

Unit 7

Developing questioning and dialogue in mathematics

Following the training in the generic unit *Questioning and dialogue*, it is important to consider how the key messages of the training apply to mathematics. As part of the whole-school focus on assessment for learning, this subject development material is intended to help you consider the key messages of the training unit and identify any areas requiring development in your department.

The following is a brief summary of the training unit.

Objectives

- To recognise effective dialogue for learning and how it helps pupils become more independent learners.
- To understand the importance of questioning in creating effective dialogue.
- To consider strategies which develop whole-class and/or group dialogue.
- To understand that some strategies to promote dialogue are planned in advance while others involve seizing opportunities during a lesson.

Key messages

- Classroom dialogue is an essential component of assessment for learning because it:
 - enables teachers to make informed judgements about pupils' learning and, therefore, make immediate adjustments to their teaching;
 - enables pupils to develop their own learning as, through talk, they become more aware of their own learning needs and pathways to improvement. Therefore it progressively enables pupils to become more self-aware, independent learners.
- In effective dialogue, pupils' responses are well developed, build on or are informed by the ideas of others and often demonstrate higher levels of thinking. Where it is well established, pupils are willing to take risks or to challenge each other's ideas in a constructive way.
- Teachers are highly influential in triggering and sustaining the kind of dialogue that promotes and sustains learning in whole-class and small-group situations. A teacher's own talk is an excellent means of securing inclusive dialogue, where learning results from the interactions between teacher and pupils, and between the pupils themselves.
- While some strategies to promote learning through dialogue rely heavily on advance planning, others require a more responsive approach and are brought into play as evidence of pupils' understanding and misconceptions is revealed during a lesson.

- Questioning is often the first move in setting up interactive classrooms. Questions are key to formative assessment as they enable pupils to realise what they know and, more importantly, what they partly know and can then guide them to further develop their understanding.
- It is possible to achieve a classroom environment where dialogue is initiated and developed by pupils but this requires preparation and takes time to evolve.

Reviewing existing practice in questioning and dialogue

The following progression table provides a tool for a department to self-review current practice and to help identify an appropriate starting point.

As a department, agree and highlight the statements that best reflect the practice of the whole department. At the bottom of each column is a reference to the tasks that will support your current practice and provide the appropriate material to develop from this point.

Having completed this review you should read 'Making effective use of the subject development material' on page 4.

	Focusing	Developing	Establishing	Enhancing
Teachers	<p>The subject leader has identified that:</p> <ul style="list-style-type: none"> in most lessons whole-class talk is usually teacher to pupil to teacher as part of 'hands up' questioning teachers' questions have a sense of 'seeking the right answer' teachers lack strategies to build pupils' confidence to contribute teachers do not invite pupils to support, expand on or constructively challenge each other's responses group or paired dialogue rarely occurs and then only as a result of advanced planning. 	<p>Teachers are planning opportunities for dialogue in their lessons.</p> <p>Teachers are trialling and practising specific strategies to improve the quality of dialogue, e.g. use of 'wait time' and 'no hands up' questioning.</p> <p>Strategies include the use of different types of questions to trigger and sustain dialogue.</p> <p>Teachers are gaining in confidence in their use of paired and group dialogue to support learning.</p> <p>All pupils are encouraged to, and expected to, contribute to discussions.</p>	<p>Lessons typically involve advanced planning for strategies to trigger and sustain dialogue, e.g. 'big questions' are broken down into a series of smaller questions.</p> <p>Teachers are more confident in judging when to use strategies which respond to evidence of learning in their lessons, e.g. 'wait time' and 'cueing in pupils using gestures and prompts'.</p> <p>Teachers use appropriate resources and engaging activities to help focus and sustain dialogue.</p> <p>Teachers have established protocols and a supportive environment in which pupils can speak with confidence.</p>	<p>Whole-class and group dialogue is an integral feature of lessons across the school.</p> <p>Teachers routinely orchestrate classroom dialogue as an integral part of learning. The move from teacher exposition to classroom dialogue is seamless.</p> <p>The role played by dialogue to accelerate learning and develop pupils' independence is well understood. It informs both teachers' advanced planning and the strategies they use in response to critical learning moments during dialogue in lessons.</p> <p>Teachers' intervention in dialogue is minimal as pupils are well practised in whole-class and group discussion.</p>
Pupils	<p>The subject leader has identified that:</p> <ul style="list-style-type: none"> some pupils rarely contribute to discussions. Questions tend to be answered by a small number of 'enthusiasts' pupils' responses to questions are typically brief, often one word, recall or repetition when pupils speak out in whole-class discussions they are sometimes mocked by their peers during whole-class discussions some pupils are 'caught out' as not listening group and paired discussions rarely last long or discussions drift off task. 	<p>Pupils are increasing in confidence in discussions and contribute willingly.</p> <p>Pupils' responses are more extended, show increasingly higher-order thinking and their views are supported by evidence.</p> <p>During whole-class discussions, all pupils listen and respect the contributions of their peers.</p> <p>In group and paired discussions all pupils contribute and are beginning to learn from each other. Discussions are usually well focused.</p>	<p>All pupils regularly contribute to whole-class and group discussions.</p> <p>Pupils listen carefully to each other. They respond to, and build on, what others have said.</p> <p>Pupils typically give extended responses, demonstrate high-level thinking and can support their views.</p> <p>Pupils are confident to take risks by sharing partially formed thinking or challenging others in a constructive way.</p> <p>In group and paired dialogue, pupils listen to and learn from each other.</p>	<p>Pupils' responses are routinely well developed, build on or are informed by the ideas of others and demonstrate high-level thinking.</p> <p>Pupils are comfortable with whole-class 'basketball' dialogue. They are confident to take the lead in initiating and building on dialogue.</p> <p>Pupils are confident to take risks, to challenge the ideas of each other and be challenged.</p> <p>Pupils reflect on the dialogue process and know how to get the most from it.</p> <p>There is always a 'buzz' in the air during classroom dialogue.</p>
	Start with task 7A	Start with task 7B	Start with task 7C	Start with task 7C

