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Chapter 20 Talk in science classrooms

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Language provides the fundamental means for communicating ideas, but it is also through talk, either with others or 'in our heads', that we can develop personal understanding. This chapter expands on the reasons for the importance of talk in the classroom and its particular value in science education. It first describes the characteristics of different kinds of verbal communication between teacher and pupils in terms of two dimensions: interactive and non-interactive; and authoritative and dialogic. The nature and impact on learning of exploratory pupil–pupil talk is then discussed.

Why is talk important?

Robin Alexander made the statement in Box 20.1 based on his extensive study of primary education in five countries. In this section we explore some of the reasons for the importance of talk in science learning, the kinds of talk that might be used and how these can be matched to different teaching purposes.

Box 20.1 Talk in science

... in English primary classrooms, although much may be made of the importance of talk in learning, and a great deal of talking goes on, its function is seen as primarily social rather than cognitive, and as 'helpful' to learning rather than as fundamental to it.

(Alexander, 2000, p. 566)

In any classroom, talk is clearly important to the teacher as a way of communicating expectations, giving instructions, explaining ideas, monitoring understanding and controlling activity. However, talk is also central to the process of *learning*. It is a common experience that if we want to make sense of difficult ideas, talking them through with others usually helps. Talk in the classroom provides children with a way to express and to work on ideas, to explore their implications and to share, compare and consolidate understanding.

Science lessons provide plenty of opportunities for talk. There are phenomena to discuss, ideas to explore, practical activities to carry out, results to report and evidence to interpret. Through these activities children can learn how to talk and think about natural phenomena in a scientific, as opposed to an everyday (or common-sense), way. This means using the ideas, explanations and approaches of the scientific community and it is important to recognise that these ideas and explanations are not there to be 'discovered' from hands-on activities. They arise from thinking and trying out ideas and are '*talked into existence*' (Ogborn *et al.*, 1996) with, and by, the children. Language is thus crucial to science learning.

However, everyday ways of thinking and talking may cause confusion. For example, common words such as force, power or weight may have specific or different meanings in science. The ways in which language is used in science may make particular demands, for example when reporting results, structuring an argument or reaching conclusions based on evidence. In some science topic areas there may be big differences between everyday and scientific accounts of phenomena and this can lead to big teaching and learning challenges (Leach and Scott, 2002). For example, there is a considerable difference in the thinking behind an everyday account of a ball falling as a result of a personal action, '*because you let go of it*', and the scientific view, based on forces acting at a distance, '*because of the pull of the Earth*'.

Effective teacher–pupil and pupil–pupil interactions are the key to supporting children in making personal sense of the science we wish them to learn and in developing their ability to reason scientifically. With this in mind we might begin to think about activities in terms of their potential to stimulate and support different kinds of talk. This is rather different from thinking simply in terms of 'what children will do'.

The word 'interactive' can be used in many senses in relation to teaching. In the next sections we use it in relation only to verbal activity in the classroom and to those aspects of classroom talk that are concerned with learning, rather than with management.

Teacher–pupil talk in the classroom

We can think about classroom talk along two dimensions (Mortimer and Scott, 2003) which address, firstly, who is speaking and, secondly, whose points of view are being discussed.

Who is speaking – the interactive and non-interactive dimension

The interactive/non-interactive dimension describes the extent to which the teacher involves the children in the dialogue. *Interactive* talk allows for the participation of both teacher and children, for example when a teacher engages children in a series of questions and answers. *Non-interactive* talk, on the other hand, involves only the teacher and largely excludes the verbal participation of the children.

Whose ideas are being discussed – the dialogic and authoritative dimension

The authoritative/dialogic dimension describes the extent to which the teacher takes account of different points of view and ensures that these are represented

through talk. *Dialogic* talk involves exploring answers or comments further by asking for more detail (*'That's interesting, why do you think that might be?'*), asking other children whether they agree with it or not (*'Do you go along with what Anita has just said?'*), making links to what someone else has said or done (*'That sounds like what David said earlier about ...'*) or writing it down for further consideration (*'Let's just put that down on the board, so we don't forget it.'*). In this way, the teacher makes room in the classroom talk for a whole range of ideas and makes it possible to consider the children's points of view as well as the school science view.

