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What's in a question..? Good question!

Strapline: Jude Penny and Colin Forster explore what makes a good question and how this links with developing science capital

Key words: Questioning

"What's in a question, you ask?" said John Dewey. "Everything. It is evoking stimulating response or stultifying inquiry. It is, in essence, the very core of teaching".

This article outlines research that was undertaken with primary student teachers at the University of Gloucestershire, focusing on the development of their ability to deploy an appropriate number of carefully chosen questions in the teaching of primary science, adopting elements of an action research methodology to enable engagement with evidence-based evaluation of practice.

How do teachers learn to ask good questions in science?

Science capital can be thought of as a teaching 'mind-set', linking to learners' interests, aspirations and daily lives, 'reaching out beyond the high flyers' to help more students to express themselves (Godec et al, 2017, p.19). The science capital approach builds on a social constructivist pedagogy, which emphasises the importance for teachers to explicitly recognise and understand the backgrounds, experiences and pre-existing ideas that pupils bring into classrooms in order to teach most effectively.

Godec et al (2017) discuss the 'three pillars' of the science capital approach, the first being (**personalising and localising** science learning, **using questions to elicit pupils' knowledge** that draw on personal, family and/or cultural experiences and, importantly, this knowledge is explicitly valued and relevant and linked to the science curriculum and building the **science capital dimensions**, which include scientific literacy, science related attitudes and values and dispositions,(see Godec et al, 2017 for the eight dimensions)

However, this approach contrasts with the findings of Ofsted's 2013 *Maintaining Curiosity* report, which found that, in many science lessons:

- **there was too much teacher talk**
- **there were limited opportunities for children to raise their own questions the best teaching maintained pupils' natural curiosity**

Within the context of teaching and learning, good questions can stimulate good thinking; however, further published research shows that teachers have a tendency to:

- **ask *too many* questions** (Grigg, 2010)
- **ask too many *closed* questions that promote little intelligent response** (Smith and Hackling, 2016)
- **give limited time for children to think about their answers** (Wragg and Brown, 2001)

- **dominate the intellectual exchanges within classrooms** (Ofsted, 2013).

When researching types of talk within British classrooms, Alexander (2006) reported a scarcity of interaction that challenged students to think for themselves. He also observed that the majority of teacher questions were closed and that Sinclair and Coulthard's (1975) 'Initiation, Response, Feedback' (IRF) model was dominant: teacher asks, pupil responds, teacher evaluates the response before moving on. When teachers' questioning is characterised by closed questions, low levels of cognitive challenge are presented (Smith and Hackling, 2016).

With this in mind, we aimed to engage a group of final year, undergraduate student teachers in some deep self-reflection in order to help them to hand over the majority of the intellectual activity to the children in science.

The aims of our study

- To extend student teachers' understanding of quality questioning in primary science
- To challenge student teachers to examine the detail of their practice of questioning through a supported action research process
- To develop student teachers' understanding of data analysis for improving practice.

The challenge

The student teachers were provided with a resource of broad beans at different stages of germination.

Figure 1 A lesson focused on teaching germination.

They were then asked to:

- Devise a 30 minute lesson related to germination and teach to a group of Year 2 children
- Encourage children's talk and questions through regulating their own talk and questions. To support this, possible approaches to refine teacher input were discussed, such as:

    a) Asking open questions
    b) Using statements and 'think alouds'
    c) Pausing and giving opportunities for discussion

The lessons were audio-recorded and transcripts were made to facilitate analysis by the student teachers.

How did it go?

<u>Transcript 1: 'Filling the void'</u>

(start text box)

Student Teacher: What if we compared it to this one here?

Child: That will come off.

Student Teacher: How long do you think that has been growing?

Child: That one is smaller than that one.

Student Teacher: So do you think it just gets bigger?

Child: And there will be more roots growing.

Student Teacher: Is it inside of it?

(end text box)

During this interaction, the child is given no (or limited) opportunities to:

- Do some thinking/wondering about the resource
- Raise questions about the resource
- Have their responses explored/extended.

The student teacher is in full blown teacher questioning flow! We refer to this example as 'filling the void' because, when student teachers are not sure what to say, they tend to bombard children with questions because they perceive this to be the primary role of the teacher or, perhaps, they feel that there is 'nothing going on' or 'dead space' if the children are not speaking.

