game (optional), group discussion	25 minutes
Progression in calculator skills Discussing progression from Key Stage 2 and difficulties faced by pupils in using a calculator	Discussion, calculator activity	25 minutes
Types of calculator Comparing four-function and scientific calculators and discussing possible responses to anomalies	Discussion, calculator activity	15 minutes
Towards a school calculator policy Determining a departmental calculator policy which supports a whole-school approach	Discussion	10 minutes

The role of the calculator 25 minutes

Show **OHT 6.0** and outline the objectives for the session.

OHT 6.0

Objectives

- To review the use of calculators within departments
- To look at progression in calculator skills
- To explore the features of different types of calculators
- To contribute to a school policy on calculator use

Point out that calculators can play several different roles. As well as doing calculations, these include:

- helping pupils investigate sequences and patterns (for example, using the constant operator function);
- checking answers arrived at mentally or using a written method;
- supporting the practice of routine skills in the context of a game.

Spend a few moments exploring these since they influence the design of effective school and departmental policies on the use of calculators. The game 'Hits of the decade' (**handout 6.1**) provides a useful example of the last point. If colleagues are unfamiliar with the approach, ask them to spend 5 minutes playing the game.

In subjects other than mathematics, calculators will predominantly be used to do calculations.

Show **OHT 6.1**. Emphasise that:

- calculator skills need to be taught;
- poor calculator skills can hinder pupils;
- pupils should 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.

OHT 6.1

Calculator skills that pupils need to develop

- Selecting from the display the number of figures appropriate to the context of a calculation
- Entering numbers and interpreting the display when the numbers represent money, metric measurements, units of time or fractions
- Knowing the order in which to use the keys for calculations involving more than one step
- Using facilities such as the memory, brackets, the square root, cube root, sign change and fraction keys, and the constant facility
- Judging whether an answer is reasonable

Ask colleagues to look at **handout 6.2**, 'Mental, written or calculator?', and, working in pairs for each question, decide whether they would use a mental, written or calculator method to do the calculation. Allow about 5 minutes.

Take feedback and, using the notes below where appropriate, try to reach some consensus on where you would normally expect mental methods to be used.

Notes on handout 6.2

1 A simple test of divisibility confirms that the answer will be a whole number of pounds. This is a mental division.

2 The convenience of the numbers means the calculations are easily done mentally. Check the answers by checking they total to 420 cm.

3 This is a clear candidate for a calculator (although formal or informal written methods are also appropriate). How can it be used efficiently?

4 Use a calculator or a written method. This provides a chance to explore different written approaches. Some pupils may use $125 \times 8 = 1000$ to solve mentally.

5 A calculator can quickly help find the total number of minutes, but how is it best to convert to hours and minutes?

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

7 The context demands an answer to the nearest whole number above so a mental approximation is appropriate.

8 For many, a calculator or written approach will be preferred. Noting the equivalence to $31.2 \div 12$ would allow some to tackle it mentally.

Progression in calculator skills — 25 minutes

Point out that it is important for teachers to appreciate the progression in calculator skills from Year 5 through to Key Stage 3. A significant number of pupils entering Year 7 will not yet have developed the technical skills necessary to use a calculator efficiently.

Show **OHT 6.2**.

OHT 6.2

Calculator skills expected by the end of Year 6

- Use a calculator to perform a one-step calculation and interpret the result
- Key in and interpret money and measurement calculations
- Extend to calculations with more than one step, e.g. $18 \times (137 + 258)$
- Recognise rounding errors, e.g. recognise 2.9999999 as 3
- Recognise negative numbers and use the sign change key if appropriate
- Find decimals equivalent to fractions
- Recognise recurring decimals, e.g. 0.33333333
- Start to use memory keys and perform more complex calculations, e.g. $(234 + 739) \div (145 - 89)$
- Have a feel for the size of an answer and check it appropriately

Using the notes below, highlight relevant points, depending on the likely incidence of the subject matter within the department's teaching.

- When solving word problems it is not always obvious which values and what operations to use.
- Interpreting the results of money calculations often causes difficulties, for example recognising if the answer is in pence or pounds, interpreting the result of a division calculation, understanding that 4.1 in pounds is £4.10.
- Pupils need to select the correct sequence of operations in calculations involving more than one step.
- Pupils need to make sense of problems and realise when answers are likely to have been rounded.
- Pupils need to be shown that sometimes they can use the sign change key when subtracting a product. For example, the calculation 2345 – (23 × 21) could first be re-written as –(23 × 21) + 2345 and evaluated using the key sequence:

  23 [×] 21 [=] [±] [+] 2345 [=]

  Many pupils will be familiar with brackets and key in a sequence similar to the original calculation.
- Pupils need to recognise that not all digits may recur in a decimal, for example 1 ÷ 6 = 0.16666666
- Pupils need to make sure that the memory is cleared before starting a new calculation.
- Most importantly, errors in entering values or operations often lead to nonsensical answers, so pupils should be encouraged to estimate and check their calculations.

