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# A talk focus for promoting enjoyment and developing understanding in science

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*ABSTRACT: In this paper we suggest a practical, talk-based model for the successful pursuit of teaching science in primary classrooms (Loxley* et al., *2010). This model is not only based on our own experience of teaching in primary schools, and of training teachers to do so, but is also based substantially on research on classroom talk, which has built upon the foundations established by Douglas Barnes. We begin by setting out the three-stage model and then go on to illustrate how it can be put into practice.*

*KEYWORDS: Primary Science Education, talk for learning, exploratory talk, stages*

## INTRODUCTION

Children like science; they enjoy practical activities. But learning factual information may not be very motivating (Murphy & Beggs, 2003). Effective science teaching involves tapping in to children's natural curiosity to help them develop understanding of a scientific point of view. Finding out what children think involves creating opportunities to talk to them – and teaching them how to talk to each other.

We advocate teaching science in three discrete stages, each involving dialogue and discussion. Children's curiosity is channelled into motivation as they work to resolve puzzles and answer questions they have raised. In the first or **exploratory stage**, children become involved in a search for understanding. They generate questions as they discuss and reflect on their own ideas and those of their classmates. In the next or **re-describing stage**, children investigate ideas that have been raised, and think together to devise ways to resolve puzzles and problems. They consider new ideas and information, sharing insights with their classmates. In the third or **application stage**, children begin to see the usefulness of their new scientific understanding by applying it to other contexts and evaluating their learning of science and discussion skills. This paper exemplifies a talk focused, three-stage approach to teaching primary science, which we believe offers a model for other curriculum areas.

## PROMOTING ENJOYMENT AND DEVELOPING UNDERSTANDING OF SCIENCE

### The exploratory stage

> "Getting the knowledge from 'out there' to 'in here' is something for the child […] to do; the art of teaching is knowing how to help them do it" (Barnes, 1992, p. 79).

The exploratory stage in learning involves enabling the child to articulate their own hypothetical or more established ideas. The most effective way to do this is through talk with others. A balance of group talk and whole class dialogue can bring out a range of thinking. Children may be surprised and interested to find that the world is not always as they first perceive it to be and that their classmates may have a range of different points of view. This is because some scientific phenomena (such as magnetism, light or forces) are puzzling; and this is where science offers children the pleasure of discovering answers for themselves (Loxley, 2005).

The exploratory stage is analogous to the opening chapter of a story in which the scene is set for the action to come. Asking children to talk about or interact with everyday contexts in science arouses curiosity and highlights puzzling situations that need resolution. For example, an extract from J. M. Barrie's *Peter Pan* (2007) offers a starting point for setting children off on a quest to understand more about shadows. (*Note that "Nana" is the Darling's child-minding dog.*)

> Mrs. Darling screamed, and, as if in answer to a bell, the door opened, and Nana entered, returned from her evening out. She growled and sprang at the boy, who leapt lightly through the window. Again Mrs. Darling screamed, this time in distress for him, for she thought he was killed, and she ran down into the street to look for his little body, but it was not there; and she looked up, and in the black night she could see nothing but what she thought was a shooting star.
>
> She returned to the nursery, and found Nana with something in her mouth, which proved to be the boy's shadow. As he leapt at the window Nana had closed it quickly, too late to catch him, but his shadow had not had time to get out; slam went the window and snapped it off.
>
> You may be sure Mrs. Darling examined the shadow carefully, but it was quite the ordinary kind. […] She decided to roll the shadow up and put it away carefully in a drawer, until a fitting opportunity came for telling her husband (p. 16?).

Shadows do act in puzzling ways. Encouraging children to share their understanding of shadows helps them to establish puzzles and to ask questions, which they will go on to investigate. In order to bring out a range of starting ideas, we have successfully used **Talking Points** resources for a range of topics (Dawes, 2010).

