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Dialogic teaching in the primary science classroom

Neil Mercer[a]*, Lyn Dawes[b] and Judith Kleine Staarman[c]

[a] *Faculty of Education, University of Cambridge, Cambridge, UK;* [b] *School of Education, University of Northampton, Park Campus, Northampton, UK;* [c] *School of Education and Lifelong Learning, University of Exeter, St Luke's, Exeter, UK*

This paper describes research on dialogue between teachers and pupils during primary school science lessons, using talk from two classrooms to provide our examples. We consider whether teachers use dialogue to make education a cumulative, continuing process for guiding the development of children's understanding. Case studies of two teachers, using observational data taken from a larger data set, are used to illustrate their use of talk as a pedagogic tool. We also consider the differing extent to which the two teachers highlight for pupils the educational value of talk, and the extent to which they attempt to guide pupils' own effective use of talk for learning. Implications are drawn for evaluating the ways teachers use dialogue, and for professional development. An example is provided of an activity which has been found to help teachers implement dialogic teaching, and which illustrates how such an approach involves organising the structural variety of talk.

Keywords: observation study; primary education; science education; talk in classrooms

Introduction

This paper has emerged from a recent project entitled 'Dialogic teaching in science classrooms', with colleagues Jaume Ametller and Phil Scott. The research involved detailed analyses of teacher–student interaction in science classrooms at primary and secondary levels. In this paper, we will use selected data from the classrooms of two primary school teachers who used talk in rather different ways. This selective use of data allows us to work within the space limitations of an article such as this to exemplify and discuss our findings from the project as a whole. We will begin by examining how, and the extent to which, the two teachers used dialogue to:

- explore pupils' current understandings of topics;
- make explicit a learning trajectory for pupils, by relating past activities to those in the present and future;
- build links between the content of earlier discussions and current concerns; and
- model, and make explicit to pupils, ways of using talk for sharing ideas, reasoning and developing shared understanding.

Having compared the practices of the teachers, we will draw some general conclusions and discuss the educational implications of our findings. We will then provide an example of the kind of pedagogic activities we have been developing, on the basis of those findings, to enable teachers to use talk effectively in the teaching of science.

*Corresponding author. Email: nmm31@cam.ac.uk

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Our investigations were partly inspired by the concept of 'dialogic teaching' as described by Alexander (2008a) in which a pedagogic approach, underpinned by specific principles, can be enacted through a range of possible talk strategies (Alexander provides a list of 47 indicators). Alexander argues that this approach, with its emphasis on the active, influential and sustained participation of pupils in classroom talk, will achieve the best educational results (Alexander 2000). A key indicator of dialogic teaching is that classroom talk should have a cumulative quality. This means that the communication between teacher and pupils should contribute to the cohesive, temporal organisation of pupils' educational experience and hence to the progressive development of their understanding. This is, of course, very relevant to the theme of this special issue.

Dialogic teaching also involves raising pupils' awareness of the potential educational power of talk so that they develop a meta-awareness of the use of talk for learning. This converges with our own previous work on science education, on whether developing children's awareness and skill in using talk as a tool for problem-solving helps their learning and the development of their scientific understanding (Mercer et al. 2004). The implication is that an effective teacher of science will not only be concerned with helping children understand the content of the science curriculum but will also help them understand better the dialogic processes involved in studying and practicing science. Thus Lemke's (1990) proposition that science education should make pupils fluent speakers of science could be elaborated to become 'science education should make pupils self-aware, fluent and reflective speakers of science'.

Another strong influence on our research has been Mortimer and Scott's (2003) work on teacher–student talk in secondary science classrooms. They use the concept of *communicative approach* to characterise how teachers use language to develop students' ideas in science. Mortimer and Scott use two dimensions to define the ways teachers and students communicate: *interactive–non-interactive* and *dialogic–authoritative*. During interactive communication both teacher and students contribute, while in non-interactive communication only the teacher speaks. Thus in interactive episodes the teacher typically engages students in a series of questions and answers, whilst in non-interactive teaching the teacher presents ideas in a 'lecturing' style. The dialogic–authoritative dimension is concerned with the extent to which both the teacher and students' points of view are represented. The most 'authoritative' talk would be represented by the teacher's presentation of the authoritative canon of scientific knowledge. Talk is considered to be more dialogic the more it represents the students' points of view and the discussion includes their and teacher's ideas. So a sequence in which several students explained their ideas about a phenomenon and discussed with the teacher and the rest of the class how those ideas related to scientific knowledge would be judged interactively/dialogically. There is no implication in Mortimer and Scott's scheme that any single type of communicative approach is intrinsically superior; the implication is rather that the quality of teaching will depend on a teacher's strategic use of interactive and dialogic approaches at different stages of a lesson or series of lessons.

An underlying assumption of our research, also taken from Mortimer and Scott, has been that the study of science inevitably involves the juxtaposition of everyday and scientific ideas. The meaningful learning of science must entail movement from the existing everyday ideas of children towards a more scientific point of view. Other research has provided evidence that talk about scientific phenomena can be an important motor for conceptual change (as discussed in Driver, Newton, and Osborne 2000; Kelly, Brown, and Crawford 2000; Lemke 1990; Ogborn et al. 1996). The continuing, dynamic process of classroom

communication thus provides a means for helping children to develop, over time, a scientific perspective which they can apply to explain a range of phenomena.