It is also important to note the difficulties pupils have when using a calculator in problems involving time. Show **OHT 6.3** and ask colleagues to:

- use their calculators to solve the problem;
- identify any prior knowledge needed to solve it;
- try to predict the answers pupils would give.

OHT 6.3

Ageing fast

Juliet works out her age as 6 311 520 minutes.

Calculate how old she is (exactly!) in years, months and days.

Check your answer by reversing the calculation.

Briefly discuss how participants solved this problem and the prior knowledge needed.

Colleagues may need to be convinced that the number of leap year days included is fixed (3) for a child of this age. It is in fact Juliet's twelfth birthday.

Standard index form

Some calculators may display standard index form at some stage. This is useful for handling very large or very small numbers. Although standard index form appears in the extension objectives for Year 9, younger pupils may be able to understand the display if it is explained to them.

Calculating percentages

Even basic calculators often have a percentage key. Since the use of this key differs between different calculators and from most mental or written methods of calculating percentages, the use of the percentage key should be discouraged.

Types of calculator 15 minutes

Calculators are everyday tools that all pupils need to be able to use accurately and sensibly. Most calculators can be classified as one of two types, although some have a mixture of characteristics.

Basic calculators use arithmetic logic, where calculations are carried out in the order they are entered (for example, entering $2 \times 3 - 4$ will produce the correct answer of 2 but $2 + 3 \times 4$ will give the incorrect answer of 20).

Most **scientific calculators** use algebraic logic, following the mathematical order of operations where multiplication takes precedence over addition (for example, $2 + 3 \times 4$ will give the correct answer of 14).

Pupils need to be able to use each type of calculator but will be expected to use a scientific calculator at Key Stage 4 and GCSE; teachers need to be aware of the differences, if they are to help pupils who get into difficulties.

Ask participants, working in pairs with a basic and a scientific calculator, to compare the results obtained on the two different calculators, for each of the examples on **OHT 6.4**.

OHT 6.4

Comparing calculators

For each key sequence, predict the outcome when you enter it on a basic calculator and a scientific calculator.

2 [+] 3 [×] 4 [=]

2 [÷] 3 [=]

2 [÷] 3 [×] 3 [=]

2 [÷] 3 [−] 3 [=]

2 [÷] [(] 3 [−] 3 [)] [=]

Now see if you were right.

Allow a few minutes for the task, then discuss and explain the differences.

In particular, teachers should be prepared to explain the calculations that have been carried out by each calculator:

- In the case of 2 [+] 3 [×] 4 [=] the non-scientific machine works through the operations in the order they are keyed to give $(2 + 3) \times 4 = 20$. The scientific machine gives priority to multiplication, working out 3×4 first and then adding it to 2 to produce the answer 14.
- For 2 [÷] 3 [=], even using different scientific calculators, the answers may vary. Some display 0.66666666, truncating the answer without any rounding, while others round the answer to 0.66666667. The basic machine usually gives the former answer.
- This then affects the answer to 2 [÷] 3 [×] 3 [=]. Basic calculators may display the answer as 1.999998 or 1.999999 while scientific machines display the answer 2.

Now ask the teachers how they might respond to situations where pupils obtain incorrect or unexpected results, arising from the type of calculator they are using.

Draw the discussion to a close emphasising the skills of calculator use:

- deciding whether it is appropriate to use a calculator in a given situation ('Can I do the calculation more efficiently without a calculator?');
- estimating answers within reasonable degrees of accuracy;
- generating the correct key sequence;
- interpreting results appropriately;
- checking the reasonableness of the answer.

Consistent approaches by all teachers will help to reinforce these skills.

Towards a school calculator policy 10 minutes

Because calculators are used widely in many subjects, it is important that teachers agree a common policy on their use. If the school has an agreed calculator policy, take a few minutes to study it.

Now consider what a departmental policy on using calculators should look like. The questions on **OHT 6.5** may help to focus the discussion. Suggest that notes could be added to **handout 1.4** or **4.3**, 'Priorities for cross-curricular numeracy'.

OHT 6.5

Departmental policy on using calculators

- Does our scheme of work make it clear when and where pupils are likely to require calculators?
- Are there times when we will expect pupils to do calculations without resorting to a calculator?
- Do we make it clear to pupils when and where we expect them to use a calculator and when we expect them not to?
- How do the calculator skills we expect pupils to use line up with those in the Framework for teaching mathematics?
- Are there opportunities in our scheme of work to teach or reinforce identified calculator skills?
- Is our departmental policy consistent with the school policy?