Talking Points provide a chance for in-depth consideration of everyone's ideas. Talking through such ideas before being asked to contribute to whole class dialogue provides every child with a safe forum in which to speak. Teachers commonly use techniques where children share ideas with a partner for a minute or two during whole-class work. This is a beneficial use of talk and certainly diminishes the

deadening effect of using inauthentic "already-known-answer" questions, with hands up to bid for a turn to speak. However, the brief time allowed for talk, and the exchange of ideas with one other person only, do limit the discussion. Groups can usefully spend ten or fifteen minutes considering a range of ideas using Talking Points. Here are some Talking Points about shadows; note that these are not questions, but ideas for consideration by a discussion group.

***Example of Talking Points: Shadows***
*What does your group think of these ideas? Are they true or false, and why do you think so?*

- Dark places like drawers are good places to keep shadows
- Shadows are not real things
- Shadows are made of dust
- Shadows follow you about all the time
- Shadows are the same shape as the person they belong to
- We only have shadows during the day
- You can get coloured shadows
- Is it not possible for people to lose their shadows
- Shadows of trees get larger in the evening
- The sun and the moon can both make shadows
- The shape of the moon depends on shadows
- You can't pick up your own shadow, or run away from it

Discussing the Talking Points, children share their hypothetical and tentative ideas, and hear several points of view. Subsequent whole-class talk orchestrated by the teacher helps everyone to consider a range of possibilities, share their thinking, establish areas of uncertainty about the topic and generally develop vocabulary and understanding (Dawes 2008). The whole class establishes areas of interest and uncertainty – that is, puzzles – for further investigation.

Discussion in a group is most effective when children are aware of the need for high-quality, **exploratory talk** (Mercer 2000; Barnes, 2008a). Exploratory talk happens when everyone is invited to give their ideas, and when children know how to challenge one another respectfully, sharing information, and giving and asking for reasons. Active listening is a major feature of productive group talk. Direct teaching of the talk skills necessary for exploratory talk is essential. This helps children to understand that it is crucial to show interest in different points of view, however hesitantly they are offered. By engaging one another in exploratory talk children establish what they know, and do not know, about a topic. With enthusiasm and interest; children look to resolve the puzzles they have raised. They become much more open to established scientific ideas because such information can satisfy their curiosity. Children do not naturally know how to generate exploratory talk, but

teaching them to do so is both straightforward and crucial, since this is a life skill, not just a skill which will give them better access to educational opportunity at school.

Below are some examples of ideas suggested by children aged 7 – 8 years, discussing the Shadows Talking Points.

> Shadows come from the sun.
> The sun makes the ground light and if you stand still you can see your shadow.
> Shadows are yourself.
> The sun makes us hot and makes a black reflection.
> Your shadow is like a mirror of yourself, but plain black.
> We see shadows at night and day and in the playground.

Such tentative ideas can help the teacher to plan next steps in learning for the class. The chance to share ideas aloud in a forum where no idea will be summarily rejected is of great value to the child. Children may never have formulated their thinking about shadows until this moment; doing so presents them with a clear idea of their own understanding in a way that stimulates curiosity and encourages further discussion and investigation.

**The re-describing stage**

"The emphasis on language for performance rather than for exploration is, of course, communicated by many teachers when they treat classroom discussion as an opportunity for cross-questioning" (Barnes 1992, p. 61). Barnes highlights the importance of reasoned dialogue in enabling learners to hear a range of points of view which can help them to re-think everyday ideas. Whole class talk and talk between learners are both important during the second or re-describing stage. This stage resembles the phase of a story when things which puzzle and intrigue start to be resolved. Practical activity coupled with provision of scientific information, and focused vocabulary work, helps children to collect evidence with which they can visualise scientific ideas. Re-describing happens as learners begin to apply relevant scientific language to their experiences, and talk through concepts to move towards the established scientific point of view

In learning about shadows, children used torches in a darkened room to observe and think about light falling on their clothing, hands and other surfaces. They talked about how light travels from the torch; they used their own words to describe a beam of light. Exploratory talk supported thinking as the children visualised the way light moves from source to object, and noted that it travels in straight lines. They drew annotated pictures to represent a beam of light. The next step was to introduce opaque objects and observe and talk about how light is blocked. A shadow then becomes a logical effect of the two scientific ideas that *light travels in straight lines* and *opaque materials block light.*

The children's talk enabled the teacher to access their developing ideas – or continuing misconceptions – during this stage. The importance of eliciting misconceptions so that children can compare their everyday ideas with a more scientific point of view has been well documented (see Allen, 2010).