There is much support from research for teachers giving attention to how they use talk to guide pupils' understanding, and for actively involving pupils in that process. However, research also shows that this seems to have had relatively little impact on the quality of classroom talk, which is still commonly dominated by closed questions, short pupil responses and little direct attention being given to the use of talk for teaching-and-learning (see, for example Galton 2007; Smith et al. 2004). On the basis of interviews with British primary teachers, Fisher and Larkin (2008) suggest that this reflects teachers' views of what counts as 'good' classroom talk, in which pupils' use of talk to explore ideas and help learning are less commonly mentioned than are their adherence to norms of politeness and 'good grammar'. We were therefore interested to see if teachers who expressed an interest in 'dialogic teaching' and who volunteered to take part in a project on it, would show a high level of awareness and skill in using talk as an educational tool.

Methods

Our research was carried out in five primary schools and three secondary schools in two regions of England, with the participation of six primary (year 5/6/7) and six secondary teachers (year 7). Video and audio recordings of three consecutive science lessons (total duration, three to six hours) were made in all classrooms. All the teachers expressed an interest in dialogic teaching and volunteered to participate in the project knowing that this was its focus. All were considered by their local authority and schools to be 'good practitioners'. The lesson topics were selected through discussion with each teacher, which were based on the normal (national) curriculum. Lessons were planned by the teachers, and in accordance with our original plans, we made no interventions as to how lessons were taught or pupils' learning was assessed. However, we did share with teachers some information about 'dialogic teaching' drawn from the work of Alexander (2000) and from Mortimer and Scott (2003). We made it clear that our interest was to see how teachers used talk to teach science. In this paper, we will draw on data from recordings of two teachers, for reasons we explain below. These teachers, due to the involvement of their schools, had some knowledge of our earlier research on developing children's collaborative talk and reasoning (as described in Dawes, Mercer, and Wegerif 2004; Mercer and Littleton 2007).

Data collection

The main data gathered consisted of the following:

(1) Video recordings, focusing mainly on the teacher, of sequences of three lessons.
(2) Video/audio recordings of one group of pupils working together during lessons (at least one group in each class).
(3) Pupils' written work related to the recorded lessons (along with teachers' assessments), if available.
(4) Any other assessment data (such as end of unit tests), if available.
(5) Recordings of interviews with teachers and six pupils in each class.
(6) Recordings of video-stimulated interview sessions with teachers.

Approximately 120 hours of classroom talk (video and audio of group work) and 20 hours of interviews with teachers and pupils were recorded, and all relevant data was transcribed.

Data analysis

Our analysis was mainly concerned with identifying processes of interaction, within and across the related series of lessons, using the methodology called sociocultural discourse analysis (Mercer 2005, 2008). This methodology highlights the historical, contextualised and purposeful nature of classroom talk and involves both qualitative and quantitative methods of discourse analysis. The qualitative analysis consisted of a detailed examination of video and transcript data, using the software *AtlasTi*. Case studies were compiled, which included contextual notes about the schools, curricula and the contents of the series of lessons overall, including the use of information and communication technology (ICT), apparatus and any other equipment.

The case studies

This paper draws only on data gathered in the classrooms of two teachers located in two different primary schools, which we call Havenhill and Beckstones. We have selected this data because these teachers differed in their use of talk in ways which highlight the kind of variation we observed across the sample of 12 teachers as a whole. Both taught in similar urban locations, one teaching a mixed class of years 5 and 6 (ages 9–11) and the other year 7 (ages 11–12: this English region was unusual in including year 7 children within the primary rather secondary section). Both schools served populations with a mixed socio-economic background, mostly children from lower socio-economic environments. For each teacher, we have chosen illustrative extracts from the beginning of the second of the series of three lessons we have recorded. The names of all participants have been changed to preserve anonymity.

In terms of some crude measures, the interactions in the selected lessons in both Havenhill and Beckstones (and the others recorded in the classrooms of these teachers) were quite similar. In whole-class sessions, both teachers contributed about the same proportion of the talk (88% of the words spoken in Beckstones, 85% in Havenhill). Most of the talk in whole-class discussions consisted of initiation-response-follow-up/feedback (IRF) exchanges (Sinclair and Coulthard 1975), and most of these were of the conventional nature whereby a teacher asked a closed question and evaluated the brief response provided by the student. Both teachers arranged for children to spend some time talking about the curriculum topic in pairs or small groups. But, as we will see, more detailed qualitative analysis of the dialogue revealed some differences which, while more subtle, have educational significance.

Case study 1. Havenhill year 7: acids and alkalis

The teacher told us that the topic 'acids and alkalis' was 'almost new' for the pupils; there had been a previous lesson (prior to our recordings) in which the teacher had 'set up' the topic and provided little new scientific content. That lesson was related to nutrition, with some consideration of the role of acids in food for causing indigestion. In the first recorded

lesson some 'learning intentions' (to use the common National Curriculum term) were set out by the teacher and shared with the pupils, which are as follows:

(1) To discover how acids and alkali are used in everyday situations.
(2) To select and note appropriate information about uses and effects of acids and alkali.
(3) To understand that neutral solutions can be made by adding acids to alkali.

However, these science education goals were supplemented by another 'talk' agenda, in which the teacher was trying to encourage the children to use talk more effectively for learning, both in whole-class sessions and while they worked together in groups. This involved the teacher talking with the class about how they should work together, and agreeing with them some 'talk rules' which they would follow while working in groups. The data being used by us here comes from the second recorded lesson of the series.