Making effective use of the subject development material

The tasks you have been referred to are intended to focus the development or extension of questioning and dialogue in mathematics and provide guidance on how to embed this into the regular practice in mathematics lessons.

The results of the self-review will have suggested the appropriate task(s) to support your department's development needs.

To make best use of the supporting material the following sequence will be helpful.

1 Read the task and the supporting exemplification.

This describes how a department has approached the task and worked through each of its stages. It is given as an example of how the task might be addressed. It is not intended that you follow this approach, which is given as a guide to the process that will support improvements in your subject.

2 Identify what the department did and the impact it had on pupils.

Discuss as a team the example provided and establish the key areas that helped to develop this practice and the impact it had on pupils. It will be helpful to identify the changes in teachers' practice and how these impacted on pupils' learning.

3 Agree and plan the actions that will develop your practice.

As a department, agree how you intend to approach this task. Clarify what you are focusing on and why. The example given will act as a guide, but be specific about which classes, which lessons and which aspects of the curriculum will be your points of focus.

4 Identify when and how you will evaluate its impact on pupils.

The purpose of focusing on this is to improve pupils' achievement and attainment in mathematics. You will need to be clear on what has helped pupils to learn more effectively in your subject. Part of this will be how your practice has been adapted. You should jointly identify what has worked well and which areas require further attention.

5 Having evaluated these strategies consider what steps are required to embed this practice.

You will need to undertake an honest evaluation of what you have tried and the impact it has had on your teaching and on pupils' learning. One outcome might be that you need to spend longer on improving this area or you may be in a position to consider the next task.

Other departments in the school will have been focusing on this area and you should find out about the progress they have made.

You may find that some teachers in the department will require further time to develop and consolidate new practice, while others will be ready to progress further through the tasks in this area (while continuing to support their colleagues). Practice across a department will need to be consolidated before focusing on a new area of assessment for learning.

The subject development tasks

Handouts and slides referenced in the text are found in Unit 7, 'Questioning and dialogue' of the *Assessment for learning whole school training materials* folder (DfES 0043-2004 G), and on the *Assessment for learning whole school training materials* CD-ROM, 2nd edition (DfES 1240-2005 G CD).

Task 7A

Observe several lessons across your department, either directly or on video, to identify the characteristics of effective dialogue which:

- feature strongly (and the strategies used to achieve them);
- are absent or might be improved.

You could use the observation template on **handout 7.5** and the cards on **handout 7.4** as prompts for this analysis.

Task 7B

Having identified the strengths and weaknesses of classroom dialogue across the department, identify one feature of dialogue you wish to improve. For example, 'dialogue is reciprocal, i.e. pupils respond to and build on what others have said'.

Highlight the feature you have chosen in **handout 7.8** (these are shown across the top of the matrix). Work together to agree and tick the different strategies you could use to develop the aspect of dialogue you want to improve.

On the basis of this, choose two or three strategies that will help to develop dialogue. Then, as a department:

- collaboratively plan several lessons in which these strategies will be trialled;
- observe or video the lessons using **handout 7.5** to analyse the quality of the dialogue and the strategies used;
- focus evaluations of the lesson on the impact of the dialogue on developing pupils as independent learners.

Task 7C

Ask your pupils to consider the features of effective whole-class dialogue and work with them to focus on ways to improve them. For example, pupils might agree a protocol for developing whole-class 'basketball' dialogue. You may wish to prompt their thinking using the column headings on **handout 7.8**.

As a department, use handout 7.8 to identify and record those strategies that can help pupils to develop features of dialogue they have identified for improvement. Agree which are dependent largely on advanced planning for their success and which are more reliant on the seizing of opportunities during the lesson. Use this information to collaboratively plan, teach and review a sequence of lessons, being mindful of which professional development activities are most likely to support this (see **slide 7.4**).

The following pages provide examples of each task.

