Renewing the Primary Framework for mathematics

Guidance paper

Oral and mental work in mathematics

Background and context

At the time the National Numeracy Strategy was introduced, there was concern that children's mental calculation skills and recall of facts were generally weak. In the 1999 *Framework for teaching mathematics from Reception to Year 6*, there is a section (page 13) that describes a typical daily mathematics lesson. This refers to the first part of the lesson as:

- Oral work and mental calculation (about 5 to 10 minutes)

  Whole-class work to rehearse, sharpen and develop mental and oral skills

The focus of this phase of the lesson was on strengthening children's oral and mental skills through regular daily practice. The 1999 Framework lists a number of activities that might form part of this oral work and mental work. This initial phase of the lesson has become known as the oral and mental 'starter' and was often judged by Ofsted to be the strongest part of mathematics lessons. Successful starters were short, focused activities that introduced the lesson and prepared the children for the main teaching activity. These 'starters' were objectives-based activities that supported children's learning and moved it on.

While the 1999 Framework states that the aims of the 'starter' were to rehearse, sharpen and develop mental calculation and related oral skills, the range of purposes and related activities has increased. Over time, the focus on oral and mental calculation has widened and become a vehicle for teaching a range of mathematics. Too often, the 'starter' has become an activity extended beyond the recommended 5 to 10 minutes. In these situations, there can be more teacher talk than there is oral and mental work that engages and involves the children. There is some evidence that the focus on oral and mental calculation has been lost and needs to be reinvigorated. It is important that the considerable gains made in schools are retained. The 'starter' to a lesson remains an effective way of engaging children at the start of a lesson through a brisk, well-focused activity that helps to secure children's knowledge and sharpens their skills.

Oral and mental activity

In most lessons, the oral and mental 'starter' activities continue to be rehearsal activities. Rehearsal and practice are designed to strengthen knowledge and skills. It is important that children have sufficient opportunity to consolidate the mathematics teaching they have received. Ofsted has pointed out that children's confidence is undermined by insufficient time to consolidate learning. This is a function that oral and mental activity can successfully fulfil, but oral and mental work fulfils many other purposes.

In the 1999 Framework there is a paragraph in the section on direct teaching (page 11) that sets out the hallmark of high-quality teaching.

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'High-quality direct teaching is oral, interactive and lively. It is not achieved by adopting a simplistic formula of "drill and practice" and lecturing the class, or by expecting pupils to teach themselves from books. It is a two-way process in which pupils are expected to play an active part by answering questions, contributing points to discussions, and explaining and demonstrating their methods to the class.'

The importance of interactive oral and mental work in the mathematics lesson is clearly stated. It is to help children to use the language of mathematics and to practise and secure their recall, thinking and reasoning skills. Children need opportunities to listen to and use mathematical language and to explain their methods, ideas and reasoning and this should be planned for during the main part of the lesson. The 'starter' remains a key point in the lesson where whole-class oral and mental work takes place and children are expected to listen, speak and think about mathematics before they move on to the main teaching activity. However, it must not be the sole opportunity for children to be active learners, speaking and listening about mathematics and thereby clarifying and refining their understanding, thinking and ideas.

The six Rs of oral and mental work

The table below identifies six features of children's mathematical learning that oral and mental work can support. There is a brief description of the learning focus and an outline of possible activities. These are not independent: oral and mental work may address more than one feature of learning and have more than one purpose. What is important is that the activity is purposeful and children understand what they are engaged in and required to learn during the oral and mental activity. The six Rs provide a vocabulary and guide to use when identifying the purposes of oral and mental work; they are not meant to provide a coverage checklist.