As is usual in English primary schools, the teacher opened the second lesson of the series with a whole-class discussion. We joined the beginning of that discussion in Sequence 1 as the teacher is eliciting from children their views about how they should work together in groups during science enquiry.

(*Note*: *In all transcripts*, *T = teacher*; *P = pupil*; *unclear words are in brackets*; all names have been changed)

Sequence 1: Lesson 2, initial whole-class discussion, Havenhill

T: So what are our talk rules? What, talk, uh, rules should we have? Paul?
P: When someone else is talking you don't call out?
T: Right, good boy. Adira, something else? You can put your hands down.
P: You have to co-operate.
T: You all have to co-operate, so it's a group responsibility for completing the task. It's not up to one person, it is a group responsibility. What about if you can't make your mind up? If two people, if things aren't quite going, going as they should be?

(*Various pupils raising their hands*)

P: Write down both ideas.
T: Write down both ideas, if that's part of the [problem]. And if you've got a real problem?
P: You could vote.
T: You could vote, good way of sorting it out.

(*Various pupils raising their hands*)

T: You still might want to write down, this is the majority. Anything else we could do, Adam?
P: Explain why you think your answer is right.
T: Right explain, take your time to – don't just say, well I think this –
P: Why.
T: Which is a word you guys often use. And if the worst come to the worst, I'm going to be working this afternoon with a little group of people that were absent for part of last week's lesson, so I shall be focused over there, but if you do need me, you could always come and speak to me if you have to. Jayden? What were you going to say?
P: Um you could um also decide like, one person says that um, if two people, if there's more than two people answers, then you could choose like um. Other people could vote if their answer is – they could work out why their answer won't work.

T: Yes if you suddenly work out that your answer doesn't work, it doesn't mean to say that you have to stick to what you suggested, it can actually be complimentary enough to say to other people – hang on a minute, oh, now I see what you're talking about. So you need to listen to each other, that is just as important.

(*Teacher addresses researchers who are video-recording*)

Have you decided where you are [going to be]? (*She turns to the class*)
Right then. Acids and not feeling too great, so you guys really need to tune into what your colleagues are saying, because this is what, part of what they were discovering last week. What did we what did we discover Nick about not feeling great and acids last week?

P: Um that you can you either dilute it, or neutralise.
T: Oh now we're, we can dilute it or neutralise it, I'm glad you got those two words in. But where is this acid that's, that's not making us feel too great? Burning on the end of my fingers? Nope, where is this acid?

(*Teacher walking around the classroom, pupils raising their hands*)

T: Oh let's have a think? Um I think we'll ask the lovely Heather.
P: Um I think it's probably inside um your tummy or inside your body.
T: Yes inside your tummy, because do you remember when we first started acids and alkalis? We were looking at some of the foods that were acidic. Can you think of any of the foods that were acidic?
P: Lemons?
T: Lemons, good boy, so lemons are acidic, what else did we think of?
P: Citric acid.
T: There was citric acid, what did you think of (*inaudible*)?
P: Tomatoes.
T: Tomatoes, so well done. So there were foods that were acidic. And what was there in our stomach, what was in our stomach that we needed to help break down these foods? Put your hand down sweetheart. Adam?

(*Teacher walking around the classroom, pupils raising their hands*)

P: Acid.
T: Acids, so we've got acids that we eat, and acids in our stomach, mm and what's that doing to our acid levels? Katie, is it going up or down?
P: Up.
T: It's going up and we discovered, last week one of the things we discovered was that acids and alkalis are used in everyday situations, to try and balance things out again. And which, we introduced two new words last week. Ben, we introduced neutralise – to neutralise and to dilute. (*Teacher pointing to the words written up on the wall*.)

Comment: Sequence 1 is essentially a series of IRF exchanges, in which the teacher checks pupils' initial knowledge on matters relevant to the lesson. We can see that both agendas – the 'talk' one and the 'scientific' one – figure in this extract. The teacher begins by invoking a set of 'ground rules', which relate to her talk agenda. These ground rules were also displayed in the class and she often referred to them at the start of lessons. The shift from one agenda to the other is made very clearly, after the teacher interacts briefly with the researchers. We have called such shifts (in either topic or communicative approach) 'turning points' in classroom dialogue (Scott and Ametller 2007).

After this turning point, the dialogue focuses on the link between everyday understanding of a phenomenon (indigestion) and the scientific 'story' – that acids can be neutralised by adding a similar strength alkali. The teacher makes a link between past and present experience, and between everyday and scientific knowledge, by asking Heather whether she 'remembers when we first started acids and alkalis' and further asks her to 'think of any of the foods that were acidic'. Overall, our analysis indicated that the Havenhill teacher regularly offered pupils information about how activities were temporally organised, with links between past and future activities explained briefly but logically. In relation to her 'dialogic' agenda, she repeatedly highlighted the functional aspects of talk, as it was used in the class, by referring back to the established ground rules and how the children were expected to behave in forthcoming group activities. In relation to science agenda, she regularly related newly introduced ideas to the children's everyday knowledge, such as linking 'acids' to indigestion.

During interviews with the children after the lessons, they also referred to their everyday knowledge, while at the same time using the new terms like 'alkaline' and 'neutralisation'. The teacher also regularly asked children to recall what they already knew about scientific procedures, in preparation for forthcoming activities.