Of course, classroom talk is not always dialogic in form. There are occasions when the teacher does not explore and take account of children's ideas as they arise in the development of the lesson but keeps the focus on the science point of view. If ideas or questions are raised that do not contribute to the development of the school science story they are likely to be reshaped or ignored by the teacher. This is *authoritative* talk.

Classes of communicative approach

Any episode of classroom talk can be identified as being largely *interactive* or *non-interactive* on the one hand, and *dialogic* or *authoritative* on the other. These can be combined (Figure 20.1) to form four broad classes of *communicative approach* (Mortimer and Scott, 2003).

	Interactive	**Non-interactive**
Authoritative	*interactive/authoritative*	*non-interactive/dialogic*
Dialogic	*interactive/dialogic*	*non-interactive/authoritative*

Figure 20.1 **Four classes of communicative approach.**

What might each of these classes of communicative approach look like in the classroom? We start with the two *interactive* approaches. Both involve a great many teacher questions. However, the purpose of these questions and the ways in which children's responses are used, distinguish the two approaches.

Interactive/authoritative communicative approach

This example is from a year 4 class (8/9-year-olds). The teacher is talking about a shadow of a face on a screen. The shape making the shadow has holes for the eyes and mouth.

Teacher: *So what are the mouth and eyes?*
Amy: *Holes*
Teacher: *Yes, and what goes through the holes?*
Amy: *Light*
Teacher: *The light. So what makes the shape of the face?*
Perdip: *The paper's blocking the light.*
Teacher: *The paper's blocking the light isn't it, to make the face. So it's a shadow. So what does that tell us about the light? How does the light travel?*
Fiona: *At light speed.*
Teacher: *Yes, I know it travels at light speed but does it travel in wavy lines?*

Perdip: *No, straight.*
Teacher: *Straight. If it travelled in wavy lines it'd be all scattered over there but because it travels in straight lines we get quite a sharp image.*

Here the teacher wants to use the formation of a shadow to support ideas introduced in a previous lesson, that light travels in straight lines and that shadows are formed when light is blocked. Relevant responses from the children, about light being blocked by the paper but travelling through the holes, are reinforced by agreement or repetition. Fiona's response about *'light speed'* is not directly relevant and, though acknowledged, is ignored; the teacher introduces the possibility of light travelling in *'wavy lines'* to bring the discussion back on track. The teacher is using an *interactive/authoritative* communicative approach. The talk is interactive in the sense of there being lots of questions and answers and is authoritative as the teacher wants to focus on answers that support the scientific view. There is a repeating *pattern of discourse*, with teacher questions directing and structuring the conversation, as in Box 20.2.

Box 20.2 Pattern of the interactive/authoritative approach

Teacher asks a question:	INITIATION (I)	*So what are the mouth and eyes?*
Child responds:	RESPONSE (R)	*Holes.*
Teacher evaluates:	EVALUATION (E)	*Yes ...*
Teacher asks a question:	INITIATION (I)	*... and what goes through the holes?*

Pattern: I–R–E; I–R–E; I–R–E; .....

Interactive/dialogic communicative approach

Of course, there is an alternative to the authoritative form of interactive talk set out above. This is where the teacher sets up interactions that are dialogic in approach. Here the intention is to open up the dialogue to include many points of view or to explore a particular way of thinking. In an earlier lesson the year 4 class had discussed shadows in the classroom which were produced by different light sources:

Teacher: *So what's a shadow?*
Simon: *Darkness.*
Sally: *A kind of reflection.*
Teacher: *A kind of reflection. And you think the same [in response to several children agreeing]? Let's follow this reflection business. In what way is it like a reflection?*
Sally: *It's kind of like a reflection of yourself.*
Teacher: *It's like a reflection of yourself ...*
John: *When you're in the mirror.*
Sally: *But it's not coloured.*
Teacher: *It's like a reflection of yourself except it's not coloured. Why is it not coloured?*
Harpreet: *The shadow's grey and dark.*
Teacher: *The shadow's grey and dark but why is it dark? Yes?*

Harpreet: *Because it's standing in the way of the light so light, when it reflects on to the light it makes it darker.*
Teacher: *Hang on, Sally says it's like a reflection and that puzzles me because a reflection has usually got my own features if it's a reflection of me. I see it wave back to me and it's got eyes and a nose and if I look at my shadow it definitely hasn't and Sally says it's a reflection which is not coloured. Go on Sally.*
Sally: *Well like when light shines on to something and then it makes darkness and then your shadow goes into the light and it makes you look dark.*
Teacher: *So what causes the shadow?*
Michael/Sally [together]: The sun.
John: *It's the opposite ... because of the sun, if the sun was in front, your shadow would be behind you.*

This discussion continued for some time, exploring and clarifying ideas. The teacher, well aware that children often use the word reflection when talking about shadows, used the opportunity to explore the essential differences between the two phenomena and, subsequently, the ideas that children introduced about light being 'blocked' to form a shadow.

