Research for Teachers

Effective classroom talk in science

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How does talk promote learning in science?

Talk is a teacher's prime teaching tool, but how many of us stop to plan or analyse what we say, or think about how it affects pupil learning? This research summary features a project* that examined in detail how teachers use talk to promote meaningful learning in science.

The researchers analysed the interactions between 12 teachers (six primary and six secondary) and their pupils in science lessons to find out what strategic use of talk in teaching (often called 'dialogic teaching') looked like in science. They found that science teachers needed to use different kinds of talk to enable pupils to move from their existing everyday understanding of natural phenomena towards a scientific view. These included 'dialogic' episodes when teachers probed pupils' everyday ideas and 'authoritative' episodes when the teacher introduced scientific ideas. Sometimes the talk was interactive and sometimes it was not. The skill lay in making the right choices at the right time.

The researchers worked in both primary and secondary classrooms so they could compare challenges and approaches to dialogic teaching in both settings. For example, although primary school teachers sometimes worked at the limit of their subject knowledge, they were more likely than secondary science teachers to focus on dialogue. The researchers felt that this was due to the wider remit they had for pupils' learning, which included 'speaking and listening' as well as science.

The analyses of classroom talk, example dialogues and suggested approaches for promoting classroom talk that are presented in this research summary will help both primary and secondary science teachers to consider how they could develop their use of talk in the classroom in ways that will promote meaningful learning.

This research summary is based on the following project outputs:

Mercer, N. (2007) *Dialogic teaching in science classrooms: Full Research Report, ESRC End of Award Report*, RES-000-23-0939-A, ESRC, Swindon

Mercer, N., Dawes, L. and Kleine Staarman, J. (2009) 'Dialogic teaching in the primary classroom', *Language and Education*, 23 (4), pp. 353-369

Mercer, N. and Littleton, K. (2007) 'Chapter 4: How dialogue with a teacher helps children learn', in *Dialogue and the Development of Children's Thinking*, Routledge, London

Scott, P., Ametller, J., Mercer, N., Kleine Staarman, J. and Dawes, L. (2007) *An investigation of dialogic teaching in science classrooms*, paper presented at NARST, New Orleans

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Overview

Why is the issue important?

Many primary teachers lack confidence about teaching science . At the same time, research (such as Alexander, 2008) shows that many teachers (both primary and secondary) are unaware of how to ensure their classroom talk is constructive for learning science. This research helps on both fronts.

What did the study find out?

The researchers found that science teachers needed to use different kinds of talk to enable pupils to move from their existing everyday understanding of natural phenomena towards a scientific view. These included dialogic episodes when teachers probed pupils' everyday ideas and 'authoritative' episodes when the teacher introduced scientific ideas. Sometimes the talk was interactive and sometimes it was not. The skill lay in making the right choices at the right time. The study also showed that while primary school teachers sometimes worked at the limit of their subject knowledge, they were more likely than secondary science teachers to focus on dialogue due to the wider remit they had for pupils' learning, which included 'speaking and listening' as well as science.

What links between classroom talk and learning did the researchers find?

The researchers identified the links between dialogic teaching and meaningful learning by examining the 'pathways' followed by individual pupils in their learning. For example, one pupil progressed from everyday to scientific thinking through a number of learning steps that included:

- becoming aware of her everyday views
- comparing everyday and scientific views
- developing an understanding of the scientific view
- applying the science view in different contexts; and
- reviewing learning.

The teacher enabled meaningful learning of the science concept in question by supporting these steps in learning through activities that were mediated by talk.

How was the research designed to be trustworthy?

The research was carried out in five primary schools and three secondary schools and involved six primary and six secondary teachers and their Year 5/6/7 classes. The researchers made recordings of the teachers' talk as they interacted with whole class, small groups and individual pupils, and the talk that occurred amongst a group of pupils in each class. From this they identified approaches and patterns of interaction. The researchers also interviewed a sample of pupils in each class immediately after lessons and several weeks later, and gathered written work to elicit their understanding of the science concepts taught. Approximately 120 hours of classroom talk and 20 hours of interviews were recorded.

