CREATIVE PEDAGOGIES IN EARLY YEARS SCIENCE: THEMATIC PLANNING AND SUSTAINED SCIENTIFIC DIALOGUES

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Abstract:
This paper draws on the ‘See the Science’ Project funded by the Primary Science Teaching Trust that took place in South West England in 2012-13. It aims to illuminate the process of transforming a curriculum document into a valuable learning experience for children through the use of classroom talk. The project was grounded in concerns that the increased use of thematic, ‘creative’ curricula in England was leading to a loss of scientific learning for children in the early years (five to seven year olds). It presents our findings that in the context of the twelve primary schools with which we worked, the type of curriculum used (e.g. thematic, cross-curricular) had less impact on teaching than we anticipated, whereas the teacher’s immediate responsiveness to children’s ideas and interests and their development of a repertoire of different forms of talk for different purposes in learning science was crucial. A framework emerged to characterise the form of talk we aimed to develop; sustained scientific dialogues, encompassing the essence of sustained, shared thinking in the early years (Siraj-Blatchford et al., 2008) with a science focus and drawing on characteristics of dialogic talk (Mortimer and Scott 2003; Alexander, 2008). Through the development of case studies using qualitative approaches including transcription and analysis of classroom talk we examine how teachers developed their practice and we argue that sustained scientific dialogues play a key role in the development of creative pedagogies. Three cases presented here are representative of the typical project findings: one inexperienced teacher developed talk that was more sustained and two experienced teachers developed talk that was more dialogic, the latter exemplifying how this maintained a strong science focus. The fourth case shows how an early years teacher with a strong dialogic pedagogy expanded his repertoire to include more authoritative episodes focussed on scientific knowledge.

Keywords: early years, primary, thematic, creative, dialogic

INTRODUCTION
The See the Science project funded by the Primary Science Teaching Trust involved primary school teachers working with university research staff to secure and strengthen the place of science within a thematic, ‘creative curriculum’ and to enhance children’s learning by improving the quality of classroom talk between teacher and pupil. This paper aims to explore:

• How science learning is identified and developed within a thematic or ‘creative curriculum’ framework;

• The challenges of promoting and implementing primary school teachers’ sustained scientific dialogues with children.

Seeing the Science within a Thematic Curriculum
Our concern is for the future of science teaching of the highest quality within educational practices that are increasingly moving away from a traditional subject focus on science as more thematic, ‘creative’ and child-centred approaches to curriculum design continue to emerge, develop and be championed in England and elsewhere. In England two major
reviews of curriculum design for children aged 5-11 proposed curricula which are not
arranged around traditional subject structures (Alexander, 2010; Rose, 2009). Although the
current National Curriculum for England (DfE, 2013) (for children aged 5 and upwards) has
set aside such recommendations and put in place a subject-based curriculum, many schools
are not obliged to teach this curriculum and have opted to adopt alternative versions that
exploit the potential of thematic learning. There is also a strong international trend in this
direction: The authors of the International Primary Curriculum (Fieldwork Education, 2013),
(claimed to be in use in 80 countries) purports to be a highly successful thematic, creative
curriculum for 3-11 year olds, Altinyelken (2010) reports on the implementation of ‘thematic
curriculum’ in Uganda and McCulloch (2011) reports on 5 high performing school systems
(including Finland & Australia) where schools are ‘increasingly taking a rigorous thematic
approach...’ (p27). Although the thematic approach is believed to have considerable benefits
in situating knowledge within a meaningful, motivating context, we were concerned that
where teachers may have multiple objectives for classroom activity the distinctive
contribution of science to children’s learning may disappear (Davies, 2011).

Creative curriculum is often used interchangeably with ‘thematic’ or ‘cross-curricular’ when
discussing the school curriculum. Curriculum design has been a highly contentious issue in
the UK since the inception of the National Curriculum in 1988 (Alexander, 2010). The debate
is often characterised as a dichotomous struggle between realists purporting that subjects
should be the fundamental units of the school curriculum, challenged by pragmatic and
progressive philosophies that champion student-centred curricula claimed to engage learners
and contextualise knowledge and skills (Ornstein & Hunkins, 1998; Alexander, 2010).
However, as Alexander (2010) argues, subject disciplines and thematic teaching are not
mutually exclusive. Subjects, he asserts, can be integrated, connected or combined through
classroom activity, yet remain as subjects. A curriculum organised in a way that does not
exploit connections between subjects, is, arguably, a poor alternative.

