Choosing Effective Mental Calculation Strategies

Key NC Statement

Perform mental calculations, including with mixed operations and large numbers

Related NC Statements

- use their knowledge of the order of operations to carry out calculations involving the four operations
- express missing number problems algebraically
- solve problems which require answers to be rounded to specified degrees of accuracy

Key Concepts

Pupils have developed a wide range of mental strategies from previous learning in Years 4 and 5. By Year 6, pupils are required to choose an efficient strategy dependent upon the numbers involved in the problem. It is important for pupils to name these strategies explicitly and know the key features of each so that they are able to think of a suitable approach quickly. At this stage, pupils require plenty of opportunities to reason about why they have chosen a specific strategy over others and to apply knowledge of estimation to check the reasonableness of solutions.

This sequence incorporates calculation using all four operations. It also includes elements of calculating with fractions where a mental strategy is the most efficient approach. It does not include dividing a fraction by a whole number, as this will be covered in a subsequent Year 6 sequence in the Spring term.

Steps within the Learning Sequence

Step 1: Reasoning the efficiency of mental strategy

Step 2: Using estimation to check mental calculations

Step 3: Applying and combining mental strategies to solve problems

Destination Questions

1 $750.2 \div 10 = \square$	2 $\frac{1}{2} + \frac{1}{4} + \frac{1}{10} = \frac{\square}{\square}$	3 $1{,}000{,}000 - 2 = \square$
4 $\square = 3600 + 700$	5 $207 \div 1 = \square$	6 $7 \times \square = (2 \times 7) + (2 \times 7)$
7 $86 \times 2.5 = \square$	8 $122{,}456 - 11{,}999$	9 60×20

Step one

Reasoning the efficiency of mental strategy

Organise pupils into small, mixed ability groups and provide the calculation cards from handout_6LS3_step1_calculation_cards.
Discuss possible mental calculation strategies.
Ask pupils to sort the cards according to the strategy they believe to be the most efficient for the calculation and justify their decisions.
Be aware that some calculations could be solved using several strategies. All of which may be efficient. It is the discussion and reasoning that is the focus for this activity.

Use the talking frame (Handout_6LS3_step1_speaking_frame) to support pupils' reasoning.
For example:

I think I will halve one side and double the other so that the calculation is easier to manage.
The calculation will be 43 x 5.

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86 x 2.5 = □

I will regroup 2.5 into 2 and 0.5. This will allow me to double and halve 86 and then recombine.

Using the formal written method for this calculation is inefficient because multiplying by 2 and 0.5 are easy using my known facts.

For the calculation, I will use doubling and halving, changing it to 43 x 5. I will then multiply 43 by 10 using my place value knowledge and then halve it.

Refer to handout_6LS3_step1_teacher_guidance for details of each core calculation strategy and further examples of questions related to each.
Remember that some calcuations may have more than one efficient strategy.

Make explicit the range of strategies by collating examples of calculations to match each strategy on a classroom display / working wall for pupils to refer to when discussing calculations throughout Year 6.

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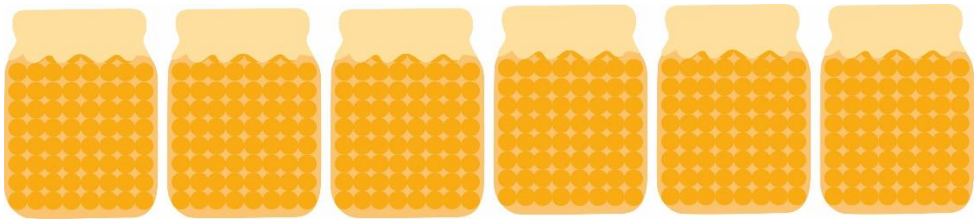
At the stage, it is crucial that pupils have secured a range of mental calculation strategies before moving on.
If pupils have gaps in knowledge, refer back to mental calculation sequences from Years 4 and 5 for guidance on consolidation.

BUFFER ZONE

Step two

Using estimation to check mental calculations

Display an image of a large quantity such as:



How many cheese balls do you think there are in all 6 containers?

I can see approximately 10 rows in each container and I think there must be around 20 in each layer.
20 cheese balls x 10 rows = 200
200 cheese balls x 6 containers = 1200

Ask pupils to record their jottings and calculations and discuss approaches.

What would be a sensible wrong answer?

What sort of number is it likely to be? Can you explain why?

Using handout_6LS3_step2_speaking_frame, link this idea of estimation and likeliness of number range to a more discrete problem such as 60 x 20.
Challenge pupils to think of a sensible wrong answer for this calculation and a suitable estimate. Ask pupils to provide their reasoning.

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Extend pupils understanding of what are reasonable answers by editing mistakes.
For example:

- 35,450 - 1,000 = 25,450

The answer is incorrect because the pupil has subtracted 10,000, not 1,000.
I think they have looked at the wrong digit.

- 6 x 47 = 66

The answer is incorrect because it should be 282. I think the pupil has regrouped 47 incorrectly into 4 and 7 rather than 40 and 7.

(6 x 7) + (6 x 4) = 66 INCORRECT
(6 x 40) + (6 x 7) = 282 CORRECT

Step three

Applying and combining mental strategies to solve problems

Play the game 'Strategy Score' using the cards on handout_6LS3_step3_strategy_score.
The focus in games such as these is to encourage pupils to compare the efficiency of calculation strategies. It can easily be adapted to include the names of other strategies familiar to the class.
Rules:

- Each player is randomly assigned a 'Strategy Card'. They will keep this for the duration of the game.
- Turn over one 'Calculation Card' at a time. All pupils attempt to solve the calculation using their assigned strategy.
- As a group, they justify which strategy would be most efficient and explain why.
- The player with the agreed most efficient strategy gets to keep the calculation card.
- Repeat until all the calculation cards have been used.
- The player with the most calculation cards wins.

Pupils need to be provided with the opportunity to apply their knowledge and understanding of mental calculation strategies in a range of contexts making links to measure and problems requiring mixed operations.

Questions could include:

- Sarah saves $\frac{2}{3}$ of her pocket money every week. After 4 weeks, she has saved £32. How much pocket money does Sarah get per week?
- Annie cuts 5m of ribbon into 3 pieces. The length of one piece is 2.83m. The second piece is 105mm. How long is the third piece?
- A recipe states that 150g of sugar is needed to bake a cake for 4 people. How much is needed to bake a cake for 8 people?
- A toy shop orders 12 boxes of stickers. Each box contains 20 packs of 6 stickers. How many stickers does the shop order in total?

Can you think of more than one way to solve the problem?

Between which two numbers is the answer likely to fall? Can you explain how you know?

Which calculation strategy did you use?