What are the implications?

The research showed the importance of teachers:

- examining and reflecting on their own dialogic teaching skills, and analysing example dialogues to increase their awareness of how they use talk and how talk can be used
- planning activities designed to make pupils' everyday assumptions explicit (such as sets of statements to talk about that include common misconceptions)

- noting down pupils' everyday assumptions to use in future lessons when demonstrating the scientific view; and
- monitoring, together with pupils, the development of pupils' understanding of scientific concepts.

It also showed the importance of school leaders:

- bringing primary and secondary teachers together to enable primary teachers to develop their scientific knowledge and secondary teachers to develop their use of dialogue in science classrooms; and
- encouraging science teachers to analyse example dialogues from science lessons perhaps using the key elements of dialogic teaching in science identified by the researchers as a framework.

What do the case studies illustrate?
The case studies complement and illustrate aspects of dialogic teaching in science explored by the researchers. They show how:

- a group of primary teachers changed their pattern of classroom talk quickly and easily through an innovative approach that involved using puppets
- a teacher alternated between two kinds of talk (authoritative talk during whole-class teaching interactions and dialogic talk during group work) and his mentor considered the messages that the two kinds of talk sent to the pupils
- a teacher's dialogue helped pupils to move from an everyday understanding of forces to a scientific view; and
- concept cartoons (which present a picture of a recognisable situation along with different points of view) were used as a stimulus for promoting purposeful argument between small groups of pupils in science.

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Study

What does dialogic teaching involve?
The researchers drew on Robin Alexander's work on dialogic teaching. Alexander found that teachers whose pupils achieved the best learning outcomes regularly used dialogue to:

- find out what the children already knew
- support and guide the children's activity
- monitor their engagement with the progress of a topic
- assess the development of their understanding; and
- encourage more active and extended pupil talk on the part of the pupils.

In short, such teachers made good judgements about what kind of interaction and talk was best suited for the occasion.

Alexander suggested that with dialogic teaching:

- teachers' questions are structured in ways that provoke thoughtful answers
- pupils' answers provoke further questions and are seen as the building blocks of further dialogue rather than the end point; and
- teacher-pupil and pupil-pupil exchanges are chained into coherent lines of enquiry rather than left hanging or unconnected.

Typically, the teacher asks pupils for their points of view and explicitly takes account of them. For example, the teacher:

- asks for further details ('Oh, that's interesting, what do you mean by...')
- writes them down for further consideration ('Let's just put that down on the board, so that we don't forget it...'); and
- asks other pupils whether they agree with the ideas or not ('Do you go along with what Julia has just said...?').

You will find further examples of dialogic teaching in the second section of the pupil participation anthology - Improving pupil learning by enhancing participation.

By seeking and comparing different points of view, a teacher both enables those views to be shared and helps children to see how to use language to compare, debate and perhaps reconcile different perspectives. Teacher questions that require only brief, factual answers do not give children such opportunities. But dialogic teaching, with its emphasis on extended explanations and discussions of problems or topics, does. Alexander's comparative, cross-cultural research revealed that such extended question and answer sessions were rare the world over. Other research (see for example the research summary - Effective talk in the primary classroom) has shown that even teachers keen to improve their talk skills find it hard to change the pattern of their classroom talk.

You may like to read **case study 1** which shows how a group of primary teachers changed their pattern of classroom talk in science quickly and easily through an innovative approach that involved using puppets.

How did the researchers characterise the kind of talk teachers used in science?
In science, meaningful learning entails movement from the existing everyday ideas children have towards a scientific view. (This juxtaposition of everyday and scientific ideas is examined in some depth in the research summaries Learning science and Students' views about science theory and practice). The researchers set out to identify strategies science teachers used to engage pupils in constructive dialogues that shifted the pupils' understanding of natural phenomena from everyday to scientific explanations. In so doing, they revealed new insights into how science teachers in particular used dialogue to support pupil learning effectively.