Curriculum transformation through classroom talk

Siraj Blatchford et al (2002) distinguish between ‘pedagogical framing’ and ‘pedagogical
interventions’; curricula become uniquely developed, interpreted and transformed by teachers
and their students. Teachers will draw on knowledge of subjects, of learners and of their own
roles, strengths and limitations, to make a unique blend of educative experiences and
practices. It is this transformation that we take to mean ‘creative curriculum’ development.
We acknowledge that such practice is, for teachers, a high-risk strategy requiring self-
confidence and an investment of time and energy (Jeffrey & Craft, 2004).

How teachers talk with children plays a key role in this creative process of curriculum
transformation. Dialogues between children and adults that have shown Sustained Shared
Thinking (SST); a practice that embodies the value of responding to children’s ideas and
interests through talk, have been found to be a common feature of early years practice leading
to higher outcomes (Siraj-Blatchford et al., 2008). Similarly, a principle of ‘dialogic’ talk is
that it is ‘genuinely reciprocal’ (Alexander, 2008), and in the context of science this means
teachers working with both children’s ideas and scientific ideas together in classroom talk
(Mortimer and Scott, 2003). The assumption of the See the Science Project was that the way
teachers develop such dialogues will be informed by their understandings of science and its
relationship with other subject areas. We invited practitioners to consider how they could
develop the scientific aspect of their talk with children within a thematic curriculum.

As the English curriculum is undergoing a period of change this project was well placed to
explore the possibilities for and challenges of developing sustained dialogues within different
forms of curriculum planning. As schools have been encouraged to adopt a ‘creative
curriculum’, often based on thematic topics rather than subject focussed planning teachers
have been working to adopt ‘creative pedagogies’ in which children’s ideas and interests
inform the content and processes of teaching and learning. Although it is used widely in educational discourse in the UK, there is no single consensus what the term ‘creative curriculum’ means in practice and the model of curriculum and of pedagogy that underpins it is under-researched (Davies et al., 2014). We will discuss some ways in which teachers have attempted to construct a creative curriculum through their planning and talk with children within the See the Science project.

Dialogic and creative pedagogies

A ‘transmission model’ of communication, in which information is simply coded by a sender and decoded by the receiver, is a common view of the purpose and process of schooling and is often associated with classroom talk is overly dominated by ‘Initiation-Response-Evaluation (IRE) triads (Sinclair and Coulthard, 1975). An alternative to the transmission view of talk, suggests that texts (both spoken and written) fulfil two functions: to convey meanings adequately, and to generate new meanings (Wertsch, 1991; 74). The first requires the codes of the speaker and listener to coincide – it requires univocality, the second involves multivoicedness. Unlike the Vygotskian use of the term dialogic, which focuses on the development of shared understandings through language (Vygotsky, 1978), Bakhtin’s use of ‘dialogic’ values the differences in meanings between any participants in creating a ‘multivocal’ discourse that is in tension with the ‘univocal’ discourse imposed by powerful groups within society (Bakhtin, 1981) This multivocality is a source of creativity as new meanings are generated (Wegerif, 2008).

The Cambridge Primary Review (Alexander, 2010) advocates pedagogy of both cultural induction and exploration, this dual view of the purpose of education as both the appropriation of cultural knowledge and its transformation is central to our view of creative pedagogies for science education. Science is about being imaginative and creative; about generating ideas, as well rigorous testing leading to (tentative) verification of concepts. When science is understood as a tentative, changing knowledge, then engaging in that discourse requires simultaneously working with the existing ideas and seeking to change them. Thus we position dialogic talk as an important element of creative pedagogies.