Task 7A

Observe several lessons across your department, either directly or on video, to identify the characteristics of effective dialogue which:

- feature strongly (and the strategies used to achieve them);
- are absent or might be improved.

You could use the observation template on handout 7.5 and the cards on handout 7.4 as prompts for this analysis.

Context

Following the whole-school focus on questioning and dialogue, the school coordinator for assessment for learning supported the mathematics department in reviewing existing practice in questioning and dialogue using the progression table.

The department had been focused on improving pupils' speaking and listening skills for about a term. During this time teachers had been modelling the use of mathematical vocabulary for reasoning and justifying and encouraging pupils to respond using the targeted words.

The review revealed that the department was between the 'focusing' and 'developing' stages in the progression table. Although teachers were identifying key questions to ask that would promote dialogue in their lessons, questioning was mostly 'hands up' and when difficult questions floored pupils, the teacher provided the answers.

Process

In order to establish the strengths and weaknesses in the department, it was decided that the department set up a series of peer lesson observations to record features of effective dialogue (on **handout 7.5**) together with some of the strategies being used.

In a department meeting teachers identified some lessons scheduled to be taught in the next few weeks which would be particularly good for developing dialogue. One lesson they selected was 'Calculation methods' (lesson 8N4.1 in the Year 8 intervention folder *From level 4 to level 5 in mathematics: Year 8 intervention* (DfES 0292/2002 G) (see **appendix 7A.1**).

Teachers observed each other's lessons and recorded their findings on handout 7.5, an example of which is shown in **appendix 7A.2**. The observation notes were discussed and evaluated in the next department meeting and teachers identified the following strengths in classroom dialogue.

- Pupils' contributions are well developed, e.g. pupils respond in sentences and use subject vocabulary.
- Pupils reprocess their thinking as a result of the dialogue, thus improving their own learning.

Then, using **handout 7.4**, the department discussed the strategies that contributed to these strengths. They identified:

- questions linked to resources or tasks;
- rich questions;
- wait time after a teacher question.

However, the department agreed that most dialogue was between the teacher and a targeted pupil and this rarely involved other pupils. They felt that the pattern of dialogue was closer to 'ping pong' than 'basketball', with few pupils engaged in the dialogue.

Evaluation

The department was positive about the outcomes of the lesson observations and felt that their focus on improving pupils' speaking and listening skills was having an impact on pupils' learning. Pupils' verbal explanations were exposing the class to a wider range of methods and approaches, and so helping pupils to make links and develop understanding. However, teachers could see that there was potential to go much further with improving dialogue in their classrooms. They decided to explore the features of effective dialogue further and to look for opportunities to incorporate more strategies into their lessons.

LESSON

8N4.1

Calculation methods

OBJECTIVES

- Understand and use decimal notation and place value.
- Consolidate the rapid recall of number facts, including positive integer complements to 100 and multiplication facts to 10×10 , and quickly derive associated division facts.
- Use standard column procedures to add and subtract whole numbers and decimals with up to two decimal places.
- Multiply and divide three-digit by two-digit whole numbers; extend to multiplying and dividing decimals with one or two places by single-digit whole numbers.

STARTER

10 minutes

Resources

OHTs 8N4.1a and 8N4.1b
Framework examples, pages 88, 96

Practise mental calculation skills and recall of number facts using a target number grid, for example **OHT 8N4.1a**. Ask questions such as:

- Q** What is the complement to 100 of this number?
- Q** What is this number multiplied by 100?
- Q** What is the sum of these two numbers?
- Q** What is this number divided by 4?
- Q** Which two of these numbers add to make 10?
- Q** What is double this number?
- Q** What is this number multiplied by 70?

Use **OHT 8N4.1b** or write 6.2×100 in the middle of the board. Invite pupils to give equivalent products, for example:

$$62 \times 10, 3.1 \times 200, 62\,000 \times 0.01, \dots$$

MAIN ACTIVITY

45 minutes

Resources

Resource 8N4.1c,
one per pupil
Resource 8N4.1d,
one per pair
Framework examples,
pages 48, 104, 106

Emphasise the importance of being able to calculate mentally and to use efficient written calculation methods.

Acknowledge that you know the sort of calculations they can already do, but you would like to find out more about the methods they use.

Ask one or two pupils to model examples of calculation methods they can use.

Ask them to explain how they would estimate and check their answers.

Note: By the age of 11, pupils are expected to use a formal written method for calculations such as $460 - 237$ or 23×17 . The most common methods expected of 11-year-olds are column addition and subtraction, long multiplication or 'grid' multiplication, short division or 'chunking' – see Framework examples, pages 104, 106.

Distribute **resource 8N4.1c** and ask pupils to work through the examples, deciding for each one whether they would do it:

- mentally (with or without jottings); or
- using a formal written method.

Emphasise that you are particularly interested in how they calculate, not just the accuracy of their answers. You are also keen to know how they estimate what might be a reasonable answer and how they check their answers after they do the calculation.

Circulate to observe and note the different calculation strategies being used. Probe pupils' understanding and help them extend and refine their strategies.