Six Rs	Learning focus	Possible activities
Rehearse	To practise and consolidate existing skills, usually mental calculation skills, set in a context to involve children in problem solving through the use and application of these skills; use of vocabulary and language of number, properties of shapes or describing and reasoning.	Interpret words such as *more*, *less*, *sum*, *altogether*, *difference*, *subtract*; find missing numbers or missing angles on a straight line; say the number of days in four weeks or the number of 5p coins that make up 35p; describe part-revealed shapes, hidden solids; describe patterns or relationships; explain decisions or why something meets criteria.
Recall	To secure knowledge of facts, usually number facts; build up speed and accuracy; recall quickly names and properties of shapes, units of measure or types of charts, graphs to represent data.	Count on and back in steps of constant size; recite the 6-times table and derive associated division facts; name a shape with five sides or a solid with five flat faces; list properties of cuboids; state units of time and their relationships.
Refresh	To draw on and revisit previous learning; to assess, review and strengthen children's previously acquired knowledge and skills relevant to later learning; return to aspects of mathematics with which the children have had difficulty; draw out key points from learning.	Refresh multiplication facts or properties of shapes and associated vocabulary; find factor pairs for given multiples; return to earlier work on identifying fractional parts of given shapes; locate shapes in a grid as preparation for lesson on coordinates; refer to general cases and identify new cases.
Refine	To sharpen methods and procedures; explain strategies and solutions; extend	Find differences between two two-digit numbers, extend to three-digit numbers to

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	ideas and develop and deepen the children's knowledge; reinforce their understanding of key concepts; build on earlier learning so that strategies and techniques become more efficient and precise.	develop skill; find 10% of quantities, then 5% and 20% by halving and doubling; use audible and quiet counting techniques to extend skills; give coordinates of shapes in different orientations to hone concept; review informal calculation strategies.
Read	To use mathematical vocabulary and interpret images, diagrams and symbols correctly; read number sentences and provide equivalents; describe and explain diagrams and features involving scales, tables or graphs; identify shapes from a list of their properties; read and interpret word problems and puzzles; create their own problems and lines of enquiry.	Tell a story using an interactive bar chart, alter the chart for children to retell the story; start with a number sentence (e.g. 2 + 11 = 13) children generate and read equivalent statements for 13; read values on scales with different intervals; read information about a shape and eliminate possible shapes; set number sentences in given contexts; read others' results and offer new questions and ideas for enquiry.
Reason	To use and apply acquired knowledge, skills and understanding; make informed choices and decisions, predict and hypothesise; use deductive reasoning to eliminate or conclude; provide examples that satisfy a condition always, sometimes or never and say why.	Sort shapes into groups and give reasons for selection; discuss why alternative methods of calculation work and when to use them; decide what calculation to do in a problem and explain the choice; deduce a solid from a 2-D picture; use fractions to express proportions; draw conclusions from given statements to solve puzzles.

Oral and mental work in every mathematics lesson

There are very rarely any mathematics lessons where oral and mental work cannot play a significant role in children's learning. Children may be asked to work individually and in silence to practise and consolidate learning but, for most learning, speaking about and listening to mathematics is an essential part of the learning activity. In every mathematics lesson some discussion and mental work will be required to stimulate and challenge children's thinking. The oral and mental 'starter' to the mathematics lesson may be quite short; a brief rehearsal of some number facts, part of an ongoing consolidation activity over a week or within a unit of work. Of course this sort of activity need not be confined to the starter or even to the mathematics lesson. For example, as children move about the room and clear away, the rehearsal activity can be reintroduced and, during those bits of time during the day when children queue up or get ready for some event, they might be asked to recite a number rhyme or tables facts.

In some mathematics lessons the oral and mental 'starter' may take longer, for example, when used to refresh past learning and stimulate thinking as a precursor to some new topic or to develop ideas that require some key knowledge and skills. When a new topic is being introduced, linking the oral and mental 'starter' to the main part of the lesson helps to sustain the focus of the learning for the children so they do not jump from one topic to another.

Planning oral and mental work into a lesson involves deciding when it is appropriate and for what purpose. It may draw on carefully planned, direct or prompting questions to support discussion with children and between children. It might be an assessment of all or some children's learning, that has taken place during or before the lesson, where the planning involves identifying more probing questions that seek to elicit what is limiting progress or to establish that learning has been secured. It might be that the children's learning is ready to be moved on and the questions and accompanying

dialogue are intended to promote explanation or reasoning, to stimulate new lines of enquiry, to evaluate alternative strategies or to propose hypotheses to test further.