The distinctive *pattern of discourse* in this case involves chains of interaction rather than the repeating I–R–E pattern of the authoritative talk (Box 20.3). The teacher started by asking a question, but followed up the response with a series of *prompts* to encourage further contributions from children in relation to the response.

Box 20.3 Pattern of the interactive/dialogic approach

Teacher asks a question:	INITIATION (I)	*So what's a shadow?*
Child responds:	RESPONSE (R)	*A kind of reflection.*
Teacher prompts:	PROMPT (P)	*In what way is it like a reflection?*
Child responds:	RESPONSE (R)	*It's kind of like a reflection of yourself.*
Teacher prompts:	PROMPT (P)	*It's like a reflection of yourself ...*
Child responds:	RESPONSE (R)	*... but it's not coloured.*

Pattern: I–R–P–R–P–R–P ...

A chain of interaction, I–R–P–R–P–R–P–, is set up and the skill of the teacher lies in sustaining the development of the interaction, encouraging responses from a range of children. When a number of children answer the same question from the teacher, the response from a child might not necessarily address the initial question posed by the teacher; it might be a comment on a previous child's response.

Although question-and-answer sequences have often been criticised as requiring children to 'guess what is in the teacher's head' we can see that, used effectively, they can provide opportunities for teachers to structure dialogue in ways that support children in constructing a scientific explanation (*authoritative*) and allow them to explore and explain their developing understanding (*dialogic*).

Non-interactive approaches

At first glance, the very notion of a *non-interactive/dialogic* communicative approach might seem like a contradiction in terms. How can the teacher be presenting (*non-interactive*) and yet attending to both the science and the children's points of view (*dialogic*)? It is possible if the teacher draws upon a range of ideas, usually in the context of a review or summary.

Consider this example, from the same year 4 class as the previous examples:

Teacher: *I think we're talking about two different things. I think on the one hand we're talking about a patch of light and what we're really trying to talk about is a patch of darkness aren't we? The shadow and not the light. I think we're getting the two things confused ... I hadn't thought about it really until you brought it up just then, that the more powerful light seems to make the darker shadow, but there's also something to do with distance ... but I think the important point that you've made is that the shadow has to do with one light doesn't it? The shadow of the table on the floor has to do with the light from the sun, nothing to do with this [a lamp on the table] ... and the shadow may be dark or light and a lot seems to depend on the strength of the light.*

Right. We'll leave that for the time being. To sum up what we've said so far. To have a shadow you have to have two things. Thomas said you need something to block the light and somebody else, I think it was Sophina, said you need to have a light as well. You have to have two things, light and something to block the light, and the shadow is where the light is blocked and it's dark. Is that right?

Here the teacher is initially using a *non-interactive/dialogic* approach to summarise ideas that have been offered during an extensive discussion of shadows observed in the classroom, how they are made and why some appear darker than others. The question of how the brightness of the source or its distance from the object affects the darkness of the shadow remains open for further investigation. At the point where the teacher says '*Right*' the approach shifts to *non-interactive/authoritative* and the standard science view is clearly presented.

Matching communicative approach to teaching purposes

In the previous sections we have set out and exemplified four distinct communicative approaches that might be used in the classroom. Is one communicative approach intrinsically better than another? For example, is teaching which uses interactive/dialogic talk better than that using interactive/authoritative talk? Is non-interactive teaching bad, simply because it's the teacher who is doing all the talking? These are important and absolutely fundamental questions. The answer to them is that:

Effective teaching involves all of these approaches. It depends on what you are trying to do!

For example, if the aim is to discuss ideas, explore understanding and raise questions then an interactive/dialogic approach which develops chains of discourse is needed (see Box 20.4).

Box 20.4 Pattern for exploring understanding

Teaching purpose: To explore children's understandings.

Communicative approach: Interactive/dialogic.

