left them behind in the public domain. These toys, made from 'throw away' stuff, are eco-friendly and the poorest children can enjoy them. In sculpting them, children learn to cut, trim, glue, fix, nail and assemble together a variety of materials. They also learn great science.

The crisis of science is that people still do not want to dirty their hands. Rote learning, the chalk-and-talk method still reigns supreme. Everyone is out to "cover" the course, forgetting that the whole task of education is to "uncover" things.

Ann Sayre Wiseman, creative director of the Children's Museum in Boston and the author of the landmark book, 'Making Things', summed up the essence of good science in these words:

It's OK to fail.

It's OK to make mistakes.
You will learn a lot from them.

It's OK to take risks.
It's OK to take your time.

It's OK to find your own pace.
It's OK to try it your own way.

It's Ok to fail.
You can always try again free of fear.

It's OK to look foolish.
It's OK to be different.

It's OK to wait until you are ready.
It's OK to experiment (in safety).

It's OK to question the "shoulds".
It's special to be you.

It is necessary to make a mess
Which you are willing to clean up.
(The act of creation is often messy)

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Listening to Children's Voices in the Science Classroom

Jyotsna Vijapurkar

A large body of research in science education has demonstrated that children have alternative concepts quite different from what is taught in the science class. Most often, the exercise of teaching changes children's ideas from one incorrect concept to a modified, but still incorrect one. The good news is that teaching does help bring about a concept change; the bad news is that often it is not quite what the teacher had in mind!

The very fact that researchers have uncovered so many alternative concepts that children hold, despite instruction, indicates that someone, somewhere was listening to what children had to say. Surely a clue of this kind would have had to be the starting point, the motivation, for further investigations.

Time and again, however, while working with teachers, it has emerged that a lot of children's ideas and theories come as a complete surprise to them. I have been struck by how large a number of teachers seem unaware of what is going on in the child's mind. Why is it that even after teaching for years, the realization that there is a disconnect between what is taught and what is learned continues to elude us?

The answer, I am convinced, lies in how our science classes are conducted.

In a typical classroom, when the teacher poses a question, one or two hands go up, one child gives the

expected answer, is acknowledged, and the class moves on. Often the question asked has a 'correct', or rather "the" correct answer from the textbook. In some rare instances, the answer may have to be original. Even here, children quickly figure out what the expected - the single 'correct' - answer is. They will please the teacher by giving this answer. Life in school has, for the child, always been about pleasing, or at least satisfying, the teacher. Kids are smart. Even if the questions are not leading, they can get their cues from the teacher's intonation, body language and expression in arriving at the expected answer.

Here is a snapshot of one classroom interaction that I recall from years ago while working with children of Class V. I asked if anyone had seen a sun bird.

“Yes,” said many, raising their hands.
“What colour is it?” I asked.

“Yellow.” (lucky guess!! “Sun” bird must be yellow).
“OK, how big is it?”

Several children started to show me with their hands, palms facing each other and separated, to indicate the size. As they closely scrutinized my facial expression for some cue, the palms went slowly closer, then slowly spread apart. I consciously maintained a poker face, so they had no idea where to stop! They got found out!

A common scene in such classes is that when children speak (generally just one or two - the class toppers), only the teacher listens; the other children probably pay no attention to the answer. If they do - and even if it conflicts with what they think - no one speaks up. This is the classroom culture that children have adapted to. All of us who have interacted with kids outside the classroom - our own children, or a neighbor's/friend's children - know how much they talk, and how they ask difficult and original questions. Parents will often proudly show this off. How unnatural it is, then, that they should suppress this natural curiosity in the science classroom!

Contrast this with a class where everyone listens to what is being said, and responds to it; a class where every child is not merely allowed, but actively encouraged to speak. This is particularly needed with the shy ones in the class. In a class full of children, some are bound to be shy, some disinterested, some aggressively seeking the teacher's attention.

It is up to the teachers to set this culture in the classroom. The techniques to do this, once laid out, seem easy, even trivial, and therein lies their strength.

Many who hesitate to speak in front of a large group in a formal setting may do so from fear of ridicule. A rule that no one laughs at anyone's answer or question has worked very well for us. Of course this is hard to enforce, given how spontaneous laughter is; but just saying something nice to the child for bringing that point up - common civilities we engage in among peers - quickly changes the situation.

The disinterested ones, having figured out that they will be heard, and seriously, do get interested. It is important also to make it clear from the outset that when the teacher or any student has something to say, the others will listen, and respond if they wish. Unless one strives to implement this, most children in our classes tend to ignore what other students say. The dialogue, if any, ends up usually as a teacher-student one; once this rule is implemented, student-student dialogue occurs freely, moderated by the teacher (to keep the focus on the topic at hand).

Once it is conveyed right at the start that the teacher expects every child to speak up, and fully intends to give every child a chance to do so, the aggressive attention seekers tone down. They are not to be discouraged to speak, but given the same chance as others.

Of course, it may not be possible to have every single child speak in every single class. Over a period of time, say several days, it has been our experience that children open up. Sometimes, when there are opposing viewpoints, I ask for a show of hands to indicate which one they agree with. And it is okay if some do not raise their hands at all - in our classes they have learned that it is okay to not be sure. Ask the natural next question - 'how can we find out?' - and we have a real science exercise in the classroom!

When there are no negative consequences for saying something, the real exploration of ideas begins. Sometimes, a really bright child gives a most wonderful answer, with all the 'ifs' and 'buts' covered. Tempting though it is, the teacher would do best to not acknowledge it as such right away - until the rest of the class is asked what they think. Otherwise no one is motivated to seek an answer of their own. And of course one should acknowledge the first answer after all have had their say.

In such a classroom environment, the teacher knows what children think. Why is it important for the teacher to know this? After all, curricula are designed, textbooks written and prescribed by someone else, often someone far removed from the actual teaching. But that is precisely why teachers, who are the last and most vital link in this long chain, should be aware of what worked and what failed. Who is better placed than a teacher to give feedback to the 'system'?

> *"Just because something doesn't do what you planned it to do doesn't mean its useless."*
>
> *- Thomas A. Edison*

This culture of the classroom reaps rewards far, far greater than just the discovery of what children's alternative ideas are. Children get truly actively engaged in the class. They know their ideas matter. They learn to resolve cognitive conflicts, to critically evaluate others' and their own answers.

And thus begins their journey towards the wonderful exploration of the world that is science.

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From the real to the abstract

G.S. Jayadeva

I do not actually hate mathematics, but for a long time I believed that I hated the subject because of various reasons. The strongest reason was the very process in which maths was taught. Especially, the tyrant teacher and his stick made maths the most formidable subject. In retrospect, nearly forty years later, I understand that I certainly was capable of learning mathematics quite well. It was my bad luck that every other incident during my school days made me believe that I could never learn maths, including the deep sympathy shown by all my well-wishers.

What went wrong? The answer to that is actually quite simple. The numbers never represented any tangible object of perception, but were mere signs that floated in a lifeless void like disentangled pieces of a complex puzzle. There was no reason why they had to be put together, and even if they were, were as lifeless as before.

Being an ardent student of science, I realized the importance of maths later in my college days, but it was too late. If this would have been taught to me as something related to my day-to-day life experience, I probably would have learnt it.

With this experience in my mind, we are now trying to make maths a true learning experience of immense joy and fun for children in Deenabandhu school, Chamarajanagara. Lessons of maths are given in a guise of biology that offers vivid experience.

Different types of dicot seeds are planted in a glass jar so that children can observe the growth of roots and shoots simultaneously. Seeds of beans, peas, green gram, etc. are planted. Every day, children measure