The use of such prompting, probing and promoting questioning is a key feature of good teaching and learning. Questioning can be used to stimulate and sustain effective oral and mental work and the questions might be the children's own, as well as those posed by the teacher. The planned questions might be closed questions, for direct assessment purposes, or open questions, to stimulate dialogue or thinking. More often they are a mix of the two in response to purpose and need. When asked a question in the mathematics lesson, children need time and space to think about their responses. Planning how to facilitate this is important. Modelling it with another adult, or in a group of children, and allocating talk partners are helpful strategies, where children are given the opportunity to talk to their partners before they share their responses more widely.

Building some opportunity into the lesson for children to engage in oral work and dialogue is important. The choice of when and how requires professional and informed decisions that take account of the topic, children's progress and the teaching and learning strategies being deployed and promoted. It is important, too, that the mental work in which children engage during the lesson is acknowledged so that the children recognise how important this is within their learning. Mental work involves rehearsal and recall, but also draws in all the six Rs. It, too, can be stimulated by good questioning that requires children to use and apply the mathematics they have learned to explain, interpret, argue, reason and select information. For example, the question may involve deciding whether or not a statement about a set of numbers or shapes is true, interpreting the accuracy of some measurements against a scale, presenting an explanation following time spent discussing a method of calculation, or reasoning that a quadrilateral may have two pairs of equal sides but not be a rectangle.

An example of an oral and mental activity

Below is an example of an oral and mental activity. It is based on a simple resource, a sheet of paper, which provides a focal point for children during the activity. The sheet of paper becomes a structured resource that offers an image the children can use to support their thinking in the lesson or beyond. The oral and mental activity involves work on fractions. These are examples of questions that might be asked to stimulate discussion on fractions. As you read through the example, think about its purposes and possible applications. Identify the nature and role of the oral and mental work and how the vocabulary of the six Rs might help to describe its purpose. Below the activity are some suggestions for how the activity might be adapted for children of other ages and for developing related ideas and oral and mental work. Before reading the section, think about how you might adapt the activity for your children and how the use of some other simple resource might be developed along similar lines.

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The activity

Objective: Identify and estimate fractions of shapes; use diagrams to compare fractions and establish equivalents (Year 3)

Hold up a large sheet of paper. Establish that the children can see the whole of one side of the sheet of paper and you can see the whole of the other side of the sheet. Fold the sheet in half. **Note:** The sheet may be folded into halves, quarters, eighths and sixteenths beforehand to make this more manageable during the lesson.

Q: *What fraction of the whole sheet of paper can you see now?*

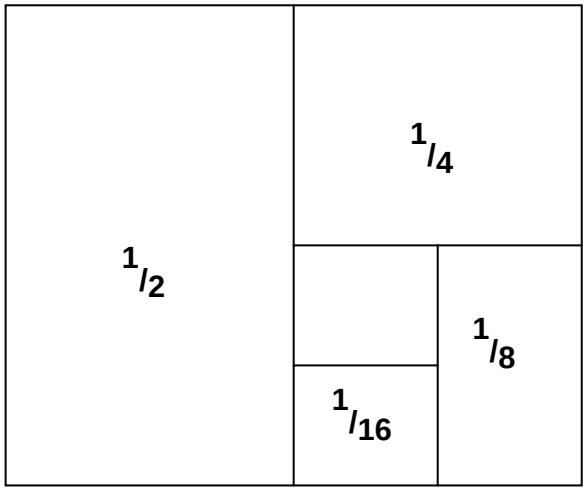
Q: *What fraction of the whole sheet of paper can I see now?*

Agree that the class and you can each see half of the sheet and ½ + ½ = 1. Unfold the sheet to confirm this and refold.

Fold the folded sheet and display a quarter. Ask the same two questions and establish that ¼ + ¼ = ½, unfolding and refolding the sheet.