Case study 2. Beckstones year 6; rocks and soils

The Beckstones data also come from the second lesson of the recorded series. In the previous lesson, the class had looked at rock samples. The teacher opened Lesson 2 with a whole-class session. Just before the lesson began, she had written on the whiteboard:

'LI : To understand the structure of soil.
SC: Can you identify the soil type in Beckstones & describe how this may affect us?'
(NB. LI = Learning intention and SC = Success criteria)

Sequence 2: Lesson 2, Beckstones

T: Right. Don't talk.

(*Teacher is at her desk preparing to start the lesson. She drops some papers*)

T: Can you pick it up Skye and Gemma? That will be so helpful, instead of just sitting there and going 'Yes right'.

(*Pupils help the teacher pick up paper from the floor*)

T: There's enough for each person, on the table.

(*Teacher gives a pupil papers to hand out*)

T: Can you just *(inaudible).* Whose mess is all that? Get it into a neat pile, and two, there should be, Hailey, a box of compasses in the bottom cupboard, can you get them out for me please? Right this table, Faye's table can we straighten up and move down a bit? This table can go to the right a bit.

(*All pupils are helping set up the classroom*)

T: I can see one pen on the floor, a pencil on the floor, and there's a chair that's got no home. Nick what's happening (*inaudible*) in front of you? Right that table, would you like to go and get your jars of soil please? And just put them in the tray.

P: Miss Johnson do you see compasses?

(*Pupils go to get their equipment and the preparation continues*)

T: Excuse me? What does that say? It's a compass. Right. Right are we sorted?

(*All pupils are returning to their desks*)

T: (*To researcher*) Um thank you. (*Teacher takes lapel microphone and puts it on*)
T: Ok, right. Books away please, let's have a look at you today. Simon we're going to be doing lots of talking today, but we need to be talking about the right things. Everything away. Come on it's a nice sunny day, and we've got stuff to do. OK. You're there so Marc and David can give you a nudge, when you need to focus. Sit next to Hailey please Becky. Alright now, today we're moving on a little bit from rocks. We did some work last week and we talked about rocks, and we're moving now onto soil. And if you remember, um, you were asked over the last weekend to collect some soil, and to do a little bit of your own investigation. Well today we're going to sort of bring that into our lesson, and we're actually going to look at soil; um it's very important. It supports habitats, it also; well let's face it, it supports our ecosystem, it supports our world. And if we need to today, to sort of just have a little think about what soil is, and what purpose it has; I think personally, personally I think it's quite an important one, but let's find out. So today we're going to understand, the intention is to understand the structure of soil. What goes in it, what makes it? And by the end of today, I am hoping, and you're going to be hoping, that you can actually identify the soil type, that we have in Beckstones. Where we are, where most of us or many of us live. And also, be aware of how that actually affects us, because believe it or not soil does affect us every day, all the time. Now I'm going to start off with a question, what is the purpose of soil? Ok, I just want you to think about that first; what is the purpose of soil? I'm going to give you about [a] 10 or 15 second[s] to think; for you to think about what the purpose of soil is. What does it do and why is it here? How does it affect you, how does it affect me or us? Who does it affect, who doesn't it affect? OK, we've started off with a bit of thinking to get us into the mode of soil. OK, with your person next to you, and you might have a, a new person next to you, that you're going to talk to today. I'd like you to think about the following points; where do we find it? What does it look like? Is it all the same? And what's it used for? I'd like you to think about those three questions. Have a moment with your, your talk partner, and then see what the talk partner opposite you or next to you think? So the question was; what does it look like? What's it used for? Is it always the same? OK, and where do we find it? Let's go.

(*All pupils start to talk to each other at the same time. Teacher is talking to one pair of pupils on one table. After two minutes 10 seconds the teacher raises her hand to call the class together again*)

T: Just a really quick feedback now, I've had quite an interesting conversation with Becky and Hailey. Um where do we find it? When do you come into contact with soil, Dominic?
D: Um you can find it under trees, near around the trees and, around bushes and everything.
T: All right, commonly known as perhaps in the garden, or perhaps outside a garden, perhaps, you know, all around us. Uh, is it all the same colour?

Class: No.

T: What colours do you know of, for soil?

(*Several pupils raise their hands*)

T: Bridget?

B: Um, sandy soil, I was just about to say that sometimes that can get washed away, so it needs trees to keep it.

T: Yes, you're jumping ahead a little bit; I'm asking actually what colour you get soil in? All right, hold that thought because we'll probably need that information a little bit later. OK? Georgina? Uh Georgina?

G: Um, you can get black soil, like kind of, like compost in the garden.

T: Right have you been to a place where you've seen black or very dark brown soil?

G: Yes.

T: Where?

G: Um my garden.

Comment: Initially the teacher is mainly concerned with organisation and order in the classroom rather than the curriculum. After some exchanges with pupils about such matters, she talks in an authoritative/non-interactive mode. During this she sets up a discussion activity amongst the pupils involving 11 questions about soil. After a very short time of group discussion (during which she talks with one group – dialogue not included here), she calls the class back to attention and engages them in a series of IRF exchanges about where soil is found – a relatively simple issue for year 6 children. She revises a child's answer 'around trees and bushes' to the more general 'inside and outside gardens – all around us'. She then asks another simple question about colour, rejecting a more sophisticated suggestion 'sandy soil' and asking a pupil to 'hold that thought' about the function of trees for preventing erosion until later in the lesson, when it will apparently be more relevant. This was the only reference made by the teacher in that lesson to the future trajectory of children's study of this topic. However, our analysis showed that Bridget's comment was not revisited later in the lesson: the topic of erosion did not figure again at all. The teacher then reasserts her question about the colour of the soil.