When pupils have completed all the questions they can tackle, say that you would like them to help you identify errors pupils have made in the past. Give out **resource 8N4.1d** and ask pupils to work in pairs to estimate an answer for each calculation, to identify what has gone wrong in each example and to correct the calculation.

PLENARY

5 minutes

Review the errors pupils have identified and establish important points for them to remember when doing calculations. These could be written on a sheet of sugar paper so that they can be referred to at a later stage.

Write the following word problem on the board and ask pupils to think about how they would tackle it:

Q A shop sells sheets of sticky labels. On each sheet there are 36 rows and 18 columns of labels. How many labels are there altogether on 9 sheets?

Model a sensible way to approach the problem, for example:

- underline the important information;
- decide what operations are needed;
- estimate the answer, then do and check the calculation;
- write the answer as a sentence, checking that it makes sense.

Solve the problem together and ask pupils to try to use a similar approach to the following problem set for homework:

Q A teacher needs 220 booklets. The booklets are sold in packs of 16. How many packs must the teacher order?

KEY IDEAS FOR PUPILS

- Always consider doing a calculation mentally.
- Check all calculations to make sure that the answer is sensible.

OHT

8N4.1a

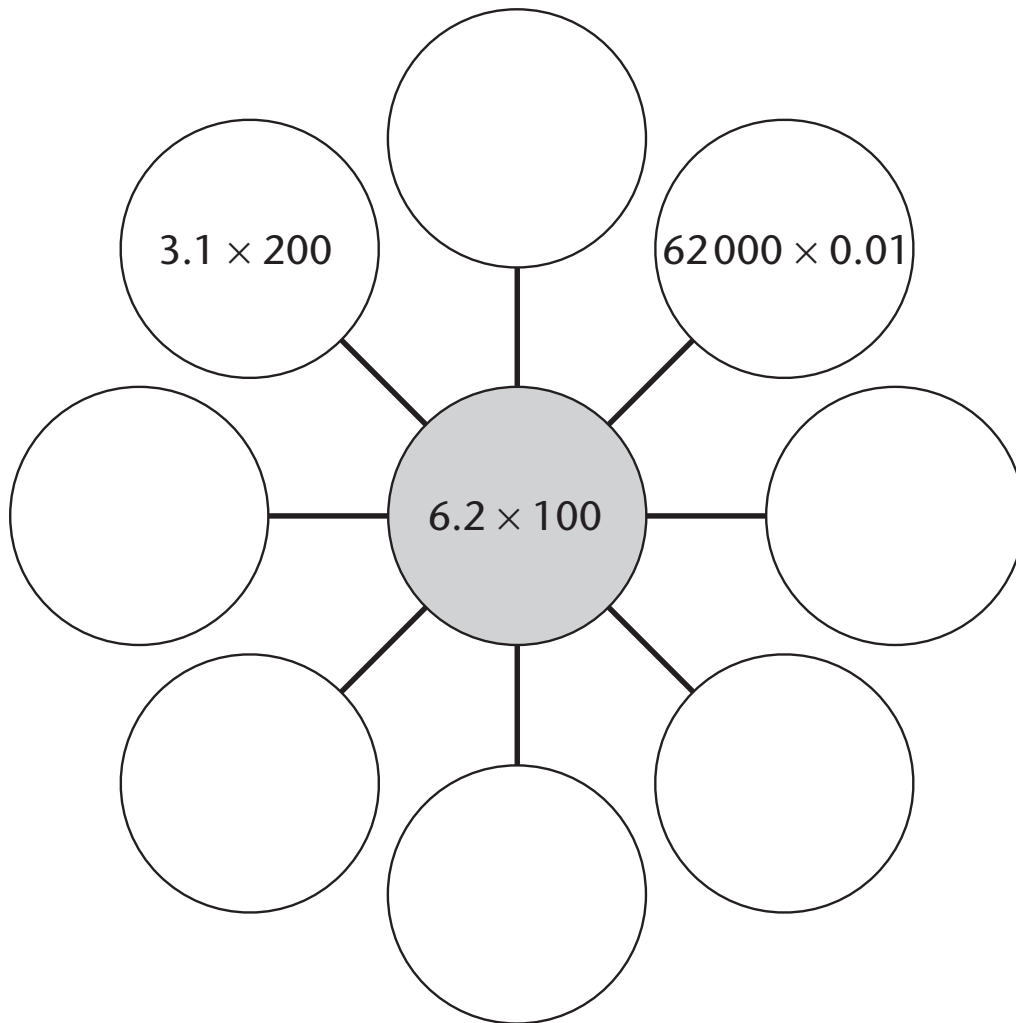
Target number grid

65	702	1.5	23
720	0.3	27	3.5
7.3	56	2.7	91
11	8.6	1200	38
850	46	125	8

OHT

8N4.1b

Equivalent products



RESOURCE

8N4.1c

Calculations

A $91 + \square + 48 = 250$	B $421.36 + 25.7 = \square$	C $\square + 1457 = 6924$
D Find the total of 42, 64, 78, 3 and 4681.	E Subtract 2250 from 8500.	F $7.65 - 6.85 = \square$
G $\square - 1457 = 2924$	H What must I add to 5.4 to make 9.3?	I $1040.6 - 89.09 = \square$
J $38 \times \square = 190$	K Calculate 673×24 .	L $9.9 \div \square = 1.1$
M Divide 109.6 by 8.	N $0.3 \times \square = 2.4$	O $428 \div 3.4 = \square$