The researchers built on the earlier research of Mortimer and Scott which highlighted the problems pupils often have in moving between everyday and scientific understandings of natural phenomena. They showed how dialogue with a teacher may be one means of enabling pupils to take on a scientific perspective of natural phenomena. These researchers identified two dimensions of teacher-led talk:

- interactive non-interactive (which represented the extent to which the pupils were actively involved in the dialogue); and
- authoritative dialogic (which represented the extent to which the teacher was positioned as the expert and the extent to which they offered possibilities for substantial contributions by pupils).

You may like to read **case study 2** which shows how one teacher alternated between authoritative talk (during whole-class interactions) and dialogic talk (when the pupils were carrying out practical experiments) and the messages that these two kinds of talk sent to the pupils.

Taken together, these two dimensions allowed any episode of classroom dialogue to be defined as being interactive or non-interactive on the one hand, and dialogic or authoritative on the other. The researchers thus identified four classes of teacher-led talk in science:

- interactive/dialogic (teacher and pupils consider a range of ideas)
- interactive/authoritative (teacher focuses on one specific point of view and leads students through a question and answer routine with the aim of establishing and consolidating that point of view)
- non-interactive/dialogic (teacher reviews different points of view); and
- non-interactive /authoritative (teacher presents a specific point of view).

For example, in an interactive/dialogic episode a teacher might ask pupils for their ideas on a topic. The teacher might record those ideas on the board for future reference, or ask other pupils whether or not they agreed with what had been said. The teacher might ask pupils to elaborate on their ideas ("Oh, that's interesting, what do you mean by that?"). But the teacher would not make evaluations of these ideas, in terms of their correctness, or lead the discussion along a narrow, pre-defined track. In a non-interactive/ dialogic episode, the teacher might draw pupils' attention to their differing viewpoints. With interactive/authoritative classroom talk, the teacher would act more explicitly as an expert, keep to a given agenda and direct the topic

of the discussion clearly along certain routes (which may reflect the structure and content of the curriculum topic being dealt with). In a non-interactive/authoritative episode the teacher would typically present ideas in a lecturing style.

The researchers emphasised that these different types of talk did not represent better or worse teaching strategies in any absolute sense, but that teaching quality depends on making the right strategic choices between them, and that different types of talk can be complementary to each other. They pointed out that classroom talk need not always be dialogic; that there will be occasions when the teacher may quite justifiably not be interested in exploring pupils' ideas and taking account of them. The teacher may feel the time is right to focus on scientific content, to introduce some new question or concept, or to redirect pupils' attention to the phenomena under investigation. The key lies in the teacher's skilful application of a varied repertoire of ways of using language as a tool for teaching and learning.

What did dialogic teaching in science look like in practice?

The researchers provided examples of classroom dialogue they had recorded and they highlighted some of the features of dialogic talk that the examples demonstrated. The examples in this section were recorded in a primary school with a Year 6 group. The first dialogue took place during a plenary that followed a group-based activity in which the children had discussed a set of statements about the solar system before deciding if they were true of false. The second dialogue came from later in the same session. At this point, the teacher had a large photo of the moon on the interactive whiteboard. She also had a lamp on the table (representing the sun) a globe (the Earth) and a tennis ball (the moon).

Example 1

The excerpt of dialogue below reveals a number of dialogic features. The teacher's questions were designed to provoke thoughtful answers and encourage the pupils to state their points of view. The pupils had the opportunity to try to express their ideas clearly and hear each other's viewpoints. The talk was interactive/dialogic because the teacher engaged in a series of questions that enabled the children to express their own ideas and did not critically assess them as right or wrong. Rather she took account of them and allowed the dialogue to continue. In this way, the teacher learned about the children's current understanding of the topic and was later able to use the information. The pupils were used to the approach the teacher used to ensure as many pupils felt able to give their views as possible - that is not commenting on whether an answer was right or wrong and asking the pupils to suggest who they would like to contribute to the discussion.

