Why Do We Have Problems Learning and Teaching Science?

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Many of us who have been struggling to teach have common ideas about why our work is so difficult. The most obvious complaints are work overload; inadequate pay (in most cases); too many duties; too many students in each class; too many classes in each day; not enough time for individual attention; too many corrections; we do not have proper training; and students have poor skills and backgrounds. These are the most important problems we face as teachers. Together with students and parents, we must demand that these problems be solved. The solutions are primarily economic. Since the government in any forward-looking country should be responsible for providing free high-quality education to all, there is no justification for this not happening.

However, there is another set of problems that plagues science teaching that cannot be solved even by alleviating the economic problems, and it is these problems that I will focus on here. Teachers complain that the syllabus is too vast and difficult; textbooks have mistakes; students are not interested, do not remember and do not get the right answers; and science seems to be irrelevant to the students’ lives. My thesis is that the main reason for these problems is that we do not understand what science is, and therefore, we do not actually teach science.

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Five Basic Reasons Why Learning Science is Difficult

Why do we have trouble answering questions like those shown in Box 1? Why do we find textbooks full of contradictions and confusing statements, as shown in the following illustration (Box 2)? It is because we are not realising what is the nature of science—and we are not realising what is the nature of nature.

Box 1

- Water always flows from a higher place to a lower place.
- Desert plants like the cactus do not have leaves.
- The largest living thing is a tree.
- We cannot see germs in our body.
- 206 bones in our body.
- We live in a house because it keeps us safe.
- We wear rubber boots when it rains.
- All living things need oxygen.
- When we are farther from the sun we have winter.
- There are many danger areas in a house.
- The sun is bigger than the stars.
- Birds live in nests.
- Some animals, like tigers, wolves and foxes are free to go where they want.
- Blood is red.
- The earth is shaped like a pear.
- The world gives us all we want.
- All animals can move.
- Plants do not eat but they make their own food.
- Saturn has 14 moons.
- The earth is shaped like a ball.
- At the age of six the milk teeth fall out.
- We have 212 bones in our body.
- All plants have stems, leaves and roots.
- It is quite easy to tell which things have life in them.
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Box 2

True or False?

1. Plants get big by taking food from the soil through their roots.
2. Burning is a process in which matter is destroyed.
3. The sun rises in the east.
4. Blood is red.
6. Electrical current is used up in lighting a bulb.
7. Heavier bodies fall faster than light ones.

(Most people do not realise that all of these are false!)

(1) We Think Science is a List of ‘Facts’

This is not correct. Science is not a list of facts to memorise. It is a process—a method of asking questions, hypothesising, observing, testing, finding evidence, collecting data, analysing, modifying conclusions, communicating and questionning. This is not a complete list, and all of these aspects need not be present, but this gives an idea of what a generalised scientific method is. In order to teach science, we have to realise that the scientific method is what we have to teach, and we have to teach science by doing science.

(2) We Rely on Faith and Authority rather than Scientific Process

Since we mistakenly think that science is a list of facts, we think that it is possible for some authoritative source to have the correct facts and the correct answers to our questions. Actually, when we rely on authority, we are not necessarily relying on science.

Relying completely and forever on authority for the answers to our questions is non-scientific. Of course, we cannot observe everything for ourselves or test out all ideas for ourselves. So, we do need to rely on authorities even when we do science. However, according to science, any voice of authority, and any answer, can be questioned. If more
convincing evidence is found, the answer can be modified or even rejected. But we need not accept an answer just because we have faith in the authority.

(3) We Restrict Scientific Method Only to Certain Areas

If, using deductive reasoning, we think that there are certain types of questions that cannot be answered by science, we may be needlessly restricting ourselves.

There are many questions which are so difficult to answer that we conclude we may never have even a tentative answer. But how can we conclude that the answer is by definition unknowable? A study of the history of science shows that people keep extending science into areas that were formerly thought to be unapproachable, such as planetary motion, the origin of life, brain function and social sciences.

(4) We Use an Inappropriate System of Logic

We often use a ‘common-sense’ logic which does not make common sense. For example, according to Aristotelian logic: A is A; A is not non-A; and X is either A or non-A, but not both at once. In other words, a rose is a rose. A banana peel is a banana peel. This seems like common sense, and it does often prove useful in day-to-day use. However, we should realise that the real world does not always abide by this kind of logic. In reality, things are not so separate, individual, unchanging or well defined.

Actually, it is more appropriate to use a system of logic in which we recognise that A is A and also non-A. In other words, internal contradictions are present in all things. This is shown, for example, in the sequential drawings of a rotting banana peel. At what point can we say that the banana peel is no longer a banana peel? It is impossible to tell. Actually, the banana peel is always a banana peel in the process of becoming a non-banana peel (see Box 3). Using science which is based on this type of logic, we come to understand that the world consists of processes, not things.

Furthermore, we come to see that everything changes and that nothing is static. There are gradual, quantitative changes, like the slow growth in
the size of a grasshopper. However, this slow process leads to a sudden, qualitative change: the death of the grasshopper. It is difficult for us to comprehend such sudden changes in quality.

Another characteristic of the real world is that things (processes) are interconnected and interdependent, not separate or individual, as they seem according to the Aristotelian form of logic. Interdependencies between organisms, for example, cannot even be understood in terms of simple food chains. We see that many interconnected food chains make up a food web. Even then, there are problems in trying to define trophic levels. The eagle that eats a snake that eats mice may also itself eat mice. A mosquito may feed on both the eagle and the mice. An animal may eat both plants and animals that eat plants, making it both a primary and a secondary consumer. An insect which is a primary consumer of a plant may also be eaten by a plant such as a Venus flytrap. Then if we try to add micro-organisms and detritivores, we soon have a very complicated maze of interdependencies. Science is difficult.

Not only that, we also see that in this scientific system of logic, nothing lasts forever. Every new thing gets replaced by a newer thing.
We are not used to this way of thinking. It is hard for us to believe that there was a time when there were no people on earth. Maybe this is why we are so quick to believe that cavemen used to fight dinosaurs (Actually dinosaurs became extinct 65 million years before the first humans walked on earth). How can we even imagine such long timelines?

(5) We Have an Unrealistic Way of Thinking about the World

Thus, we see that our ways of thinking about the world make it difficult for us to learn science. Our tendency to think that our minds are more powerful and more basic than our bodies makes us discount the physical reasons for processes we observe through science. Our tendency towards conservatism makes it difficult for us to see change. Our tendency to want to understand the purpose of everything makes it hard for us to understand how things happen without purpose or design, although, of course, there are reasons. We keep confusing correlation with cause.

Perhaps the wonder of the natural world that we investigate through the process of science is, in a way, too wonderful and too awesome to fully comprehend. The more we learn, the more we realise how little we know. But this realisation also gives us the freedom, and shows us the necessity, of continuing the process of science.