Teaching Teachers a New Way to Teach

Karen Haydock, published in Hindi in Sandarbh 41, pp. 11-16 (2002)
haydock@gmail.com

If you're not into science you may not have heard all the complaining about the state of science education in India. You may even be under the impression that we are doing an excellent job of teaching science - just look at all the first class NRI scientists!

But if you listen to one of these good NRI scientists, they will all lament the present state of science teaching in Indian schools. They are shocked to find that science is still being considered as just a bunch of facts to memorise. Students do not get any idea of what science really is. They don't realise that science actually is asking questions, guessing, figuring out ways to answer questions, making and recording observations, analysing results, forming conclusions, and reformulating questions. But students think science is all about **answering questions** (with the 'correct', 'factual' answers that are always given in their books), rather than **questioning answers**!

This is not just occurring in village schools, or government schools - it is a general phenomenon everywhere. Of course India isn't the only place where science education is in such a sorry state - schools in the west suffer from their own (somewhat different) problems.

So what happens when an attempt is made to introduce innovative, activity-based science teaching methods in a school? Here I'll describe an experience I had in introducing these types of science teaching methods in an elite English medium school in Chandigarh.

This is what happened one day in a Science Teaching Workshop for teachers. We were going through a lesson on Calendars, Weather, and Temperature. So that the teachers could see the new methods first hand, I was acting as the teacher and the teachers were the students. As part of the lesson, I had planned that the students could make a big calendar chart on which they would record daily measurements of the temperature.

At one point I asked each teacher to guess the present room temperature. Then I passed around a thermometer and asked each teacher to read it and record their measurement, without telling each other. When I asked them what they had measured, we found out that the measurements had varied from 24 to 24.5 and 25° C.

I asked the teachers what the reasons for these differences might be. They said it could have been due to (1) mistakes in reading the thermometer due to different viewing angles, or mistakes in counting the degrees; or (2) the temperature might actually have risen due to hands on the thermometer heating it up as it was passed along, or due to different temperatures in different parts of the room.

Then I asked them why they thought the temperature in different parts of the room might be different. Could it be the wind or the fan in one part of the room? The teachers were getting quite restless that I was going on and on about such unimportant details.

However, I decided to deviate from the lesson plan and take this opportunity to try to get the teachers to answer this question in a scientific way. I asked them to write the question in their notebooks, then guess the answer, and devise a method we would use to answer the question. I wrote the following on the board:

Question: Can a fan cause a change in air temperature?

Hypothesis: Some teachers thought a fan can change air temperature, and some thought it couldn't.Method: The teachers suggested holding the thermometer under the fan and away from the fan, and comparing the temperature. I held the thermometer under the fan for about 2 minutes and asked a teacher to read the temperature, and then take another measurement away from the fan.

Results: The temperature was 24.5° C under the fan, and only 23.8° away from the fan!

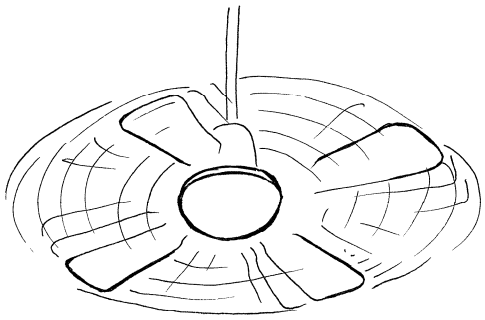
Conclusion: After some discussion, the teachers thought that the unexpected difference in temperature must have been due to an inadvertent difference in heights - the thermometer was held under the fan at a height of about 2 meters, whereas when it was away from the fan it was at a height of only 1 meter. So I suggested that we modify the method and try again.

By this time the teachers were very distraught that we were wasting so much time on such nonsense. Anyway, I persisted and we did a few more measurements.

In the end everyone could not agree on what the experiment showed - some thought it showed that the fan decreases the temperature, and some thought it showed that the fan had no effect. More experiments would have to be done to reach a conclusion.