If the school does not have a whole-school calculator policy, draw up a list of points to include in an outline one. Before concluding, agree how this is to be finalised and implemented. Suggest that departments may wish to provide feedback to the mathematics department on what they would find useful in such a policy or by way of further guidance.

OHT 6.0

Objectives

- To review the use of calculators within departments
- To look at progression in calculator skills
- To explore the features of different types of calculators
- To contribute to a school policy on calculator use

OHT 6.1

Calculator skills that pupils need to develop

- Selecting from the display the number of figures appropriate to the context of a calculation
- Entering numbers and interpreting the display when the numbers represent money, metric measurements, units of time or fractions
- Knowing the order in which to use the keys for calculations involving more than one step
- Using facilities such as the memory, brackets, the square root, cube root, sign change and fraction keys, and the constant facility
- Judging whether an answer is reasonable

Key Stage 3 *National Strategy*

OHT 6.2

Calculator skills expected by the end of Year 6

- Use a calculator to perform a one-step calculation and interpret the result
- Key in and interpret money and measurement calculations
- Extend to calculations with more than one step, e.g. $18 \times (137 + 258)$
- Recognise rounding errors, e.g. recognise 2.9999999 as 3
- Recognise negative numbers and use the sign change key if appropriate
- Find decimals equivalent to fractions
- Recognise recurring decimals, e.g. 0.33333333
- Start to use memory keys and perform more complex calculations, such as $(234 + 739) \div (145 - 89)$
- Have a feel for the size of an answer and check it appropriately

Key Stage 3 *National Strategy*

OHT 6.3

Ageing fast

Juliet works out her age as 6 311 520 minutes.

Calculate how old she is (exactly!) in years, months and days.

Check your answer by reversing the calculation.

Key Stage 3 *National Strategy*

OHT 6.4

Comparing calculators

For each key sequence, predict the outcome when you enter it on a basic calculator and a scientific calculator.

2 [+] 3 [×] 4 [=]

2 [÷] 3 [=]

2 [÷] 3 [×] 3 [=]

2 [÷] 3 [−] 3 [=]

2 [÷] [(] 3 [−] 3 [)] [=]

Now see if you were right.

Key Stage 3 *National Strategy*

OHT 6.5

Departmental policy on using calculators

- Does our scheme of work make it clear when and where pupils are likely to require calculators?
- Are there times when we will expect pupils to do calculations without resorting to a calculator?
- Do we make it clear to pupils when and where we expect them to use a calculator and when we expect them not to?
- How do the calculator skills we expect pupils to use line up with those in the Framework for teaching mathematics?
- Are there opportunities in our scheme of work to teach or reinforce identified calculator skills?
- Is our departmental policy consistent with the school policy?

Handout 6.1 Hits of the decade

A game for two players, practising estimating decimal multiplication

Equipment: score sheet; calculator

Aim: hit more decades than the other player

How to play

Clear the calculator (note: this is the only time the screen is cleared during the game).

Player A: start by entering any number between 1 and 99. Score a point for the decade in which it falls by putting your initials in the adjacent box on the score sheet. Press [×] and pass the calculator to player B.

Player B: enter a number and press [=]. If the answer shown is in an unclaimed decade, enter your initials in the appropriate box. If the answer is in a claimed decade or is outside the 0–99 range, you lose your go. Press [×] and pass the calculator to player A.

Player A: enter a number and press [=]. Score as player B above.

The game continues until all decades have been claimed.

The winner is the player who claims most decades.

Example

Player	Keys pressed	Calculator shows	Decade hit	Who scores
A	28 [×]	28	20–29	A
B	2 [=] [×]	56	50–59	B
A	1.5 [=] [×]	84	80–89	A
B	.3 [=] [×]	25.2	20–29	decade claimed – no score
A	.1 [=] [×]	2.52	0–9	A

etc.

Hits of the decade: score sheet

Player A: _____

Player B: _____

Decade	Initials
0–9	
10–19	
20–29	
30–39	
40–49	
50–59	
60–69	
70–79	
80–89	
90–99	

Total scores

Player A:

Player B

Handout 6.2

Mental, written or calculator?

1 Three friends shared £411 equally. How much did each receive?

2 In a large sculpture of a human figure the length of one arm is 420 cm. The ratio of the length of the upper arm to the lower arm is 3 : 4. How long is each section?

3 Rashida travelled 532 miles for work last month. She is paid 35p a mile for the first 250 miles and 20p a mile for the remainder. How much will she receive?

4 6200 ÷ 125 =

5 A turkey is cooked for 45 minutes per kilogram plus 20 minutes. How long would you cook a 5.2 kg turkey?

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 On a school outing, 372 pupils and 12 adults are due to travel by coach. How many 51-seater coaches will be needed?

8 The mass of an object is 0.312 kg and its volume is 0.12 m^3. Density is mass divided by volume. What is the density of the object?