Helping Children Engage with Science

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Science gives us a way of observing, wondering about and understanding natural and physical phenomena. Science is an important achievement of human civilisation that needs to be shared with the future generations. Most of us who have worked with children have witnessed their capacity for keen observations and insightful questions about the world around them. Such qualities are crucial for engaging in processes of science. Given this, how can we introduce ideas from science to children while also drawing on these innate abilities that they possess? Here I wish to share a framework suggested by the educationist Eleanor Duckworth (Duckworth 2006) that can be useful and can help us reinforce children's learning in science as well as support the pedagogical practice of teachers and educators.

Direct contact with subject matter and sense-making

First, we aim to put the learners in direct contact with the subject matter – earthworms, pendulums, ice cubes, balance beams, and seeds, etc. This brings the teaching and learning to life and catches the interest and imagination of the children.

The second aspect of our approach '...as teachers in classrooms, we find again that when we are interested in the learners' thoughts, the learners take a deepening interest in their own thoughts, too. We find that we focus on the learners' thoughts rather than on our own, as the engine for what generates the intellectual life of the classroom.' (Duckworth, 2009)

Duckworth has described her approach of engaging students in subject matter through 'critical exploration in the classroom'.[i] After identifying an appropriate concrete phenomenon or context to experience it, progressively get involved in it, think and wonder about it and express what they notice and think about the same. The emphasis is on listening to children's ideas about physical and natural phenomena (which they experience directly) in a dignified manner. Care is taken to avoid overwhelming them with big words or scientific jargon. This is a key aspect of Duckworth's approach and interestingly, it resonates with Richard Feynman's famous words asking us to realise 'the difference between knowing the name of something and knowing something'.[ii]

Example: Exploration of leaves

To think about pedagogies that might suggest ways of reinforcing children's learning and supporting their sense-making, let us look at an example of engaging children in a sequence of explorations with leaves of trees and plants. These instructions are only indicative and should be given one after the other, as and when the children complete the previous task. It is good to have more than one facilitator as one needs to make sure that children understand the instructions and also keep track of and make a note of the work done in different groups. It would also be useful to do this over a block class and across multiple sessions.

The activity

Each group of four to five children goes around the neighbourhood and collects twenty fresh leaves from various plants and trees. They are instructed to carefully pluck only one leaf from each plant and after coming back, keep the leaves together. Every child gets a blank A4 sheet and a pencil.

Facilitator's instructions:

1. Now each of you should select one leaf. Sit separately from your group. Place your leaf on the paper. Make a sketch of the leaf while looking at it carefully. Draw slowly and try to notice as many things as you can.
2. Now hold the leaf, look at it from different angles, touch it, feel its texture, scratch it, crush a small part of the leaf, smell it, nibble at it to taste a small bit, make a smudge on the paper with it and explore various aspects of the leaf (without destroying it).
3. What are the thoughts, ideas, observations or questions that came to your mind while observing and sketching the leaf? Write down

three of these just the way they came to you. These points could start with 'I wonder why/ how/what etc. (The facilitators must go around and could take a photo of each student's sketch, questions and their leaf.)

4. Read all the points that you have noted down and select the one which you find most interesting.
5. Now return to your group and sit down together. While showing your leaf and sketch to your group, share your most interesting idea/ observation/question. Make sure each person in your group gets to share their work. Others can ask questions if they do not understand something or want to add something.
6. Now take all 20 leaves that you have collected earlier. Keep them in front of you and arrange them according to their size - from the smallest to the largest leaf. (The facilitators can note down or take photos of each group's arrangement.)
7. Now arrange or group the leaves according to something else that you have noticed, for example, the texture of the leaf, the edges, veins, smell, or the shades of green, etc. (The facilitators can note down or take photos of each group's arrangement.)

In the next class, the work of individual students and the groups can be shared with the entire class. Before that, teachers/facilitators need to carefully go through all the children's sketches, the points that they have written down individually and those that they noted after sharing within the groups and the ways in which they arranged or classified the leaves. This process will help us to identify their thought patterns and observations of different aspects of leaves. We could then take printouts for an exhibition or create a slideshow to help the children learn about each other's work.

> According to the scientist Niels Bohr, 'The task of science is both to extend our experience and reduce it to order.' In the context of this exploration with leaves, we need to make conscious efforts to connect these new experiences that children had with helping them start seeing the patterns or the ways of ordering the same.

We could follow this up further with other interesting ways of engaging students in thinking about leaves (and other aspects of plants) as suggested in books, such as *Small Science* (HBCSE),[iii] *Joy of Learning* (CEE),[iv] Environmental Studies textbooks by NCERT and other state boards, such as SCERT Sikkim which is a wonderful example of the contextualised approach.

Role of mixed media documentation

Such a process that blends the experience of 'direct contact with subject matter' and scaffolding sense-making can be woven into broader themes and topics through further sequences. In the preschools of Reggio Emilia in Italy, a multimodal documentation of children's work and ideas emerging through such processes is used for the continuous professional development of teachers, collective reflection on pedagogy and for building a community of teachers at school (Edwards 2012). They also exhibit children's work to 'make learning visible'[v] for initiating and sustaining a dialogue among children, teachers and parents (the community) that is anchored in the work of children and the sense that children make of their work. For example, the visual documentation of sketches, questions, arrangements of leaves and observations made by teachers on children's work and sense-making could all be material to be put up as exhibits.

Reinforcement in science

In higher classes, students and teachers have to grapple with nuances of the *nature* of science as well as challenges, such as the often counterintuitive nature of scientific ideas and developing a scientific temper. However, it is crucial for children in primary school to get opportunities to engage in the practice of observing scientific phenomena and articulating what they understand of these experiments. This familiarity with phenomena and expressing one's tentative ideas would also help students as a context to engage in abstract theory-building required later on. We can thus think of reinforcement in science as creating opportunities for students to 'map multiple paths into the subject matter'.

I find it apt to conclude with these words of the philosopher David Hawkins:[vi] '… a recognition that the subject matter of science is not, except in a derivative sense, to be found in books. The subject matter of "the liquid state of matter" is the liquid state of matter, and we had better sometimes have some of it in the classroom. Along with aprons and mops as needed!' (Hawkins, 1965)

Endnotes

i It is interesting here to consider the origins of this approach. Duckworth says that the first part of this approach comes from her experience of working with Elementary Science Study (ESS), a science education reform effort in the US from the 1960s. While the second part comes from her work with the psychologists, Jean Piaget and Bärbel Inhelder on interviewing children to understand their thoughts and ideas.

ii https://www.youtube.com/watch?v=px_4TxC2mXU

iii https://smallscience.hbcse.tifr.res.in/

iv https://scienceshop.vascsc.org/product/joy-of-learning-teachers-manual-1/

v https://pz.harvard.edu/projects/making-learning-visible

vi https://en.wikipedia.org/wiki/David_Hawkins_(philosopher)

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