Teacher: Keighley, would you read out number nine for us?
Keighley: (reads) The moon changes shape because it is in the shadow of the Earth.
Teacher: Right, now what does your group think about that?
Keighley: True.
Teacher: What, why do you think that?
Keighley: Hm, because it's when Earth is dark then, hm, not quite sure but we think it was true.
Teacher: Right, people with hands up. (To Keighley) Who would you want to contribute?
Keighley: Um, Sadie?
Sadie: I think it's false because when the sun moves round the Earth, it shines on the moon which projects down to the Earth.
Teacher: (to Sadie) Do you want to choose somebody else? That sounds good.

Example 2

In the sequence below, the talk had a different pattern. The teacher's talk took up a much greater proportion of the dialogue. She used the longer turns to explain (with the use of the models of the Earth, sun and moon) how the solar system generates the moon's phases. She again interacted with the children, but this time her questions were mainly used to check the children were following her explanation. The dialogue was thus interactive/authoritative, though also non-interactive/authoritative in parts. The researchers felt that the pupils' rapt attention was enhanced by their earlier opportunities to talk about the moon in their groups and in the previous interactive/dialogic episode.

Teacher: Right look, if the sun's shining from here there is nothing between the sun and the moon, so from here on Earth what we can see is a circle, a big shiny full moon. (She held the 'moon' so it was the third object inline with the 'sun' and 'Earth') Right? That's a full moon; we can see the whole caboodle, if we're here on Earth and the suns over there. However, have a look now, what happens now. If I put the moon here (she put the 'moon' between the 'sun' and the 'Earth') here's the sun, is there any light from the sun falling on this moon that we would be able to see from Earth?
Children: No.
Teacher: What would we see if the moon is in that position?
Children: Nothing.
Teacher: Yeah, it's dark, yeah, the light needs to land on it for us, it can't shine on itself. So that's when it's the darkest bit of the moon, we can't see it (the teacher returned the 'moon' to the first position). That's a full moon, over here relative to the Earth, (moves 'moon' to second position) and that's when it's dark. However (a child tries to interrupt) wait a minute, let's get this right. If we come half way around (she repositioned the objects so that the 'moon' and the 'Earth' were next to each other, facing the 'sun') the sun's shining on this bit, but not on this bit, what would we see then?
Children: Half/half-moon.
Teacher: It would look like that. (The teacher pointed at a picture of a half moon on the whiteboard)

You may like to read **case study 3** which provides an analysis of a series of longer dialogues.

What links between dialogic teaching and meaningful learning did the researchers find?
To find out the links between dialogic teaching and learning, the researchers developed detailed records of the learning journeys of targeted pupils. The pupils' pathways were developed from a range of sources including what pupils said in class, written work, sketches and drawings and how they engaged in activities. For example, they charted Josie's (a Year 7 pupil) learning pathway about the normal force (which Josie's teacher referred to as the 'up-push').

Josie's learning pathway
Josie's learning pathway led from an everyday view through to the correct application of normal force in different contexts. It was clear that specific teaching activities, and especially the talk around them, enabled her to take steps in meaningful learning.

The starting point was a picture (a 'concept cartoon') that depicted four points of view about what forces might be acting on a bottle standing on a shelf:

- The bottle is not moving. There are no forces on it.
- The only force on the bottle is the force of gravity pulling it downwards.
- There are two forces on the bottle - the force of gravity and the push of the shelf upwards, which balances it.
- A shelf cannot push. It is just in the way of the bottle and stops it falling.

The (Year 7) class was expected to discuss the points of view presented in the concept cartoon in pairs before contributing to a whole-class discussion.

When discussing the picture of the bottle on the shelf with her partner, Josie stated that "the only force acting is gravity" and that "the shelf cannot push". This was in disagreement with her partner who maintained that "there are two forces on the bottle - the force of gravity and the push of the shelf upwards which balances it". In a plenary, Josie articulated her view to the class, "Well like, I don't think that a table can push. Cos gravity pulls, it's a force...but a table can't push upwards, it's just in the way of the erm...that's all".