RESOURCE

8N4.1d

Errors in calculations

<p>A</p> $\begin{array}{r} 238 \\ + 1487 \\ \hline 3867 \end{array}$	<p>B</p> $\begin{array}{r} 720 \\ - 196 \\ \hline 536 \end{array}$
<p>C</p> $\begin{array}{r} 234 \\ \times 52 \\ \hline 468 \\ 1170 \\ \hline 1638 \end{array}$	<p>D</p> $\begin{array}{r} 176. \\ 7 \overline{)123.2} \end{array}$ $123.2 \div 7 = 176$

Lesson observation sheet

Feature of effective dialogue	Strategies used to promote dialogue	Whole class	Group work
Everyone is engaged with the dialogue			
Teacher talk does not over-dominate the dialogue			
Pattern of dialogue is 'basketball' rather than 'ping pong'			
The dialogue is reciprocal, i.e. pupils respond to and build on what others have said			
Pupil contributions are well developed, e.g. at least a few sentences in length and include subject vocabulary	Teacher uses good questions to get pupils to use targeted vocabulary: <i>'Is there a mathematical word you can use in that answer?'</i> Teacher also uses wait time to give pupils time to think through their answers. Teacher encourages pupils to verbalise their methods, e.g. <i>'What is it about this calculation that means you know you can do it mentally?'</i> , <i>'How did you get that answer?'</i> , <i>'Try to explain your method again'</i> , <i>'What did you do first?'</i>	✓	✓
Pupils are willing to take risks, e.g. being prepared to verbalise partially formed thinking	Teacher uses good questions when pupils are on edge of learning: <i>'Has anyone got a strategy for multiplying by 1.5?'</i> , <i>'If I multiply by 0.3 will the answer be bigger or smaller?'</i> , <i>'How do you know?'</i> There are positive pupil responses – pupils are willing to have a go.	✓	
Pupils are willing to challenge and see the value in challenging each other's ideas in a constructive way			
Pupils demonstrate higher levels of thinking, e.g. analysis, synthesis, prediction or evaluation			
Pupils reprocess their thinking as a result of the dialogue and thus improve their own learning	Teacher uses rich questions to get pupils to justify their classification of calculations, e.g. <i>'What is it about this calculation that means you know you can do it mentally?'</i> Teacher uses questions to get pupils to evaluate methods of calculation, e.g. <i>'Can you do the calculation in a different way?'</i> , <i>'Which is the most efficient?'</i>	✓	✓

Task 7B

Having identified the strengths and weaknesses of classroom dialogue across the department, identify one feature of dialogue you wish to improve. For example, ‘dialogue is reciprocal, i.e. pupils respond to and build on what others have said’.

Highlight the feature you have chosen in handout 7.8 (these are shown across the top of the matrix). Work together to agree and tick the different strategies you could use to develop the aspect of dialogue you want to improve.

On the basis of this, choose two or three strategies which will help to develop dialogue. Then, as a department:

- **collaboratively plan several lessons in which these strategies will be trialled;**
- **observe or video the lessons using handout 7.5 to analyse the quality of the dialogue and the strategies used;**
- **focus evaluations of the lesson on the impact of the dialogue on developing pupils as independent learners.**

Context

The department had been focused on developing pupils’ speaking and listening skills for more than a term and through this had seen an increase in dialogue in lessons. Much of the initial focus was on the use of mathematical vocabulary with teachers modelling the use of targeted words and supporting pupils in doing the same. Following the whole-school focus on questioning and dialogue, the mathematics department audited the quality of classroom dialogue and identified the following strengths in their practice.

- Pupils’ contributions are well developed, e.g. pupils respond in sentences and use subject vocabulary.
- Pupils reprocess their thinking as a result of the dialogue, thus improving their own learning.

They also identified some areas of weakness in classroom dialogue. The key ones were that:

- everyone is engaged with the dialogue;
- the pattern of dialogue is ‘basketball’ rather than ‘ping pong’.

Process

The head of department met with the Key Stage 3 coordinator to discuss ways forward. They agreed to focus on ‘everyone is engaged with the dialogue’ as the next stage in developing effective dialogue. The head of department wanted to start by focusing on particular classes so decided to link the development to their approaches to strengthening pupils’ understanding of fractions. Analysis of pupils’ scripts for Year 8 and Year 9 end-of-term assessments had revealed several major misconceptions and gaps including:

- finding fractions of quantities;
- ideas of equivalence.