Pattern of interaction: Open chains of communication I–R–P–R–P–R–P...

If, on the other hand, the teaching purpose is to introduce a key scientific concept, then this approach is unlikely to be helpful. Instead the combinations in Box 20.5 need to be used.

Box 20.5 Pattern for introducing concepts

Teaching purpose: To introduce a scientific concept or develop a clear line of argument.

Communicative approach: Non-interactive/authoritative and/or interactive/authoritative.

Pattern of interaction: Presentational and/or I–R–E.

A non-interactive/dialogic approach allows the teacher to review 'where we are up to in our thinking' by considering and summarising a range of ideas (Box 20.6).

Box 20.6 Pattern for summing up

Teaching purpose: To consider a range of points of view.

Communicative approach: Non-interactive/dialogic.

Pattern of interaction: Presentational.

The 'rhythm' of the classroom talk

What is suggested here is that in any teaching sequence it makes sense to adopt a range of approaches matched to teaching purposes in the ways outlined above. Expert teachers demonstrate a 'rhythm' in their teaching, whereby now they open up matters for discussion (*interactive/dialogic*), now they work on helping children to understand and use the science point of view (*interactive/authoritative*), now they summarise the science view (*non-interactive/authoritative*) and link it to children's thinking and experience (*non-interactive/dialogic*). There is no special order in which they go about these transitions but there is a strong sense of rhythm as ideas are opened up for discussion and then closed down.

Pupil–pupil talk

In a whole-class setting, the opportunities for individuals to talk are inevitably limited. Working in groups or pairs provides opportunities for more children to participate and to explore and develop their understanding but, without the support of the teacher, children may lack the skills to talk productively. Teachers, therefore, have a responsibility to model, in their interactions with children, the kinds of interactive/dialogic talk that they are aiming for in group work:

offering ideas, listening to others, asking for clarification, making links to others' ideas and so on. In addition, the skills needed for such talk can be taught (Dawes, 2004), to allow children to develop their ability to think things through both together and alone.

Although teachers may encourage children to talk in groups, Mercer *et al.* point out that they are rarely given any guidance on doing this effectively:

> *Children cannot be expected to bring to a task a well-developed capacity for reasoned dialogue. This is especially true for the kinds of discursive skills which are important for learning and practising science: describing observations clearly, reasoning about cause and effects, posing precise questions, formulating hypotheses, critically examining competing explanations, summarizing results, and so on.*
>
> (Mercer *et al.*, 2004, p. 362)

Without guidance, talk among children may be 'disputational' (unproductive disagreements) or 'cumulative' (often repetitious and uncritical) but rarely 'exploratory' – the term used when talk has the characteristics listed in Box 20.7.

Box 20.7 Characteristics of exploratory talk

In exploratory talk:

- all relevant information is shared;
- all members of the group are invited to contribute to the discussion;
- opinions and ideas are respected and considered;
- everyone is asked to make their reasons clear;
- challenges and alternatives are made explicit and are negotiated;
- the group seeks to reach agreement before taking a decision or acting.

(Mercer *et al.*, 2004, p. 362)

Mercer *et al.* (2004) investigated the effect of helping children to use exploratory talk on the children's understanding of science. In this study the researchers developed a 'Thinking Together' intervention programme for teachers to use. This comprised a series of lessons in which the children were first introduced to 'ground rules' designed to encourage exploratory talk and then given opportunities to practise these skills in their group work. Various analyses of their talk in groups were conducted; these showed that the programme resulted in increased use of words indicating exploratory talk, with children explaining and justifying their views in longer utterances. Assessment of their science knowledge and understanding showed that the children who had experienced the programme increased their science scores significantly more than control groups of children. Tests of reasoning also showed a significant difference between the gains made by groups with and without the programme.

Concluding comment

Talk, whether initiated by teachers or taking place among children, provides important learning opportunities. How such talk is stimulated, its content and its nature are key to its impact. The framework set out in this chapter enables us to think about the kinds of talk used in teacher–pupil exchanges. Teachers

also need to consider how they encourage pupil–pupil discussion so that the talk is exploratory and advances children's thinking. In combination such classroom experiences will support children in developing their scientific understanding. To quote Alexander (2004, p. 5):

> *Reading, writing and number may be the acknowledged curriculum 'basics', but talk is arguably the true foundation of learning.*

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