Does children's science capital affect the types of questions they ask?

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Abstract

According to the National Curriculum - children should develop a sense of excitement and curiosity about natural phenomena- but are they?

Questioning is high on our agenda. I am conducting this research because we are an accredited communication friendly school (ELKLAN) so we have already undertaken professional development on higher order questioning. In other subjects, children were being challenged to ask questions and lead their own enquiry but science investigations were prescriptive.

This research has given me the scope to explore children's questions. I wanted to find out if children's curiosity was being hindered by teacher's reluctance to facilitate child led learning in science. I also questioned whether the children were able to lead their own scientific enquiry.

Background of the School

A Church of England Voluntary Aided primary school with distinctive Christian values. A high proportion of pupils live in wards which are in the 80thper-centile of deprivation on raise on line. The school is serving pupils from a disadvantaged socio -economic area with an ever changing ethnic and social mix.
* There are 29% of pupils in receipt of pupil premium

* EAL – 25% and steadily increasing

* SEND 13.0% - 1 with an EHC plan.

Methodological approach

Firstly I decided I needed to make a judgement of each child's science capital: an individual's level of exposure and knowledge of science
I used a sample of ten Year 3 children which consisted of 7 girls and 3 boys. 8 of these children are working at the required standard in science and 2 children are working towards. Two children are recognised as working at greater depth within science. Two children are pupil premium and two children are EAL.
I completed 1:1 interviews with these children to find out about their exposure to science at school and at home. I asked the children to select green, amber or red according to how much experience or understanding they had of each question (Red= no experience, amber = some experience, green= lots of experience) The traffic light system worked well as the children had time to collect their thoughts and they naturally explained their decisions. I then scored each child according to the colour choices and this provided me with a score out of 27.
After completing the questions, I did an observation of the children preparing questions. I provided the children with a set of different plants ranging from bedding plants, a cactus, a flower, vegetables, a carnation stem and some grass. I wanted to provide the children with an interesting stimulus to create awe and wonder. I started by asking the children to name the plants and asked where would they be found. (putting the learning into real life context) I then moved on to asking why plants are important in the world and why a scientist may be interested in them. I asked the children what does a plant need to grow to remind them of prior learning from KS1.
After the initial planned questions from me I asked the children to write questions on post it notes to find out what plants need to grow. I asked them to think like a scientist and generate questions (lines of enquiry) that would help them to find out what a plants needs to grow well. I recorded this observation and analysed the children's responses and the questions that they wrote on the post it notes.

Background reading

Ely & Cooper (2018) suggest the following frameworks for starting children off with their own enquiry.

- Provide a challenge or open ended problem to solve.
- Take children on observation walks, get outdoors.
- Ask the question "I wonder why?"
- Make links to other areas of the curriculum.
- Present them with a conflict (prove it questions)
- Use teachers demos or illustrations to show something unexpected.
- Create awe and wonder moments

They found that questions give insight into the world of children. To foster question asking teachers need to provide suitable stimuli, model question asking, develop a receptive classroom and include question asking in evaluation. (Fred Biddulph and David Symington and Roger Osbourne (1986)
As teachers, we get clues into science content when we listen intently to children's questions. (N.S.S.E 1975)
White (1977) queries that the development of the ability to ask questions is an important but overlooked objective in science education.
"The person who really needs to know something, does not need to be told many times, drilled or tested. Once is enough. The new knowledge fits into the gap ready for it, like a missing piece in a jigsaw puzzle. (Holt 1971)

Myers, McGrory & Westgate (2016) say that children need to work more authentically as scientists. Teachers need to provide interesting stimuli from real world contexts. Their research encouraged a school to support children's independent enquiry skills and they found the most effective approach to working scientifically was to raise questions, investigate and discover answers. They explained that children act as though they are "world blind" and scientific phenomena is very mysterious to them. The answers to questions are not known so the excitement they experience at being able to investigate their own questions is priceless. Their findings lead to them concluding that children need to be provided with topic themed contexts to capture children's prior knowledge and to stimulate curiosity such as stories, visits, observational walks, discovery bags, mystery boxes, use puppets/characters with problem to prompt questions. One major influence that teachers need to be secure with is that lines of enquiry need to reference national curriculum, EYFS requirements.