In the next lesson, the teacher referred back to the debate about the bottle on the shelf and asked Josie "What were you arguing about?" Josie replied, "That a table can't push up". The teacher used this as a starting point for arguing, with the help of a balloon, that a table can provide an upward force. After the demonstration with the balloon, Josie worked with her partner on an activity where they were asked to write down a useful way of thinking about a 'bottle on a shelf'. Josie wrote: 'The table has up-push normal force. Gravity is pulling it

down. The table is pushing upwards. The bottle is pushing downwards'.

In the third lesson the teacher represented forces with arrows on a whiteboard. Josie and her partner worked on an example which showed tomatoes in the pan of a weighing scale. In answer to the question 'What are the forces acting on the tomatoes?' they showed one arrow acting down which they labelled 'gravity' and one arrow acting up which they (incorrectly) labelled 'tension'. In the plenary following this group activity, Josie contributed to placing the force arrows on the whiteboard. She correctly placed the upward and downward arrows.

At the end of the series of lessons, Josie was involved in an activity in which she had to give a 'clue' to enable a fellow pupil to guess the term 'up-push/normal force'. Josie stated, "Like a bottle standing on a shelf has gravity on it and something keeping it up from the table".

In summary, Josie progressed from everyday to scientific thinking through a number of learning steps that included:

- becoming aware of her everyday views
- comparing everyday and scientific views
- developing an understanding of the scientific view
- applying the science view in different contexts; and
- reviewing learning.

The teacher enabled meaningful learning of the science concept in question by supporting these steps in learning through activities that were mediated by talk.

You may like to read **case study 3** which provides a more detailed account and analysis of the dialogues that helped Josie to move from an everyday understanding of forces to a scientific view.

How did upper primary and lower secondary teachers differ in the way they interacted with their pupils?

As might be expected, the primary science lessons that the researchers observed were mostly taught by teachers without any higher qualification in science. They taught their own class in their own classrooms with little specialist apparatus. The secondary science lessons by contrast were taught by science specialists, in laboratories with easy access to specialist equipment. These factors impacted on the way in which dialogic teaching was played out in classrooms across the two phases. The researchers examined this impact in relation to four elements.

Working on knowledge

In terms of developing the scientific point of view, the researchers observed differences that related to the primary teachers' lack of depth of subject knowledge. (Some secondary teachers also expressed uncertainty about aspects of a topic/subject not within their own subject specialism). Secondary teachers and pupils also tended to use more technical vocabulary and secondary teachers mentioned the importance of pupils learning technical language while primary teachers did not. In terms of allowing ideas to be revisited during a sequence of lessons, primary teachers had the advantage as they inevitably knew the class of children better and were able to refer to what individual children had said in previous lessons. One secondary teacher commented, "Given all the classes that I teach, I barely know all their names, let alone remember what someone said last week".

Shifts in communicative approach

The researchers found evidence of all four classes of communicative approach (interactive/dialogic, interactive/authoritative, non-interactive/dialogic, and non-interactive authoritative) in both primary and secondary classes.

Teacher actions

While all teachers organised teaching activities to address specific purposes, sometimes they used activities whose contribution to developing science knowledge was not clear. Primary teachers did this more often than secondary. But primary teachers were more able to adjust the pace of lessons to allow for an exploration of views, which the researchers attributed to the fact that they had the advantage of lessons that lasted the whole afternoon. Primary teachers also seemed to find it easier to create an encouraging ethos whereby pupils felt confident about expressing their views. The researchers attributed this to primary teachers having the advantage of knowing their pupils better and being able to organise pupils into working groups or a discussion circle more easily than their secondary colleagues working in labs. Primary teachers were also more likely to focus on dialogue (for example, by asking the pupils to consider how they talked together which secondary teachers rarely did). The researchers felt that this reflected the wider remit primary teachers had for pupils' learning, which included 'speaking and listening' as well as science whereas the secondary teachers were more focused on science.

Pupil engagement
Primary pupils were more willing to articulate their own points of view and refer to the points of view of others. Secondary teachers commented that their pupils did not like passing an opinion in case they were wrong or appeared 'not cool' in front of their peers. A striking difference was the extended time pupils spent in whole-class plenary sessions (20 minutes and more) in primary classes compared to secondary, which was partly due to the longer lesson time available (often the whole afternoon). Secondary teachers focused on keeping up the pace and moving on.