> Put a big torch in front of you and put something in front of it and you can make a shadow.
> Light comes from lights. Shadows come from dark.

It was evident that the children had not yet understood that dark is the absence of light, rather than a phenomenon in its own right. A subsequent activity involved children suggesting how they would stop torch light reaching a surface. Own experience was brought into the discussion as children considered how we try to block sunlight in summer. Children tested their suggestions using a range of materials. Having established, for themselves, which are truly opaque materials, such as thick card or balsa wood, children created shadows. They considered shadows as areas of darkness created by blocking light. They investigated and talked about a range of transparent, translucent and opaque materials, learning to understand the relevant vocabulary. To complete the re-describing stage children went into the playground in sunshine to observe, discuss and draw one another's shadows.

Here are some examples of the children's ideas at this stage:

> *(Using a red card and thinking about the shadow)*
> It will be red but a bit lighter. No, it will be black, because it's a shadow and shadows are black. But it might be a bit red, just a bit.
>
> The light gets trapped and a black shadow shows.
>
> The light is so bright that your body reflects it back and makes the shadow.
>
> We see shadows when it's sunny and there are lots of sun rays.

***Further thinking about the puzzles that are shadows***

The children needed more experience of looking at shadows, to understand that they are not to do with trapped light or reflection. Using a torch and small plastic animals children developed their ideas about light and shadow by shining the torch from different angles and drawing pictures of the shadows formed. They generated their own explanations of why shadows are black or dark, why they are not all the same size and why they are always formed on the opposite side of the model to the light. With this mix of experience and shared thinking, children readily accommodated the idea that dark is absence of light, and a shadow is an area where light is blocked.

Assessing children's new understanding of shadows involves asking them to draw an annotated picture, which explains why we (or Mrs Darling) cannot fold up a shadow and put it in a drawer; and asking them to explain what happens to shadows when there is no light.

## The application stage

> The readiest way of working on understanding is often through talk, because the flexibility of speech makes it easy for us to try out new ways of arranging what we know, and easy too to change them if they seem inadequate. Of particular importance is the fact that we can talk to one another, collaborating and trying out new ways of thinking (Barnes, 1992, cited in Dawes, 2010, p. 7).

As Barnes points out, talk is a way to "work on understanding". For children who are not yet fluent readers and writers, it may be their only way; and even after they have

acquired literacy, it is still their "readiest" way. In classrooms we can use talk with children in order to offer them chances to generate new learning. In the application stage, children can use their newly acquired scientific knowledge for decision-making and problem-solving. The more often they use their new knowledge, and its associated vocabulary, the more meaningful it will become. Indeed they may find few opportunities for such discussions in their everyday life – but having experienced the power of productive talk in the classroom, they may begin to generate their own discussions in other contexts.

Working on shadows, children designed and made shadow puppets to animate a scene from a story. A white sheet suspended from the classroom ceiling and a light projector created an impressive shadow theatre. Children working collaboratively designed their own shadow scenery, props and characters, using a range of transparent, translucent and opaque materials, including coloured acetate.

During this stage children furthered their understanding by using their knowledge of shadows creatively, for example, by moving puppets relative to the light source to change size or sharpness of image. Children provided a performance for others using their shadow puppets, putting to use scientific vocabulary and understanding to communicate their ideas. The science learning was again emphasised by whole-class discussion using the children's examples. In addition, children were asked to evaluate the quality of their group talk. They provided examples of, for example, interesting ideas shared by others, of conflicts resolved, and of reasons given for ideas. The children were asked to give positive feedback on the shadow puppet performances of other groups, with suggestions of how to make the show even better. The children were aware that their use of talk was part of the learning experience, and that their "task" within the classroom involved acting as a learning resource for one another.