Both the head of department and the Key Stage 3 coordinator saw an opportunity for addressing these weaknesses through greater dialogue in the classroom.

At the next department meeting, the Key Stage 3 coordinator introduced the idea of linking the need to strengthen pupils' understanding of fractions with further work on effective dialogue. The department looked at **handout 7.8** and identified the strategies most likely to ensure that all pupils engaged in dialogue (see **appendix 7B.1**). The department agreed to focus on the following strategies. Teachers would:

- introduce a 'no hands up' policy in some lessons;
- give pupils discussion time to talk through answers to questions before responding.

They chose these to supplement the established practice with use of rich questions, questions linked to tasks and the use of wait time after a teacher question.

The department then planned a key lesson for the Year 7 unit, number 3. The key lesson was then adapted for different abilities.

The lesson was based on paired work using 'follow me' cards to help teachers to engage all pupils in discussion during the lesson. **Appendix 7B.2** is the lesson they planned for a lower-ability group working towards level 4 in number. **Appendix 7B.3** is the set of 'follow me' cards used in the lesson. In order to stimulate talk about mathematical thinking, they included problems that had a high level of challenge, so taking pupils to the edge of their learning.

Teachers carefully considered questions they could use to help pupils explain their thinking and so secure their understanding of finding a fraction of a given quantity. To ensure that every pupil was engaged in dialogue, they decided to have pupils working in pairs throughout the lesson.

One teacher volunteered to make an audio recording of the interactions of one pair of pupils during the main activity part of the lesson. A transcript of the dialogue between the teacher and a pair of pupils is included in **appendix 7B.4**. At the next department meeting, teachers listened to the audio recordings and evaluated the impact of the follow-me cards lessons.

Evaluation

Pupils said that they felt more confident to answer questions when they had been given discussion time and they became used to the 'no hands up' strategy fairly quickly, although this had taken some time to establish because pupils tended to call out in the initial stages. As a result of the gain in confidence by some of the quiet pupils, the teachers could now ask the majority of the class to answer questions.

The discussion time had enabled pupils to rehearse their answers, thereby improving the quality of responses. However, most discussions were taking place in pairs and consequently the level of discussion was still quite limited.

The department was keen to develop the strategies further to manage larger groups and whole-class discussions where pupils built on what others had said.

Strategies for promoting classroom dialogue

Teaching strategies	Everyone is engaged with the dialogue	Features of effective dialogue							
		Teacher talk does not over-dominate the dialogue	Pattern of dialogue is 'basketball' rather than 'ping pong'	Dialogue is reciprocal, i.e. pupils respond to and build on what others have said	Pupil contributions are well-developed sentences or phrases	Pupils are willing to take risks by sharing partial understanding	Pupils are willing to challenge each other's ideas in a constructive way	Pupils demonstrate higher levels of thinking	Pupils reprocess their thinking as a result of dialogue
Rich questions	✓								
Big questions									
Higher-order thinking questions									
Questions linked to resources or tasks	✓								
Peer discussion following a question	✓								
Wait time after a teacher question	✓								
Wait time after a pupil response	✓								
Varying length of wait time									
'No hands-up' questioning	✓								
Using wrong or partially correct answers to prompt responses									
Negotiating whether answers are right or wrong and why	✓								
Pausing to survey									
Eavesdropping on group dialogue									
Cueing in pupils using gestures and prompts	✓								
Modelling prompts and body language to encourage continuation									
Acknowledging where pupils demonstrate effective dialogue	✓								
Group-work strategies									

Year 7 lesson on fractions

Learning objectives

To discuss and develop a more secure understanding of:

- adding fractions with the same denominators;
- finding fractions of quantities;
- identifying equivalent fractions.

Learning outcome

- You will be able to confidently solve some or all of the word problems in the 'follow me' card game.

Key vocabulary

fractions, equivalent, numerator, denominator, quarters, half, halves, fifths

Oral and mental starter

10 minutes

Using OHT 3.1 from the consolidation lessons in *Targeting level 4 in Year 7: mathematics* (DfES 0085-2003), pupils work in pairs to consider ways to find the answer. Give 30 seconds for discussion in pairs and then take feedback.

- How many parts has the petrol window been divided up into?
- What is each part called?
- What fraction has been used?
- What fraction is left?
- How do you work out $\frac{4}{5}$ of 60?
- How would the answer change if the tank held 85 litres?

Main activity 1

10 minutes

Write the following fractions on the board: $\frac{2}{5}$, $\frac{3}{5}$, $\frac{3}{6}$, $\frac{6}{8}$, $\frac{4}{8}$, $\frac{1}{2}$, $\frac{75}{100}$, $\frac{4}{10}$, $\frac{1}{4}$, $\frac{60}{100}$, $\frac{20}{50}$, $\frac{4}{16}$.

Give pairs of pupils a few minutes to decide which ones are equivalent and why.

- Give me another fraction which is the same as $\frac{1}{2}$, $\frac{1}{4}$, etc.
- Where is $\frac{4}{10}$ on your ruler? What is it as a decimal?
- Let's see if we can use the fractions to find parts of 60.
- Which ones are easy and which ones more difficult?