How could teachers set about developing dialogic teaching and learning in their classrooms?
The researchers' observations of the 12 primary and secondary teachers involved in their study revealed that the extent to which dialogue was effectively exploited as a teaching and learning tool varied considerably. Only two teachers came close, in their view, to representing Alexander's definition of dialogic teaching and only three teachers regularly engaged pupils in extended discussions of the type Mortimer and Scott called 'dialogic-interactive'. According to the researchers, many teachers do not exploit the learning potential of their 'prime tool' because they do not have a high level of understanding of how talk 'works'. Even the teachers who took part in this study (who had volunteered on the basis of their interest in dialogue) indicated that they were unaware of the patterns and functions of teacher-pupil talk in their classrooms. The researchers argued that this aspect of initial teacher training and professional development warranted significant investment.

The researchers have previously described activities that teachers can use to help develop their pupils' awareness and skill in the use of talk for collaborative, group-based problem solving, such as establishing ground rules for exploratory talk - see the research summary Raising achievement through group work. In this project, they devised teaching and learning activities designed to help teachers instigate and develop useful whole-class dialogue between them and their pupils. One such activity was 'talking points'.

'Talking points' are a list of statements on a particular theme that are factually accurate, contentious or downright wrong. Pupils are then asked to decide whether they are true or false. The statements provide a focus for discussion by offering a range of ideas about a topic that pupils can consider together. Assessing the truth of the statements stimulates the pupils' thinking and enables them to compare their understandings (by making their knowledge and experiences explicit to justify their beliefs). The teacher can also learn about pupils' current levels of understanding from the outcomes of these discussions and bring in useful points raised in subsequent whole-class discussions.

The researchers suggested that the talking points are best used in a classroom where pupils know that there are ground rules that allow for and encourage extended responses and tentative exploratory contributions. The researchers' observations suggested that the following strategies are important too:

- making it clear that some parts of lessons are intended to be discussion sessions, in which questions and diverse views on a topic can be expressed
- whole-class discussion of a particular question or issues is preceded by paired or group discussion during which pupils can prepare responses for sharing with the class

- during whole-class discussions, the teacher allows a series of responses to be made without making any immediate evaluations
- if some different views have been expressed, the pupils are asked to give reasons and justifications for their views before proceeding; and
- the teacher links the scientific explanation to several pupils' ideas on the topic.

Examples showing the value that can arise from the use of talking points were given earlier in this research summary. (See the discussion that arose from the statement: 'The moon changes shape because it is in the shadow of the Earth' and the description of Josie's learning pathway that started with her considering the statements relating to the 'bottle on the shelf').

You may also like to read **case study 4** which explores the value of concept cartoons as a stimulus for promoting purposeful argument between small groups of pupils in science.

How was the research designed?
The research was carried out in five primary schools and three secondary schools from the north and south of England and involved six primary teachers and six secondary teachers and their Year 5/6/7 classes.

The teachers were selected for the study because they were considered by local advisers and their peers to be 'good practitioners' and because they had expressed a special interest in the use of dialogue in their teaching. The secondary teachers were science specialists, but only one of the primary teachers had a science degree. The researchers gathered a variety of data including:

- video/audio recordings focused mainly on the teacher, of 12 series of three lessons
- video/audio-recordings of pupils working together during lessons (at least one group in each class)
- pupils' written work from the 12 classes
- recorded interviews with teachers and pupils in all classes involved; and
- stimulated recall sessions with three teachers (two primary; one secondary).

All the teachers' talk in the target lessons was recorded, as they interacted with the whole class, small groups and individual pupils. Talk amongst a group of pupils in each class was also recorded. The researchers interviewed a sample of pupils in each class immediately after lessons and several weeks later to elicit their understanding of the science concepts taught. They also gathered written work. Approximately 120 hours of classroom talk and 20 hours of interviews with teachers and students were recorded.