Transcript 2: Rephrasing and modelling

(start text box)

Child: Why is it … (unclear)

Student 2: That's a fantastic question and you start with a 'why' which I really like. If you put a 'why' at the beginning, that makes a really good question

Child: The leaf is green

Student 2: So why is the leaf green ? Is that your question? So why…is .. the.. leaf.. green… good question

Child: I've got a question

Student 2: Go on then

Child: Some of the root is brown

Student 1:You could use L's word couldn't you? What did L start her question with?

Student 2: Some of it, so shall we say why…why is the root brown?

Child: You've got more dots on it's….

Student 2: Oh , what? You've noticed that it's got dots?

Student 1: Brilliant question. That's exactly it C, you're getting the hang of it

Student 2: Yes. So, that could be another question. So why is the root brown

Student 1: why is the root …inside of the yellow thing

Child: why has it got black dots ?

(end text box)

In this example, the student teachers are seeking to provide explicit opportunities for children to raise questions. However, on close reading, it appears that the student teachers are doing the majority of the intellectual work. The children's natural curiosity leads to observations and the student teachers are working hard by rephrasing these observations and modelling 'why' as a sentence starter. This is positive because they are helping the children to raise questions, but this may have an impact on the authenticity and flow of the children's questions. Focusing on the wording of a question and projecting this as the most important aspect may affect the children's natural curiosity. A child does raise a 'why' question eventually, but the student teachers dominate the 'air time'.

The student teachers' evaluations of this experience

After the teaching session, the student teachers completed an initial evaluation and noted key points for consideration.

- *It seemed that the children became quite reliant on our questioning.*
- *Overall, minimising the amount of questions used was proven to be difficult and we asked more questions than planned*

- *We asked some POINTLESS QUESTIONS*
- *We predict that we asked <u>80-100 questions</u> between 3 student teachers during the 30 minutes of teaching!*

Focused analysis of transcripts

The student teachers then had the opportunity to read through the transcripts and *analyse* the speech in terms of:

- The balance of teacher/pupil talk
- The number of questions they asked
- The types and range of questions they used
- Their ‘best’ questions
- The children’s ‘best’ responses/comments
- The children’s most limited responses

..and then *evaluate* their practice in terms of:

- Their most ‘cringe-worthy’ moments
- Suggestions for specific rephrasing of their questions or statements
- Missed opportunities to develop the children’s thinking
- Improvements they might have made.

They were encouraged to use literature to support their evaluation and devise specific action points for next steps based explicitly on their analysis.

Next steps: developing practice

Figure 2 Using microscope images to generate pupils' questions.

Children's questions

The student teachers worked with the children once again. This time, they supported the children in observing some leaves under a microscope. Building on their previous experience, which highlighted their overuse of questions, they consciously aimed to say less and facilitate children's scientific discussion. The children raised questions that were rich and authentic and excellent starting points for scientific enquiry.

(start text box)

- Why are there a lot of lines on the leaf?
- Why do plants grow so slowly?
- Why did it look like a road map (leaf)?
- How do plants move?
- How do plants drink?
- The cress roots could be weaker than the bean roots
- Will the size of the root make it stronger?
- Why are plants green?
- Why do plants need leaves?
- How do plants get their colour?
- Why do plants close up sometimes?
- Why do plants have so many roots?
- How long does it take a plant to grow?
- How does the seed get its food and drink?
- Where do seeds come from?
- What are the hairs on the leaves for?
- Why do leaves have veins?

(end text box)

The student teachers had the opportunity to reflect on this experience and its impact on their learning. They drew some formative conclusions or 'top tips' for the facilitation of primary science activities that may encourage increased intellectual activity on the part of children.

Student teachers' top tips for quality interactions

- Don't fill every silence with a question: enjoy silences
- Don't dominate the children's thoughts
- Allow children time to respond
- *Listen* to children's responses
- Use statements instead of questions: good statements can be just as good to promote thinking
- Plan your questions beforehand
- Ask the children if they have any questions: sit back and *listen*
- Think before you ask!

Conclusion

Our student teachers discovered that adopting an evidence-based approach to evaluating their practice forced them to confront engrained approaches to teaching and learning. Using an action research methodology (Forster and Eperjesi, 2017) had a transformative impact, as they examined their own assumptions and approaches to questioning, and identified specific points for action to increase their impact on children's learning. They discovered that, to have more impact, they did not need to work so hard: to give children more intellectual air time, they needed to reduce the number of questions they asked and listen more to children's observations and authentic responses. Children come to science with a wealth of scientific knowledge and experience and a deep appreciation of the world around them: science enables teachers to promote children's intellectual development if we offer them a central role in the process.

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