Results and discussion

As illustrated by the commentaries on the examples above, our analysis indicated that:

- Both teachers referred to the temporal organisation of events, both within and across lessons.
- Both teachers used questions to encourage children's active involvement in lessons. That is, they both regularly generated some interactive/authoritative dialogue (as defined by Mortimer and Scott, 2003).
- In both the classes, the dynamic progress of the talk in the whole-class sessions depended heavily on teacher-generated IRF exchanges. This is not, in itself, a critical comment on their practice, as IRF exchanges can be used very effectively to sustain dialogue, and for a variety of pedagogic purposes (as discussed by Mercer 1995; Wells 1999). Initiating questions can be used to provoke pupils' imagination, to explore their wider relevant experience, and to get them to explain their reasoning. However, in these two classrooms almost all of the initiations were used in the 'traditional' way, to check the state of pupils' understanding of the topic being studied.

- Both teachers provided opportunities for children to talk together in pairs or groups in the normal course of a lesson as would be expected within a dialogic teaching approach. However, only the Havenhill teacher allowed such discussion to continue for more than one or two minutes.
- Neither teacher generated the sort of whole-class discussion which Mortimer and Scott (2003) call 'dialogic/interactive', wherein pupils take extended turns, the teacher picks up ideas pupils have offered in those turns and then uses them to build new directions for the discussion. This kind of discussion has been identified as an important aspect of dialogic teaching by Alexander (2000).
- In their own 'authoritative' presentations, both teachers sometimes made connections between everyday experience and scientific explanations. But only the Havenhill teacher made pedagogic use of this, by regularly relating the everyday phenomena that had been discussed to new scientific knowledge as the class moved from everyday accounts of phenomena to more scientific ones.
- Both teachers elicited pupils' existing ideas about the topics under discussion, but neither picked up what was offered by pupils and used it to make connections between the various ideas and contrasts with the scientific perspective on the topic (a positive feature of dialogic science teaching identified by Scott, Mortimer, and Aguiar [2006] which they call *interanimation*). Moreover, the Beckstones teacher invariably left little space for pupil's contributions based on their wider experience, and avoided any extended discussion on them. Issues raised by pupils were never 'built in' to the content of the lesson as it developed.
- The Havenhill teacher more often used discursive strategies that gave the dialogue a cumulative, temporally cohesive quality, such that it might be expected to help pupils perceive a meaningful trajectory through their classroom activities.
- The Havenhill teacher made quite explicit the trajectory of learning for the relevant science topic across activities and lessons, and set out clearly an agenda for learning, as identified by Alexander (2000) as a feature of dialogic teaching. In contrast, the Beckstones teacher offered little in the way of helping pupils see that their activities were cumulative and purposeful.
- The Havenhill teacher made the use of dialogue itself a matter for consideration with the class, and explicitly focused on the quality of the talk of the pupils in their groups (again identified as a feature of dialogic teaching by Alexander 2008a). She reported that before the recorded lessons, she had spent time developing the awareness and skills of the children in ways of taking turns and working together effectively, and she regularly referred back to that common experience of setting up group-based activities in the recorded lessons. She also regularly emphasised the value of talk for learning. The Beckstones teacher did not report such preparatory activity, or refer to it in the recorded lessons. There was little evidence from her lessons that she wished pupils to value talk as a tool for learning, or that she felt that they needed to become more aware of how to use it. Although she required the children to talk together at certain points, any comments about their talk were concerned with classroom order and control rather than with its use as a tool for learning (which is consistent with the responses of the teachers interviewed by Fisher and Larkin, 2008).

Despite some superficial similarities in the organisation of talk in the two classrooms that have figured in this paper, it can be seen that there were some interesting and important differences. The practice of the Havenhill teacher embodied a much higher regard for the value of talk as a tool for learning, and of the need to develop children's awareness and

skills in using it. She showed greater awareness of her role as a model for using talk for learning and of the value of balancing group work with whole-class activity. Less tangibly, the ethos of her classroom seemed more encouraging for the expression of children's ideas, which then informed further discussion. In Alexander's (2008b) terms, her teaching was much more 'dialogic'. The effects of this seemed apparent in the more committed and enthusiastic participation of children in her class.

Nevertheless, although both these teachers generated some features of dialogic teaching in their practice, others were absent or rare. Much of the whole-class talk in both classrooms matched the conventional characteristics of classroom talk observed in schools in many countries over recent decades (as described, for example, in Edwards and Westgate 1994; Mercer 1995). Observations in the project as a whole, across the 12 primary and secondary teachers, showed that the extent to which dialogue was effectively exploited as a pedagogic tool varied considerably. Only two teachers came close to representing Alexander's 'dialogic teaching' (one of whom was the Havenhill teacher) and only three teachers regularly engaged pupils in extended discussions of the type Mortimer and Scott (2003) call 'dialogic-interactive'. There are several possible reasons for this. It is widely acknowledged that the pressure English primary teachers are under to 'get through' the prescribed National Curriculum militates against a more adventurous, open-ended approach to classroom dialogue (Smith et al. 2004). Fisher and Larkin's (2008) survey suggests that teachers continue to be more concerned with keeping talk polite and orderly than with exploiting its learning potential.