Here are some of the children's ideas during the application stage:

> The sun goes through you and makes you hot. You get a shadow because the sun casts a shadow ahead of you. Or behind you. The shadow is the bit that can't get around you.
>
> As the light gets lower the shadow gets longer. But when it gets higher the shadow shrinks.
>
> The shadow is a dark patch.
>
> If you stand on tip toes your shadow can change, really into the shape of anything.

From such spoken evidence, we can see that children's ideas have developed and they are beginning to use relevant vocabulary. For example the use of the word "casts" in relation to shadow indicates appropriation of vocabulary. Children have learned that shadows change as light angle and proximity change, and have begun to see that a shadow is darkness and is the absence of light.

## Talk in the classroom: An illustration

We can demonstrate the value of this approach further through the sequence below, recorded when one of us was teaching a Year 5 primary school class. After a brief introductory session, the children were given a Talking Points activity in which, in

threes, they discussed a set of statements about the solar system and tried to decide if they were true or false; or if their group was unsure. Uncertainty was highlighted as a positive outcome in that learning was then possible. The transcript consists of three sections: an extract from the discussion one group of three children; an extract from the following whole-class session in which the children reported the results of their group discussions; and then part of a whole class "demonstration" which concluded the lesson.

***Talking Points: the solar system***

(a) *Group Discussion: The exploration stage*

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

(b) *Whole class "reporting back" session: The re-describing stage*

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.

(c) *Whole class lesson plenary*

*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.

In the first part of this sequence, three children discuss their ideas about a Talking Points statement, drawing on whatever experience and knowledge they consider relevant. 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 prior knowledge, in a way that would not be so easy in a teacher-led discussion. Their talk has some exploratory features (Mercer, 2000; Barnes, 2008a). They may not determine the correct answer, but they do examine what they think they know about this topic. In this way, their talk "primes" their receptiveness to new knowledge, and perhaps for conceptual change (Howe, McWilliam & Cross, 2005). Moreover, we can see that they all participate and listen to each other's contributions. The quality of the talk in this group, and in most of the other groups in the classroom, reflects the successful pursuit of a talk focus in the lesson.

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 a series of questions, but these provide an opportunity for the children to express their own 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 teacher's talk takes up a much greater proportion of the dialogue; the dialogue here can be described as interactive/authoritative (Scott *et al.,* 2006). However, the content of her "authoritative" talk is contingent – responsive to – the limited understanding of the solar system, which the children have revealed in the earlier whole-class sessions. She uses her authoritative role 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. 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 a most effective way of doing so. At the end of the sequence, 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 simply begun the lesson with the authoritative demonstration. A further application stage would involve children in demonstrating phases of the moon using models, designing a story board on this topic, or looking at video of the transit of Venus and explaining what is observed.

## CONCLUSION

Children's natural desire to enquire and to find answers to puzzles helps them to engage with, and make good use of, established science knowledge. A creative approach to science involves establishing some interesting puzzles and quests, and then investigating together to discover answers. Following this, new understanding can be applied to other contexts, so that learning is put to use and ideas are consolidated. This three-stage approach to the teaching and learning of science helps children to maintain their interest in the natural world.

Working together through speaking and listening enables children to develop science knowledge, a scientific way of thinking, and a positive attitude to undertaking learning in group situations. In order to benefit from this approach, children need direct tuition in talk skills. They need to know what exploratory talk is and how to generate it with their peers; how to listen, think and respond effectively; how to challenge the ideas of others with respect and interest; and how to work towards a negotiated agreement in which every member of a group is included.

The three-stage approach for effective science teaching is based on the idea that we can offer children the satisfaction of finding things out. Coupled with talk-focused teaching, this approach can ensure the engagement of every child, promoting enjoyment and learning and making the most of the social situation that is the classroom.

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