Working with teachers to understand the theoretical model in practice, Mortimer and Scott (2003) argue that moving between univocal and multivocal discourses by using different communicative approaches that include both dialogic and authoritative elements in science lessons is fundamental to supporting children’s appropriation of scientific concepts and suggest that in most cases this requires an increased use of dialogic talk in classrooms. This is how dialogic talk can support univocal outcome of shared understanding of existing science concepts. Extending this, we advocate a repertoire of talk to support multivocal as well as univocal outcomes (McMahon, 2012). Alexander also provides indicators of dialogic talk in the classroom, arguing that the key features are that is collective, supportive, cumulative, purposeful, and reciprocal and suggesting that the cumulative feature in which ideas build upon each other through sustained chains of utterances is particularly challenging to achieve.

**Sustained Scientific Dialogues**

Teachers and researchers discussed literature on classroom talk and experiences of practice in terms of our views of the aims of science education within a thematic curriculum as the See the Science project progressed. We developed a framework (summarised in Table 1 below) to characterise and reflect on the form of talk we wanted to develop, coining the term sustained scientific dialogues (SSD) as encompassing the essence of sustained, shared thinking in the early years (Siraj-Blatchford et al., 2008) with a science focus and drawing on features of dialogic talk from Mortimer and Scott (2003) and Alexander (2008).
METHOD

The *See the Science* project combined research with professional development as university tutors worked collaboratively with teachers to reflect on practice and how it can be developed. By developing narratives based on cases situated in a diverse range of contexts we were able to generate rich accounts of the complexities of teaching that engages with the tacit knowledge of the teachers and we intend will resonate with readers (Stake, 1995). The use of multiple case studies increases the external validity as findings can be compared across the cases (Yin, 2003).

Case studies were developed with twelve teachers in six primary schools in three different environments; rural village, city centre and city suburbs. The schools were self-selecting in response to an open invitation to approximately 250 schools within the university teaching partnership so we can assume that science was already important to those schools and this limits the extent to which they can be seen as representative of English schools.

The project intervention strategies over one year were: workshops on identifying science in a thematic curriculum, workshops on research into classroom talk, teacher self-audit and target setting, teachers sharing approaches to planning, audio-recording and transcription of teacher-pupil talk and reflective dialogues on transcripts.

This generated the following data sources:

- Teacher self-audit questionnaires and on-going reflections
- Samples of planning
- Audio recordings of teacher –pupil talk in three science rich lessons per teacher over the course of the project supported by observational field notes.
- Audio transcription of selected episodes
- Teacher and tutor reflection on transcripts
- Teachers’ PowerPoint presentations and accompanying narratives at project end.

Analysis of the transcripts drew on elements of the literature discussed by the whole project team that, during the course of the project, emerged into the analytic framework summarised in Table 1. The first analysis was a reflective discussion between the tutor and teacher then the validity of their interpretation of the transcripts was enhanced by further analytical discussion with another teacher.

<table>
<thead>
<tr>
<th>Element of SSD</th>
<th>Key Questions for Reflective Analysis</th>
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<tr>
<td>Sustained</td>
<td>Were ideas developed over several exchanges in a sustained way? (Siraj-Blatchford et al. 2008)</td>
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<td></td>
<td>Were there chained utterances, not limited to IRE triads?</td>
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<td></td>
<td>Was the development of ideas cumulative? (Alexander, 2008)</td>
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<td>Scientific</td>
<td>Was the episode purposeful in terms of scientific learning? (Alexander, 2008)</td>
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<td></td>
<td>Did the content go beyond factual recall to conceptual and/or procedural understanding? (Wegerif, 2013)</td>
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<tr>
<td>Dialogue</td>
<td>What was the overall balance of pupil to teacher talk? Were children’s ideas expressed and explored? Was the talk collective, &amp; genuinely reciprocal? (Alexander, 2008)</td>
</tr>
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<td></td>
<td>Was the communicative approach dialogic or authoritative? (Mortimer &amp; Scott, 2003)</td>
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The time consuming nature of producing and analysing transcripts meant that selection was required. The lessons observed were planned by the teacher and so were likely to represent what they saw as their ‘best’, but possibly also ‘safest’ teaching. Episodes of audio recording were selected for transcription by the tutor in discussion with the teacher after the lesson, enabling the teachers to feel in control of this potentially exposing process. So the transcripts presented in the findings are not chosen as typical of a teacher’s practice, rather they represent their journey of professional development.