Alexander (2008b) suggests that the continued dominance of the 'basics' of reading, writing and numeracy within the English education system diverts away teachers' attention from talk. This is in contrast to the way talk is accorded value in the classrooms of France, Russia and some other European countries. Our own view (supported by other researchers, e.g. Hardman 2008) is that the results of years of research about classroom talk have had relatively little impact on the content of the initial and in-service training of teachers in the United Kingdom. Most teachers do not have a high level of understanding of how talk 'works' as the main tool of their trade, and very few have been taught specific strategies for using it to the best effect. Our interviews and other discussions with the teachers in our project – who were self-selected on the basis of their interest in dialogue – indicated that even they were relatively unaware of the patterns and functions of teacher–pupil talk in their classrooms. Yet our experience of providing initial training and professional development courses for teachers suggests that they are very receptive to information and guidance on such matters. It would seem that this is an aspect of initial teacher training and professional development which, in England at least, would merit as a significant investment.

Developing pedagogic activities: talking points

One test of applied educational research, such as the one we have described, is whether the results can be used to offer relevant advice to teachers about how to develop their practice. We have described elsewhere activities which teachers can use to help develop their pupils' awareness and skill in the use of talk for collaborative, group-based problem solving (Dawes, Mercer, and Wegerif 2004). In this project, we have tried to devise pedagogic activities which will help teachers to instigate and develop useful whole-class dialogue between them and their students. We provide here an example of one activity, *Talking points*, which combines both of those aims and, as we know (from observations and informal feedback from teachers), has been found useful.

Talking points (Dawes 2008a, 2008b) is a simple resource for stimulating speaking, listening, thinking and learning. The 'talking points' are basically a list of statements which may be factually accurate, contentious or downright wrong. They provide a focus for discussion, by offering a range of ideas about a topic which the children can consider together. Assessing the truth of these statements stimulates children's thinking; and making explicit their knowledge and experiences to justify their beliefs enables children to compare their understandings. As we will show, a teacher can also learn about children's current levels of understanding from the outcomes of those discussions and decide on useful points for subsequent whole-class talk, further exploration, activity, demonstration or research. Once they are familiar with this technique, teachers can readily generate their own talking points or teach children how to do so.

We can demonstrate the value of this kind of activity in practice by using Sequence 3 given below, recorded in a year 5 English primary school class. After a brief introductory session, the children were given a group-based activity in which the group of three students discussed a set of talking points about the solar system and tried to decide whether they were true or false. The transcript consists of three sections: an extract from the small group discussion; an extract from the whole-class 'feedback' session that followed; and then part of a whole-class 'demonstration' that concluded the lesson.

Sequence 3: year 5, talking points

Viola: OK (*reads*) 'The moon changes shape because it is in the shadow of the earth'.
Frannie: No, that's not true because there's the clouds that cover the moon.
Viola: No, it isn't . . . Yes . . .
Gabrielle: Yes.
Viola: Because in the day we think, oh the moon's gone, it hasn't gone, it's just the clouds that
Frannie: Have covered it.
Gabrielle: Yes, that's why I, like, every time, well on Sunday I went out and it was like five in the morning right, and the moon was still out so that's fine 'cos it was still dark, right ?
Viola: Yes.
Gabrielle: So when we went out it was like five, four, four o'clock, something like that, like at that time there wouldn't be the moon out would there, but I saw half the moon out and I said, I said to my Mum's friend, I said 'Look Tony, there's the moon already out', and he said 'Oh yes'. Because in the morning when we came, there was the clouds.
T: OK everybody, finish up the one you're talking about.
Viola: So what do we think?
Gabrielle: I think it's false.
Frannie: False.

(*We now move into the following whole-class 'feedback' session*)

T: Keighley, would you read out number nine for us?
Keighley: (*reads*) 'The moon changes shape because it is in the shadow of the earth'.
T: Right, now what does your group think about that?
Keighley: True.

T: What, um, why do you think that?
Keighley: Hm, because it's when earth is dark then, hm, we're not quite sure but we think it was true.
T: Right, people with hands up – (*to K*) 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.
T: (*nods*) do you want to choose somebody else? That sounds good.
Sadie: Matthew
Matthew: Well, we weren't actually sure 'cos we were (thinking) the actual moon changes which it never does, or, if it is our point of view from earth, which it puts us in the shadow.
T: That's a good point, isn't it, it doesn't actually change, it looks as if it changes shape to us, that's a really good point.

We move now to the last part of the lesson. The teacher has a large photo of a half moon on the interactive whiteboard. She also has on a table a lamp (sun) a globe (earth) and tennis ball (moon).