The next day, we had a discussion about this lesson. The teachers were all feeling that it was not right to do the fan experiment as part of the lesson. They insisted that they could not and should not do this sort of thing in class. They said I should not have made the mistake of holding the thermometer at different heights. I should have thought it out better beforehand. One teacher said, 'I don't make

mistakes in class because it will confuse the students more - therefore I should not have anything wrong with the format.' Another teacher said, 'children cannot do research - they cannot make conclusions- it is of no use.' Others said, 'It is not learning,' 'What is important is core knowledge,' 'Knowing,' 'What you are doing is logical thinking, not science,' 'Children don't have faith in you if you make mistakes.'



I then asked the teachers what were the objectives of doing such an experiment in class. We came up with the following list:

(1) To see the effect a fan has on air temperature
(2) To find out that we can get unexpected results - to see that guesses are not always correct
(3) To put thought processes into motion.
(4) To find out that we can make mistakes
(5) To find out the importance of controlled variables
(6) To find out that there is variation in measurement
(7) To encourage scientific temper

Still, the teachers objected that, 'this is not in the syllabus', and 'We should do experiments only to clarify fundamental concepts'. One teacher vehemently objected that, 'In this entire lesson we have left out the most important thing - which is the reason for the little bulb at the bottom of the thermometer. We didn't say anything about the construction of the thermometer, the different scales on different types of thermometers, mercury and alcohol, thin glass tubes with constrictions, etc.'

I asked, at what level do they think students should use a thermometer. After some discussion they decided that Class IV students could use a thermometer, but they needn't learn about its structure until later - maybe Class VI.

Finally, the teachers decided that this calendar lesson is appropriate for Classes IV, V, and VI - except without the extra experiment. However, when we went over each one of the objectives of doing the experiment, they did agree that the objectives were important, and were a part of science.

One teacher pointed out that she has had her students do experiments in class, but they have never been able to record experiments as they do them. She conceded that recording experiments was important, and she said it could maybe be done the day after the experiment. Another teacher said that the Class IV students have been able to make graphs (for data analysis), but she complained, 'Why should we force students to plot graphs in Class IV?'

A number of teachers seemed to be getting very uneasy that we were spending so much time talking about objectives. They did not seem to understand what the use was of going into such an in-depth analysis of objectives - why not just teach what was in the old books?

Then another teacher said that actually guessing and estimation is not needed in science. This lead to a discussion on, 'Why learn estimation?' The teachers asked, 'Is it a science topic?' One teacher said, 'The ability to estimate is innate. It's not something you learn. It can't be taught.'

I asked, 'Does it give you a scientific way of thinking?' Some teachers said that rather than **estimation**, we should teach **accuracy** in class. One teacher said that teaching estimation like this would 'sow a seed.' Someone else said, 'You don't need a classroom for teaching estimation.'

I asked the teachers if they thought estimation skills would improve with practice. They seemed doubtful. I asked them each to estimate what the present classroom temperature was (just as they had done yesterday). They each made a guess - between 24 and 28°. Then they read the thermometer and found out it was 24.5°. I pointed out that yesterday their estimations had been between 18 and 28°, so their estimations had improved with practice. Some teachers said, 'It just came by trial and error.' Then I asked, 'Can't this be done in class?' Some teachers said, 'I don't like trial and error in class,' 'It could be a fun activity, but it's not learning,' and 'As a formal lesson in school, estimation is not important. But it is important in life.'

So by the end of the workshop, was I discouraged? Not really. I would have been discouraged if I had simply told the teachers to go do this experiment in class and they had all nodded their heads and said okay. But what actually happened was that I kept trying to get inputs from the teachers and they gave me their honest inputs - which of course were according to their own beliefs, not mine.

This is the beginning of a dialogue - we are all developing our own scientific tempers. Teachers are beginning to think about what they are doing and why they are doing it. Of course there is resistance to change, and there is confusion about what kinds of changes are needed, but isn't this necessary? Isn't this the essence of a scientific way of thinking and acting?