RESULTS

Framing of science within the schools’ curriculum

The project schools situated science within their curricula in different ways: most teachers (10) taught science as a distinct thread within a topic and only two had science fully integrated into a theme. None taught science as an isolated subject. Questionnaire data showed that no school made large changes to their medium term planning during the project. Some teachers reported frustration in realising their view of a creative curriculum within the constraints of whole school approaches. Most were content that their existing planning provided sufficient opportunities for science and were more interested in changing the kind of science this was and ensuring that it allowed time for discussion of questions and building on children’s ideas.

Curriculum transformation through classroom talk

During the analysis of data from the project it became clear that the teachers had limited control over the medium-term planning as all the project schools had adopted externally produced schemes of work. Whilst there were espoused notions of ‘creative’ or ‘thematic’ curriculum organisation at school level intended to make learning more relevant and effective, the impact such curricula had at the level of teacher-pupil interactions were difficult to discern. It became apparent that it was still in the teacher’s control to determine the kinds of talk that happened in the classroom and there were many opportunities (that were sometimes missed) within curriculum frameworks to develop sustained scientific dialogues with children. By exploring these issues with teachers we produced case studies to provoke further discussion about how to manage the delicate balance between a rigorous approach to progression in science and providing meaningful, engaging contexts for learning.

Analysis of early observations and transcripts showed few episodes of SSD and confirmed concerns in research literature on classroom interactions that many teachers dominate the talk of the classroom and use of limited three part ‘initiation, response, evaluation’ triads were the most common structure, validating this as a focus for development. Samples of teacher talk with children at the start of the project showed very few instances of dialogic talk, suggesting there is no simple relationship between practicing dialogic talk and a commitment to a ‘creative curriculum’. Teachers reflecting on transcripts of their talk led to some changes in practice as they have realised there is a difference between their espoused values and their practice.

The four cases in two schools presented here have been selected to show different ways in which the analytic framework was applied to develop practice depending on the analysis of teachers existing practice, illustrating the more typical and unusual. In the transcripts T: indicates the teacher is speaking and C1, C2 etc. indicate different children speaking.

Sam – more sustained

The first case represents features common to the majority of project schools as teachers strove to realise their espoused views on a creative curriculum by shifting classroom dialogues from
more authoritative to dialogic talk. This school described their curriculum as ‘creative’; science was embedded within thematic curriculum planning under the title ‘Exploring’ which encompassed a broader range of activities. In practice, science was clearly visible as a distinct lessons linked to the overall theme.

Sam, a newly qualified teacher of six to seven year olds reflected on the following episode:

T: Right. So we're going to have a race. H said we've got a start line, a finish line and a race. Now, we're going to have to get our boats from the start line to the finish line. Can you move right back behind the line please.

C1: Yes.

T: Now how do you think we could move these boats across from the start line to the finish line? H?

C2: We could umm blow them.

T: Okay. Okay. So you're waving your hands, but you're also saying we could blow on them, so to move some air were you thinking?

C2: Yes.

T: Now if we were … if we were either creating air from blowing or moving some air, what forces would we be using to get these boats to the finish line through air?

C3: Air.

T: Oh good. So we could use the air to push the boats across couldn't we?

The content here was scientific, but limited to labelling a force as a push, and characterised by IRE triads it was neither sustained nor dialogic. Sam commented that: ‘It was a real eye opener looking at those transcripts. I hadn't realised how much I was talking and how I was leading what they were saying.’ In discussion with the tutor/researcher Sam focussed on planning classroom organization so that he could be with a small group at a time and work extending and using children’s contributions in what he termed ‘learning discussion’ time.

The episode below shows children’s utterances became longer and more detailed and Sam sustained exchanges with one child over several turns.

T: Okay, that's fine. Right, so C1, let’s have a look shall we.

C1: He still looks like any new toy. I can see the material. It's kind of stretched. Mr Z?

T: Yes. (pause) Why do you think the material look stretched then?