Continue to fold, generating eighths and sixteenths. Each time, pose the questions and agree the fraction and confirm the fraction statements.

Unfold the sheet and invite the children to recall the fractional parts they have identified and used. Write these onto the sheet (see below).



With the annotated sheet displayed, ask a series of questions involving these fractions, such as:

Q: *How many quarters are there in the whole sheet?*

Q: *I am looking at one half of the sheet: how many eighths can I see?*

Q: *How many eighths are there in a quarter of the sheet?*

Q: *How many sixteenths are there in one half of the sheet?*

Q: *I am looking at four sixteenths, how many eighths can I see?*

Q: *If I shaded in three eighths and you shaded one half, which part would be bigger?*

Q: *If we removed one sixteenth, what fraction would be left?*

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Q: *I see one quarter and one eighth, how many eighths is that altogether?*

Q: *If I halve one quarter, what fraction would this give me?*

Q: *If I halve one sixteenth, what fraction would I get?*

Q: *Can you explain to me what happens to the number on the bottom of the fraction as I keep halving?*

Q: *What can you tell me about the relationship between halves, quarters, eighths and sixteenths?*

Q: *Suppose I start with a sheet and divide it into three parts. I then divide these three parts into three parts, what fractions would I get this time?*

Adapting the activity

The activity can be adapted by folding different strips of paper in various ways. For example, a long strip of paper could be folded into six identical adjacent rectangles. With younger children the strip might have an object drawn on each of the six rectangles so that children can count them aloud. As the strip is folded, so that the children see some of the objects while others are hidden from their view, they might be asked to say how many they can see and how many are hidden, then use these numbers to identify pairs of numbers that total six. Other strips or sheets of paper may be used to represent numbers greater or smaller than six.

A strip of ten rectangles might have fractions marked on them. For example, tenths are marked in the rectangles on one side of the sheet and, on the other side, fifths are marked in larger rectangles made up of two of the smaller ones. Alternatively, combinations of decimal and percentage equivalents might be incorporated. Other families of fractions might be used by folding a strip or sheet of paper in other ways.

Children might be set related tasks in other areas of the curriculum. For example, in art children analyse the way colour is used in abstract paintings. Children might design and create their own resources to support their work on whole numbers or fractions. They might strengthen their proportional reasoning through analysis of diagrams or charts that incorporate different shapes or use them to represent quantities.

Oral and mental activity in the teaching and learning of mathematics

Below is a table listing the **six Rs** in the first column – those six aspects of children's learning that oral and mental work can support. Across the first row is a list of the seven strands used to structure the objectives in the Primary Framework for mathematics. Use the table to review how you build the different aspects of oral and mental work into your mathematics teaching and where there may be some areas where the opportunity to incorporate oral and mental work might be strengthened. Use the **six Rs** to help you assess the balance of the oral and mental activity used to support children's learning.

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Questions for reviewing oral and mental work in mathematics teaching and learning

- Within each strand, what opportunities are there for children to **rehearse** and what do they rehearse?
- Are there key facts, other than number facts, that children should **recall** quickly and accurately?
- How does oral and mental work provide children with the opportunity to **refresh** and consolidate their previous learning?
- How does oral and mental work help children to **refine**, reinforce and use, with increasing precision, key aspects of mathematics across all strands?
- What mathematics do children **read**? Is reading mathematics a feature of each strand and what role does the oral and mental work play?
- How is children's ability to **reason** developed by oral and mental work? How is this work planned and organised across all strands?

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Oral and mental activity six Rs	Using and applying mathematics	Counting and understanding number	Knowing and using number facts	Calculating	Understanding shape	Measuring	Handling data
Rehearse To practise and consolidate existing skills…							
Recall To secure knowledge of facts…							
Refresh To draw on and revisit previous learning…							
Refine To sharpen methods and procedures…							
Read To use mathematical vocabulary and interpret…							
Reason To use and apply acquired knowledge…							