T: Can anybody describe to me why we can only see one side of the moon from earth? Gabrielle?
Gabrielle: (*inaudible*; *nobody else offers a response*)
T: OK, we can only see one side of the moon from earth because the moon is going round the earth, OK, and it keeps the same side of itself to the earth all the time like that. This little dot here (*indicating dot on the tennis ball*) look, that's one of those craters on the moon. If we're in the UK here, we can only see this dot here, and we can't see anything on *this* side at all because it doesn't turn round, it keeps that dot (*orbits the moon round the earth*) – we have to colour it so that we will be able to see. OK, let's see why the moon actually changes shape. It takes about a month, 27, 28 days for the earth, for the moon to go round the earth. A moonth, that's what a month means. Yes 27.3 if we're going to be precise. OK?
Child: A mownth.
T: A moonth, that's why it's called a month. Here we are, somebody was saying they thought it might have ice, doesn't have any water, no atmosphere and no water. It's just rock. OK. This phrase, 'the phases of the moon', we use to mean the way the moon *appears* to, as Matthew pointed out, change shape. The way the moon appears to change shape. You can see here we've got this half moon effect, you see here? (*indicates whiteboard*)
All: Yes.
T: But there's something making a shadow on the moon here, let's look what that is. Because that's what we need to find out before we finish today. Carlie, are you with me?
Keighley: I brought in a book in which it shows all the different stages of the moon.
T: Right, OK, that'll be helpful. We'll look at it in a book 'cos I think to see pictures really helps doesn't it? OK, let's just see if we can work it out now. (*Teacher positions the ball, the 'earth' and the lamp in a line, with the earth in the middle; the 'moon' is, however, lifted so that the lamp shines on it.)* Here's the earth,

here's the sun, here's the moon. Right. How much of the moon do you think we can see from earth?

Children: Half (*which is wrong; this would be a full moon).*

T: Think! The *moon*; this is the sun, our source of light, it's really shining off into space, we're facing the moon, here we are (*the UK is facing away from the sun*) we're facing the moon, how much of that moon can we see?

Children: Half/a third maybe?

T: Right.

Walter: We can't see these sides, or the back.

T: We can't see any of this (*indicating the back of the 'moon'*).

Walter: So we can only see about a third (*children still do not understand*).

T: 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. Right? That's a full moon, we can see the whole caboodle, if we're here on earth and the sun's over there. However, have a look now, what happens now. If I put the moon here (*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.

T: What would we see if the moon is in that position?

Children: Nothing.

T: Yes, it would be totally dark. We get a completely black effect because we can't see it, we can only see it if there is light falling on it, and all the light is falling on this side and we're not over there, we're over here. Yes?

Tom: If it's like that, the reason we can't see anything really because it's so dark around it.

T: Yes it's dark, yes, 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 (*returns 'moon' to 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, wait a minute let's get this right. If we come half way around (*moves the moon so that the lamp and ball are at a right angle with the earth at the vertex*), the sun's shining on this bit, but not on this bit, what would we see then?

Children: Half/half-moon.

T: It would look like that (*points at picture of half moon on whiteboard*).

Children: Yes/Ooh.

T: Yes, the sun's shining on that bit, but not on this bit, we'd see a half moon. So that means that the moon is putting a shadow on itself, it's not the earth throwing a shadow on it, or a planet throwing a shadow on it, it's in its own shadow if you like. The shadowy bit is just not lit up by the sun. And from earth we can only see about half of it, while the other half of it is this side. And this is how it works (*moves the moon round the earth*) dark, half moon, full moon, half moon, and that's what happens. With those little crescents in between. Viola? (*Viola has her hand up*)

Viola: I've learned something now.

T: Yes (*laughs*) I'm a bit worried about what. Go on then.

Viola: I didn't know that, I know that you can't see the other half, but I don't know how to explain it (*laughs*)

T: Maybe, you need to give it a chance for it to sink in and think about it, it's quite hard to understand, I find it hard to understand.

Comment. In the first part of this sequence, we see three children discussing a 'talking point', drawing on whatever relevant experience and knowledge they can find to judge its veracity. We can see that they do not understand why the moon 'changes shape'. Nevertheless, the group activity focuses their attention on this topic and their relevant collective knowledge, in a way that would not be so easy in a teacher-led discussion. Moreover, we can see that they all participate and listen to each others' contributions. The quality of the talk in this group, and in most of other groups in the classroom, reflects the teacher's successful pursuit of a 'talk agenda' in her lessons (as described for the Havenhill teacher above).

In the middle section, we see the teacher engaging with the pupils in talk which has some 'dialogic' features (in the sense that this term is used by both Alexander [2008a] and Scott, Mortimer, and Aguiar [2006]). In relation to Alexander's use of the term we can see that students are given opportunities and encouragement to question, state points of view and comment on ideas and issues which arise during lessons; the teacher's questions are designed to provoke thoughtful answers ('Why do you think that?'). The children's answers provoke further questions and form building blocks for further dialogue. In Scott, Mortimer, and Aguiar's (2006) terms, the talk is *interactive/dialogic* because the teacher engages the children in a series of questions, but these provide an opportunity for children to express their ideas. Moreover, the teacher does not make a critical assessment of these ideas as right or wrong, but rather takes account of them and allows the dialogue to continue. By using this interactive/dialogic approach, the teacher learns about the children's current understanding of the topic of the lesson and is able to use this information in developing the theme of the lesson.