C1: It's because umm I know umm … I saw it (inaudible ) it's kind of stretchy.

T: Oh wow. What great links you are making, just like the spider in our (inaudible). So how do you think the material being stretchy will help you to use it?

C1: Umm it will be useful for making clothes.

T: Yes, why is that?

C2: It's because clothes if made of material.

T: Yes.

C2: (inaudible )

T: Okay, C2, make sure you share please. Why is it important that clothes are made of material?
C2: It's because if you don't make any kind of clothes in material, you can't even make a coat anyway.

T: Yes, because we couldn't … if we made … if we made clothes out of metal, that would be quite difficult wouldn't it?

C2: Yes.

T: So why do you think it's important that clothes are made of soft material?

C1: Umm … so that it won't be so kind of hard and kind of cosy.

Although the original purpose of the activity was to invite children to consider how the materials of the toys may have aged, Sam saw and took the opportunity afforded by Child 1’s observation that the fabric looked stretched to encourage the children to think and express their ideas about how the properties of a material, a fabric, relates to its uses, going beyond simple recall.

Judith – more dialogic

Working in the same school, but in contrast to Sam, Judith was the most experienced teacher in the project. She described the curriculum as ‘completely creative’. Also teaching six to seven year olds she aimed to explore: ‘how children really respond to my questioning and at their interactions with myself and others, developing my own questioning confidence and extending science opportunities within a creative curriculum to have a greater understanding of how to extend children's science thinking.’

On analysis of her transcript (below) Judith found that although she was often phrasing questions as open ended and inviting a range of different children to participate, the children were responding with brief answers. Her feedback extended the scientific ideas available to the children, but there was limited opportunity for the children to be the ones explaining ideas.

T: Who can think of anything they know that starts off as a liquid, but can also change into a solid? Anything else that might change in the same way? C1.

C1: (inaudible)

T: Water. What does water do?

T: Right, A says that water can start off as a liquid and then it can turn solid. How does it turn solid then? Do you mind if we ask somebody else just for a minute, C2?

C2: Umm … you put it into the fridge and it turns solid.

T: Even colder than a fridge? What's even colder than a fridge? Freezer, that's right. It has to be turned somewhere … well it has to go somewhere very cold for it to turn into what?

C3: Into a solid.

T: What is the solid called, C4? What's the solid of water called?

C4: Ice (? inaudible)

T: Ice. Well done. E, could you sit down please. Anything else that can start off as a liquid and turn into a solid? What do you think then C5?

C5: soap

T: Okay soap. Ahh let me think … do you know, soap, could well have started off as a liquid, and then are you thinking of the hard soap? I think there must be chemicals
that when they're mixed together, like this, make the particles stick to turn that into something solid, well done. Does anyone on this table have an idea? C6?

C6: Cake.

Judith focused on extending her range of responses to children to encourage them to expand on their ideas and develop them. Recognising from other transcripts that she did this more readily in small group contexts she sought to bring more of this form of discourse to the high status whole class discussions to show she valued the children’s insights (McMahon 2012). In the following episode she works on extending discussion of the children’s observations of some old and decaying objects.

C1: Umm I … (inaudible) and it was really disgusting.
T: Something disgusting? What was disgusting about it?
C1: Well … this is … (inaudible) disgusting.
T: It just made you think of the word disgusting did it? Somebody else, B?
C2: Umm … I saw like the sewing bits that was like the umm … M's (inaudible) saw like the sewing bits.
T: You could actually see the thread could you?
C2: Yes.
T: What did it look like when you look at this? C2:
It was like cross, cross and then it went like …
T: Like that?
C2: Yes.
T: Wow. So you saw the detail of things. That's why someone like a history detective or an archaeologist or a scientist would use magnifiers because they see really closely the little detail that you can't see with your ordinary eye. Did anyone else see something that made them go, oh, I hadn't noticed that before? C?

In this episode, Judith’s acceptance, expressed by repeating back or rephrasing children’s ideas, and her interest, expressed by asking questions that stayed with the child’s idea, and invited more contributions on the same topic, maintaining a sustained focus. Overall, the balance of talk was shifted so that the children had a greater share and the episode was more reciprocal, more dialogic. Judith maintained the scientific content by explaining how close observations relate to the work of scientists, but in this episode chose not to develop specific content on properties of materials.