Ofsted (2013, maintaining curiosity report) state that best science teaching sets out to sustain pupils' natural curiosity by equipping children with the investigative skills required to make sense of the world around them. Therefore teachers need to change in the way they think and such whole scale change requires visionary leadership, reflection and enactment by participating teachers (Clark and Hollingworth 2002)

Enquiry skills are the act of collecting evidence to inform decision making. But what skills would an observing teacher see when children are working scientifically.

Miller (1994) found there were 3 types of knowledge as essential in enabling individuals to construct scientific understanding; conceptual, procedural and epistemic (evaluating evidence). "Consensus placements", a Kagan strategy has been highlighted as a good technique for encouraging lines of enquiry. It states that if one idea doesn't work – go back to the drawing board.

Findings

Science capital questionnaire
From the questionnaire I found that most of our children had low science capital. All children were very enthusiastic to tell me that they enjoyed science lessons. (all selecting green). Question 5 and 6 generated the most reds. This suggests that children are not being exposed to science books and videos which could be having an impact on the children's subject knowledge.
The two children who are greater depth scored 17 and 19 out of 27 for their science capital score. The two children who are pupil premium scored 17 and 15. The two EAL children scored 17 and 18. This suggests that one of the children who is greater depth has a low science capital score. The two pupil premium children scored low so we could question does their lack of exposure to science link to limited opportunity to experience science at home. The two children who are EAL scored low to medium scores for their science capital which suggests to me that their EAL is not really having much influence on their science capital as they scored similar to the children who are working at greater depth. These scores have made me really think about how we are challenging children who are greater depth and really emphasising that greater depth links to the children's abilities to reason, problem solve and analyse science rather than just their knowledge acquisition.

Observation
From the observation, I found that the children were more engaged when presented with an interesting stimulus. (The large range of plants). The children enjoyed handling the plants however their responses were really interesting as some children acted like they were "world blind" at first. Their prior knowledge started to resurface as they became more familiar with the plants. I felt that they children were seeking clarification from me (which I was intentionally not giving) and this sometimes hindered their ability to generate their own lines of enquiry.
The children found it extremely difficult to find similarities between the plants (Classifying and identifying).
The children were able to tell me the basic things that plants need to grow (water, sunlight) but their prior experience of understand that there are many different types of plants was limited. I feel this matches the science capital questionnaires as children were very limited in suggesting where they would use science in their daily lives and many stated that they do not talk about science with their families at home.
I have organised the questions under the five characteristics of working scientifically. Most of the questions asked by the children slotted in to the category of research. This suggests that our children are not using the enquiry approach yet as their questions focus on the acquisition of subject knowledge rather than comparative testing.
Some children did ask questions that would make fantastic lines of enquiry such as:
Do plants need water, sun and soil?
Do plants need a particular type of soil to grow?
Are plants affected if you give them too much water?
How much light does a plant need to grow?
These questions did come from the children with the higher science capital scores.

Reflections

The research has given me clear direction of what I want science to look like in my school. I want to ensure that our children have good enquiry skills in science .To achieve this:

We need to teach the children about what a scientist is and promote a curriculum where children believe that they are scientists in their own right.

-Teachers need further CPD on how to facilitate Child led enquiry and there needs to be clear distinction between child led learning. (We do not want children to lead the learning, we want them to ask questions that enable them to further their understanding through working scientifically).
-Teachers need secure subject knowledge including a good understanding of what children have learnt in previous years.
-The children need to have curiosity in science lessons and teachers can create this by using interesting stimulus, outdoor learning for science, problem solving/reasoning opportunities.

Children need to learn how to ask a question that will help them to work on comparative testing. (If I change… , how will this affect ….)

-We need parents to support us to increase our children's science capital. This can be achieved by inviting stem ambassadors into school, making more links with parents in science (eg, family science events), encourage parents to engage in science events in the local area, science club targeted at pupil premium children, ensure class libraries