In the final part of the sequence, the talk has a different pattern. Scanning over the sequence as a whole, it is quickly apparent that in the final part the teacher's talk takes up a much greater proportion of the dialogue. She uses these longer turns to explain to the children (with the use of models) how the solar system generates the moon's phases. She again questions the children, but this time the questions are used for different purposes – to check that the children are following her explanation, and to carry out some 'spot checks' on whether they have understood its implications and so on. Twice it seems that the children evidently have not understood, so the explanation and demonstration continue, with the questions simplified to focus on key points and to reinforce correct responses. The dialogue here can be described as *interactive/authoritative*. It is used to provide children with information about the solar system, which is absolutely necessary for their understanding of how it works, and a model-based spoken presentation of this kind is the most effective way of doing so. We might note at the end of the sequence that Viola, one of the students in the earlier group discussion extract, comments 'I've learned something now'. We cannot be sure, but it seems likely that the group discussion had 'primed' her to be receptive to the teacher's demonstration and explanation in a way that would not have happened if the teacher had begun the lesson with the authoritative demonstration. In describing and evaluating the talk in this lesson, then, we can see that it is the quality of the dialogue as whole that matters, and important is the way it is temporally organised as a means for establishing and maintaining a collective consciousness. It is the complementary variety of the talk that makes this 'dialogic teaching'. The *talking points* type of activity offers a way to help a teacher pursue such a dialogic pedagogy.

Conclusion

Our research leads us to believe that initial teacher training and professional development should include more specific tuition in the effective use of talk for learning. We have found that even teachers who express an interest in dialogic teaching may need reassurance that this is, indeed, an effective way to help children's learning and understanding of science, and need to develop an awareness of the nature and importance of their own participation in classroom talk. Our research supports the view that better motivation and engagement are found amongst children whose views are sought and valued through dialogue. Finally, we suggest that teachers can be helped to develop a more dialogic pedagogy through the use of certain techniques like *talking points*, which can be incorporated into the fabric of a lesson and used with children who know that their ideas and voices will be listened to with respect.

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References

Alexander, R. 2000. *Culture and pedagogy: International comparisons in primary education*. Oxford: Blackwell.

Alexander, R. 2008a. *Towards dialogic teaching: Rethinking classroom talk*. 4th ed. York, England: Dialogos.

Alexander, R. 2008b. Culture, dialogue and learning: Notes on an emerging pedagogy. In *Exploring talk in schools*, ed. N. Mercer and S. Hodgkinson. London: Sage.

Dawes, L. 2008a. *The essential speaking and listening: Talk for learning at key stage 2.* London: Routledge.

Dawes, L. 2008b. Encouraging students' contribution to dialogue during science. *School Science Review* 90, no. 331, 101–7.

Dawes, L., N. Mercer, and R. Wegerif. 2004. *Thinking together: A programme of activities for developing speaking, listening, and thinking skills*. 2nd ed. Birmingham, England: Imaginative Minds.

Driver, R., P. Newton, and J. Osborne. 2000. Establishing the norms of scientific argumentation in classrooms. *Science Education* 84, no. 3, 287–312.

Edwards, A.D., and D.P.G. Westgate. 1994. *Investigating classroom talk*. 2nd ed. London: The Falmer Press.

Fisher, R., and S. Larkin. 2008. Pedagogy or ideological struggle? An examination of pupils and teachers' expectations for talk in the classroom. *Language and Education* 22, no. 1, 1–16.

Galton, M. 2007. *Learning and teaching in the primary classroom*. London: Sage.

Hardman, F. 2008. Teachers' use of feedback in whole-class and group-based talk. In *Exploring talk in schools*, ed. N. Mercer and S. Hodgkinson. London: Sage.

Kelly, G.J., C. Brown, and T. Crawford. 2000. Experiments, contingencies and curriculum: Providing opportunities for learning through improvisation in science teaching. *Science Education* 84, no. 5, 624–57.

Lemke, J.L. 1990. *Talking science: Language, learning and values.* Norwood, MA: Ablex Publishing Company.

Mercer, N. 1995. *The guided construction of knowledge: Talk amongst teachers and learners*. Clevedon, England: Multilingual Matters.

Mercer, N. 2005. Sociocultural discourse analysis: Analysing classroom talk as a social mode of thinking. *Journal of Applied Linguistics* 1, no. 2, 137–68.
Mercer, N. 2008. The seeds of time: Why classroom dialogue needs a temporal analysis. *Journal of the Learning Sciences* 17, no. 1, 33–59.
Mercer, N., L. Dawes, R. Wegerif, and C. Sams. 2004. Reasoning as a scientist: Ways of helping children to use language to learn science. *British Educational Research Journal* 30, no. 3, 359–77.
Mercer, N., and K. Littleton. 2007. *Dialogue and the development of children's thinking: A sociocultural approach*. London: Routledge.
Mortimer, E.F., and P.H. Scott. 2003. *Meaning making in secondary science classrooms*. Maidenhead, England: Open University Press.
Ogborn, J., G. Kress, I. Martins, and K. McGillicuddy. 1996. *Explaining science in the classroom.* Buckingham, England: Open University Press.
Scott, P., and J. Ametller. 2007. Teaching science in a meaningful way: Striking a balance between 'opening up' and 'closing down' classroom talk. *School Science Review* 88, no. 324, 77–83.
Scott, P., E. Mortimer, and O. Aguiar. 2006. The tension between authoritative and dialogic discourse: A fundamental characteristic of meaning making interactions in high school science lessons. *Science Education* 90, no. 4, 605–31.
Sinclair, J., and R. Coulthard. 1975. *Towards an analysis of discourse: The English used by teachers and learners*. Oxford: OUP.
Smith, F., F. Hardman, K. Wall, and M. Mroz. 2004. Interactive whole-class teaching in the national literacy and numeracy strategies. *British Educational Research Journal* 30, no. 3, 395–411.
Wells, G. 1999. *Dialogic inquiry: Toward a sociocultural practice and theory of education*. Cambridge: Cambridge University Press.