In these two classrooms, having a ‘creative’, thematic curriculum did not of itself lead to sustained scientific dialogues, but reflection on features of talk in the transcripts supported the development of a repertoire that included more sustained scientific dialogues for both a new and experienced teacher. This striving to move from more authoritative to more dialogic talk was a feature of 9 of the 12 cases.

Julia – more dialogic and still scientific

Julia and Jae, whose work will be considered in the next section, both taught at a school which made a distinction between the curriculum planning for the youngest children (4-5) which was entirely thematic and flexible to respond to children’s interests and that for the older children (6-11 years) which was in transition from being generic ‘skills-led’ to adopting an externally planned scheme in which science lessons were linked with a theme or topic but were clearly defined lessons.
Julia had previously taught 8-11 year olds and wanted to develop what she saw as features of good early years pedagogy in her work with 6-7 year olds: “I wanted to build on children’s responses, …but I was driven by the content or plan of the lesson. [I want] to take risks [and] to think about making the science curriculum more child-led… building on from their interests and questions/thoughts.”.

Analysis of this episode in which the children sorted pictures into living and non-living reassured Julia that her following children’s lines of thought did not have to weaken the scientific content. In fact the children’s contributions extended the science as Julia recognised that these young children were more knowledgeable than she had supposed.

C1: I know how the trees, how umm plants help us to …
T: How do they help us?
C1: They produce oxygen.
T: They do, you're quite right. Well done, they do help us; they do help produce oxygen which we breathe, well done. What's oxygen?
C1: It's what … it's the air that we breathe in.
T: That's quite right, well done.
C2: We breathe umm … trees breathe … umm … us and trees are the opposite.
T: How are we the opposite?
C2: I can't remember the other one, umm, oxygen.
T: Are you thinking about another gas called carbon dioxide, is it carbon dioxide are you thinking about?
C2: Because we breathe out carbon dioxide and breathe in oxygen and that … and trees breathe out oxygen and breathe in …
T: Carbon dioxide. Do you know what they do with the carbon dioxide, with that special gas, do you know what they do?
C2: Does the oxygen come from the trees and the plants or does it just come … does it just come? Was it made or does it just come from the plants?
T: That's a good question isn't it?

This was not an isolated episode, other scientific topics of talk included the human rib cage and snail trails. This case illuminated the importance of establishing that dialogic talk can be scientific talk and not to see ‘child centred’ learning as being in opposition to scientific discourse.

Julia’s questions were understood as genuine questions explore the children’s their ideas not as questions to test them. She also gave feedback that told the children when an idea was right and in this context this affirmation did not close down the child’s talk but validated it. Rather than setting up a pattern of IRE triads led by the teacher, the child was the one initiating the new turns of the conversation. It is also notable that the focus of discussion was sustained over a large number of turns and it was cumulative in that each utterance built on the one before.

‘...I realised I needed to make the science curriculum more child-led, to allow children to explore and to encourage dialogue and discussion. Through doing this, the children were heavily involved, engaged and they felt at ease to impart their knowledge or to ask questions. This classroom talk stimulated and extended their thinking and allowed for a wide range of
scientific discussion. ‘I feel I have discovered how classroom talk can lead to a greater level
of engagement and how it can extend learning and depth of understanding.’

As Wegerif (2014) argues, if our aim is for children to engage with and take part in the
discourse of science, some scaffolding may be required, in this case this was provided by the
problem posed by Julia about classifying things as living or non-living and her questioning,
but the overall dialogic purpose of the episode was maintained.

**Jae – more scientific and still dialogic**

An expert early years practitioner, Jae was led by children’s ideas and interests during
‘science rich’ activities, even if that took them in an unintended and sometimes non-scientific
direction. He aimed to: ‘extend my repertoire of classroom talk strategies; to explore science
concepts, generate new meanings, and pose genuine questions (Mortimer and Scott, 2003).’.