Main activity 2

20 minutes

Give out the 'follow me' cards sheet – one to each pair of pupils.

Ask pairs to pick three questions: one easy, one reasonably difficult and one difficult and work out the answers. Ask pairs to prepare their explanations to share with the class. Tell pupils you will be asking for volunteers to justify their solutions on the board.

- Which are the difficult ones? Why?

Plenary

20 minutes

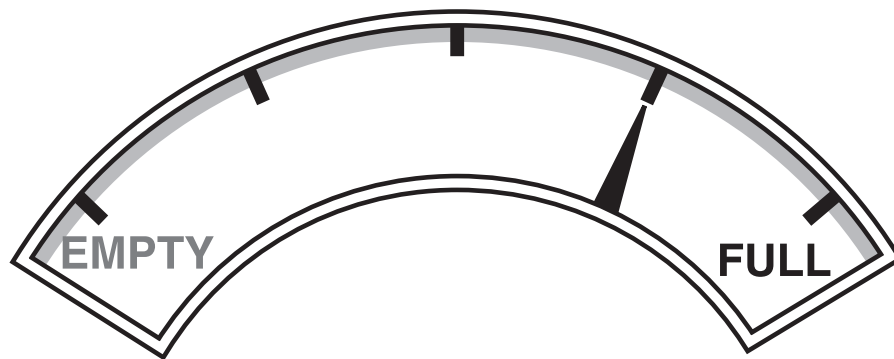
Use the cut-up version of the 'follow me' cards. Give each pair of pupils two or three of the 'follow me' cards. Then get all the class to do the complete 'follow me' card game.

Finish the lesson by asking pupils to assess what they have learned and what needs to be addressed next.

OHT 3.1

Fractions

A car's petrol tank holds 60 litres when it is full.



How much petrol is in the tank now?

Fractions ‘follow me’ cards

100	What fraction is £100 of £400?
$\frac{1}{4}$	What is $\frac{1}{2}$ of $\frac{1}{4}$?
$\frac{1}{8}$	What is added to $\frac{1}{8}$ to equal one half?
$\frac{3}{8}$	$\frac{3}{8}$ is equal to how many sixteenths?
6	What is $\frac{1}{2}$ of 6?
3	What is $\frac{1}{3}$ of 3?
1	How many tenths in a whole one?
10	What is $\frac{2}{5}$ of 10?
4	What fraction is £4 of £6?
$\frac{2}{3}$	How many eighteenths in $\frac{2}{3}$?
12	What is $\frac{1}{6}$ of 12?
2	What is $\frac{1}{4}$ of 2?
$\frac{1}{2}$	What is $\frac{1}{2}$ of $\frac{1}{8}$?
$\frac{1}{16}$	What is added to $\frac{1}{16}$ to equal $\frac{1}{2}$?
$\frac{7}{16}$	What is $\frac{7}{16}$ of 160?
70	What is $\frac{4}{7}$ of 70?
40	What is $\frac{3}{8}$ of 40?
15	What fraction is 15 of 25?
$\frac{3}{5}$	How many hundredths in $\frac{3}{5}$?
60	If $\frac{3}{5}$ is £60, what is $\frac{5}{5}$?

Lesson Transcript: extract from the Year 7 fractions lesson

Teacher = **T**

Pupils listed by pseudonyms

The pupils are finding $\frac{4}{5}$ of a quantity.

The teacher had drawn a 10 cm line to scaffold the understanding of $\frac{1}{5}$ of a whole.

T: On this number line where would one fifth be? Show me with your finger.

Joe: About here.

T: If I asked you to put a mark to show exactly where one fifth is what would you do?

Joe: Measure it? Get the ruler.

Adam: The line is 10 cm. It would be here because you cut it into 5 for one fifth so 2 cm.

Joe: One fifth was used up.

Adam: So ten take away two is eight.

T: Let's go over what you did and then you could try your method for finding four fifths of sixty.

Joe: Share sixty by five.

Adam: Fifteen.

Joe: No that's a quarter. How many fives in sixty, fifty, ten ... Think it is twelve.

Adam: Yes, five tens are fifty.

Joe: The answer is twelve from sixty, fifty, forty-eight. Forty-eight is the answer.

T: If I know that one fifth of sixty is twelve, which it is, how could I find four fifths of sixty without using subtraction? If I asked you to share your strategy with the class, would you do that? Joe would you do that?

Joe: Suppose so.

Discussion time has allowed the teacher to intervene to support pupils who can't get started

Discussion time has created an opportunity for a more secure understanding through pupils repeating and reinforcing the strategies they have used

Joe rarely answers questions in lessons. Paired discussion time has enabled him to become engaged in a learning dialogue

Through the learning dialogue Joe has confidently applied the subtraction strategy Adam used for finding four fifths of ten

This significant gain in confidence could not have occurred without the 'no hands up' policy

Task 7C

Ask your pupils to consider the features of effective whole-class dialogue and work with them to focus on ways to improve them. For example, pupils might agree a protocol for developing whole-class ‘basketball’ dialogue. You may wish to prompt their thinking using the column headings on handout 7.8.