The researchers' analysis was mainly concerned with identifying processes of interaction, within and across the related series of lessons. For each series, they noted any learning objectives (stated or implied), distinguished episodes within the lessons, and identified themes that were pursued across episodes and lessons. They then identified particular approaches and patterns of interaction within episodes, creating detailed case studies that noted indicators of dialogic teaching and related language features.

Some implications for teachers and leaders
Teachers may like to consider the following implications of the research.

Dialogic teaching involves eliciting pupils' views, drawing out their reasons for them and seeking and comparing different pupils' views without evaluating them. But the research showed that such extended dialogues are not common place. Would you find it helpful to work on developing your dialogic teaching skills? You could record a teaching episode and reflect afterwards on how far you succeeded in gathering different pupils' viewpoints and reasons for them. You could then plan (perhaps with the help of a colleague) a repertoire of phrases you could use to promote extended discussions with pupils.

The research showed how teachers who used dialogic approaches generated learning conversations in which pupils contributed tentative views and thus made their everyday assumptions explicit. Could you plan specific activities designed to promote such learning conversations? For example, you could work with a colleague to develop sets of statements for particular science topics that include common misconceptions as well as the

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scientific view as talking points. (You may find **case studies 1 and 4** useful starting points for this).

Teachers (especially those in secondary schools) involved in the study said they found it hard to remember what pupils had said in previous lessons which made building on their everyday views of science phenomena difficult. Would you find it helpful to make a note during the lesson on the board 'So we don't forget' or on post-it notes (or ask a teaching assistant to make a note) of what pupils say which you could refer to in future lessons?

The researchers kept a record of the comments pupils made during dialogic teaching episodes, and used them to document the pupils' journey from everyday assumptions to the scientific view over a series of lessons. Could you involve your pupils in creating a story board of their learning journal in relation to key scientific ideas that they and you can draw on? (You may like to provide your pupils with a framework for doing this, such as 'First I thought ..., then I thought ... now I think ... because ...).

Leaders may like to consider the following implications.

- The research showed that primary teachers may find themselves working at the limits of their scientific knowledge, but that they are more likely to focus on dialogue than secondary science teachers. When thinking about professional development for your colleagues, could you arrange for secondary science teachers to work with primary teachers over a sustained time period to enable the secondary science teachers to help develop their primary colleagues' scientific knowledge and the primary teachers to help develop their secondary colleagues' use of dialogue in science lessons?
- Dialogic teaching requires teachers to adopt different communicative approaches - at times encouraging exploration of different views and at other times focusing on the scientific view. To increase their awareness of the ways talk can be used, could you work with colleagues to analyse example dialogues from science lessons (perhaps recorded in your school and/or taken from this research summary) using the dimensions of teacher-led talk and key elements of dialogic teaching in science identified by the researchers as a framework? (You may find **case studies 2 and 3** helpful for this too).
- Could you raise your colleagues' awareness of the importance of effective talk in the classroom and how this impacts on pupils' cognitive development? Perhaps you could share with your colleagues video evidence of good practice that you have recorded in your school and/or think about having a speaking and listening champion?

Gaps in the research

Gaps that are uncovered in a piece of research have a useful role in making sure that future research builds cumulatively on what is known. But research also needs to inform practice, so practitioners' interpretation of the gaps and follow-up questions are crucial. We think the following kinds of studies would usefully supplement the findings presented in this summary:

- more enquiry or research into ways of uncovering pupils' everyday understandings and helping them towards a scientific view
- studies showing the impact of dialogic approaches to children's learning in other subjects; and
- studies investigating professional development programmes that support teachers in developing their classroom talk in science.

What is your experience?

Do you have any evidence regarding developing pupils' ideas in science through dialogue? Do you know of action research designed to explore ways that teachers can be helped to develop their dialogic teaching skills? We would be interested to hear about examples of effective approaches that could perhaps be featured in the case study section.

Your feedback

Have you found this study to be useful? Have you used any aspect of this research in your own classroom teaching practice? We would like to hear your feedback on this study. Click on the feedback link 'Tell us what you think' on the left to share your views with us.

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