In the episode below in which the children were exploring plant life in the school playground,
Jae made a deliberate shift to focus attention on the scientific features of plants, in this
episode, the roots.

T: Shall we pull the flower up and see the roots? Ready. Oh it's a bit messy. Can you
see them? Have a look … careful look at those roots, what can you see when you look
at those roots?
C1: They're brownish.
T: It is quite brownish isn't it. What else can you see?
C1: Mud.
T: Lots of mud, that's the soil.
C1: And lots of kind of strings.
T: Strings, that is the root, yes, you're right. Can you see … yes, they look a bit like
straw, C2, you're right, can you see them? Yes. What else can you tell me about the
roots that you can see?
C2: Umm … they're going round and round and in and out.
T: They are, round and round and in and out aren't they. Can you see, they're really
long as well, look at this one here, look at this one. What can you tell me about this
one?
C2: It's all stringy.
T: It's all stringy, yes, you're right, it is isn't it. Wow. It's going down quite far isn't it.
So what other parts of the plant can you see, apart from the roots, now?

Jae introduced and reiterated the word ‘roots’ while drawing children’s attention to the salient
features of the roots. Reflection on this change from his practice Jae argued that:

‘[practitioners must]…be ready to challenge children in their thinking. This is most effective
in an interactive-dialogic approach which gives the children and the practitioner equal
weighting in the discussion…however, [they]must always be ready to interject the correct
vocabulary and scientific concepts when they arise, thus tilting the conversation towards a
more interactive-authoritative slant as the children begin to gain a more scientific mind-set’.

Over the course of the project Jae concluded that his repertoire of talk to support learning
should include more scientific talk; ‘I have really begun to tailor my repertoire towards the
objectives I want the children to achieve’. The tension inherent in Jae’s thinking, and likely
that of other early years science educators concerned with maintaining children’s own lines of
enquiry while also valuing the scientific discourse, is mirrored in the conversation between
Wegerif and Matusov (2014) about the ends and means of a dialogic education. Matusov argues that

‘…dialogic education has to be a genuine dialogue and this means that a curriculum goal cannot be specified in advance because learning in a dialogue is always emergent and unpredictable.’ (Matusov)

Whereas Wegerif counters that:

‘…dialogic education can include ‘scaffolding’ for full participation in dialogue as long as dialogue is the aim.’ (Wegerif).

**DISCUSSION AND CONCLUSIONS**

The *See the Science* project can be considered in terms of the finding of Stylianidou et al (2014) in nine European countries that teachers of young children failed to see the potential of dialogue in relation to creativity and underemphasised the knowledge and understanding present in policy documents. *Sustained scientific dialogues* proved to be a useful framework for conceptualising analysing and developing dialogues to support creativity and valuing scientific knowledge and understanding in a range of school curriculum contexts.

Although the place(s) of science in a thematic/creative curriculum are not clearly defined, teachers can work with this professional uncertainty and take advantage of the permission it implies to develop a pedagogy that enables meaningful and scientific learning to take place. Teachers’ skills in choosing the right words and questions (or silence) at the right moment in order to establish a *sustained scientific dialogue* are key to a dialogic and creative pedagogy within a thematic/creative curriculum, i.e. where teachers enable learners to take ownership of their learning, take risks, make new connections and make new meaning.

Analysis of the English Primary science curriculum (Department for Education, 2013) reveals an emphasis on conceptual knowledge presented as facts and on limited procedural knowledge associated with methods for testing and verification, not open exploration. The importance of discussion with children to support their learning has been recognised and this presents useful justification when working with teachers, but does emphasise children ‘developing their scientific vocabulary and articulating scientific concepts clearly and precisely’ (ibid p4). This could exacerbate the existing challenge for teachers of engaging with children’s ideas through discussion to support their learning and instead move teaching in the direction of a model based on the transmission of ‘facts’. We believe learning is motivated by dissatisfaction with extant explanations and facilitated by opportunities to consider alternatives - neither process is supported explicitly by the proposals. However, there are possibilities to interpret the curriculum in ways that will build children’s capacity to engage in meaningful scientific learning.

**REFERENCES**