As a department, use handout 7.8 to identify and record those strategies that can help pupils to develop features of dialogue they have identified for improvement. Agree which are dependent largely on advanced planning for their success and which are more reliant on the seizing of opportunities during the lesson. Use this information to collaboratively plan, teach and review a sequence of lessons, being mindful of which professional development activities are most likely to support this (see slide 7.4).

Context

The department had been focused on developing pupils’ speaking and listening skills for more than a term and through this had seen an increase in dialogue in lessons. Much of the initial focus was on the use of mathematical vocabulary with teachers modelling the use of targeted words and supporting pupils in doing the same. The department then decided to use strategies to engage all pupils in dialogue, focusing on:

- a ‘no hands up’ policy in some lessons;
- giving pupils discussion time to talk through answers to questions before responding.

They found that this further improved pupils’ engagement in lessons. All but very few pupils were now engaging in dialogue with their peers and/or with the teacher. The department felt that they were now ready to develop this practice further – to move towards a ‘basketball’ rather than ‘ping pong’ pattern of dialogue. It was decided that pupils would be asked to agree a protocol for developing group and class discussions and, based on this, teachers would plan a sequence of lessons where pupils could practise their protocol.

Process

Two teachers volunteered to work with one Year 8 class to start the development of the protocol. They gave pupils a short group task to compare the differences between discussing their work with one other person and discussing their work in a group. The following question was posed:

What do you have to consider when you are working in a group?

The pupils came up with the following.

- Listen to what others say.
- Give people time to think.
- Ask questions.
- Make sure that everyone contributes.
- Include people who aren’t contributing.
- Look at people with interest when they are talking.
- Allocate roles, e.g. scribe, spokesperson.

After further discussion with the teachers, pupils identified 'ask questions' as the most important feature for effective talk in a group because it ensures that everyone is engaged in the thinking process. So pupils decided that, during group work, everyone should ask a question.

The two teachers then met to decide on a strategy to help pupils engage in group work through asking each other questions. They looked at the strategies on **handout 7.8** and recognised that they needed to model, for pupils, ways of asking questions in lessons. They decided to give pupils a list of generic rich questions commonly used by teachers in the department that pupils could also benefit from using with each other.

- *How did you get your answer?*
- *Does it always work? Why?*
- *When doesn't it work? Why?*
- *What happens if you ...?*
- *Can we find a rule?*
- *Is the answer reasonable?*
- *How will we write it down?*
- *Could we do it in a different way?*
- *What are the clues in the question?*
- *When did we do some maths that was like this?*
- *Is there a connection with ...?*

They produced these rich questions on A5 card for pupils to reference during group work and then worked for a second time with the same group of Year 7 pupils. To help pupils try out the rich questions, they gave groups big questions to explore through discussion. The big questions they used in this lesson were:

- $93 \times 26 = 39 \times 62$ – do you always get the same product when you reverse the digits of two 2-digit numbers?
- Why is 2, 5, 8, 11 ... called a linear sequence?
- Does division always make a number smaller?
- Why is the formula for finding the area of a trapezium $h(a+b)/2$?
- Is n^2 always greater than n ?
- Find an equation to fit this curve ...

Pupils found it difficult at first, and the two teachers needed to help groups by modelling ways of asking the rich questions. Pupils were becoming more confident by the end of the lesson.

After the second lesson the two teachers met briefly to consider the planning implications for this work. They agreed that the big questions could and should be planned in advance of all lessons, but that the use of rich questions by both teachers and pupils was different. While these questions could be planned, their use in specific contexts was more spontaneous and needed more consideration by both teachers and pupils.

The two teachers presented their findings at the next department meeting and suggested that the team should incorporate more big questions into their lessons alongside the rich questions cards for pupils.

In the lesson planning, teachers anticipated times in the lesson when they would say 'what question could we ask?', or model questioning by saying 'I am going to ask this question about the problem. What other questions could we ask?'

Evaluation

It was agreed that the discussion skills being taught and learned as a result of this task were transferable to the development of whole-class dialogue. Some teachers who would not have been confident enough to do this previously were managing longer whole-class dialogues with relative ease. The focus on pupils' questions during group work had raised the level of curiosity in the classroom and pupils were much more engaged in solving problems collaboratively. Teachers were planning more group work in lessons as they became more confident with managing pupils' dialogue.

The department's next focus was to develop whole-class dialogue through pupils building on what others had said.

Subject-specific references

Referenced strategy materials

From level 4 to level 5 in mathematics: Year 8 intervention (DfES 0292-2004 G)

Targeting level 4 in Year 7: mathematics (DfES 0085-2003)

Other strategy materials of interest

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

QCA materials

Using assessment to raise achievement in mathematics: Section 2 Using effective questioning techniques (QCA, www.qca.org.uk)