Did Scientists Ever Err?

Neeraja Raghavan

We often teach children about the genius of scientists, but seldom talk of the errors they made. This leads children, naturally, to regard the entire process of discovery as being magical, like a rocket that takes off and zooms straight into its target: always. It is essential that we infuse our teaching of the subject with real life instances of erroneous thinking as well, as this demystifies the entire process of discovery and brings it closer to the learner and teacher of science. In addition, it shows us how we are ever in an ongoing iterative process of thinking, rethinking and revisiting many so-called 'truths', and how this is what learning is all about. The Internet contains a plethora of information on the history of science, and there are many excellent books on the subject. [One of the finest among such books is A HISTORY OF SCIENCE by John Gribbin.] As it is impossible to do justice to such a topic in these few pages, we present below a smattering of examples to show how erroneous thinking has long been a part of scientific discovery, like it is a part of human lives.

- For over 400 years, the Alexandrian School of Medicine taught that arteries carried air! Galen had to actually test this out in the second century AD and find that they carried blood, after which people had no choice but to drop this erroneous belief. Galen did make some significant contributions to the medical world, as he was the first physician to make use of the pulse rate to diagnose any illnesses of patients and was successful to a great extent.
- Galen (about 129 AD to 210 AD) proposed that blood is produced continuously in the liver and considered blood to be a combustible fuel for the body. He did not believe in the double circulation of our blood and thought that blood was the result of direct conversion from food. People believed him so implicitly that they held onto this belief for 14 centuries! Only when William Harvey dared to question this assumption in 1628 did the circulation of blood get discovered! Harvey first considered the circulation of the blood, when noting how much blood is expelled by the heart with each contraction: over the course of a full day, the amount was more than the body's intake of food by weight. Doing rough calculations, Harvey easily proved that the point is beyond doubt, and that the blood must be re-used. From here, circulation is but a short leap.
- In the early part of the nineteenth century, Lamarck proposed some correct and some incorrect theories about evolution. Amongst his incorrect guesses were: a flamingo's legs get longer because the flamingo is always stretching up to avoid contact with water, and secondly, that acquired characteristics can be inherited. Darwin and Wallace were more or less in agreement on the origin of species, and what is remarkable is that while the former drew his conclusions largely from detailed observations made during his nautical sojourn, the latter did so by adding voracious reading to rock survey: he devoured books from Malthus and spent four years in the forests of Brazil, exploring and collecting samples. Students' and teachers' take off points from the above: How can mere observation be aided by reading that goes along with it? Can you classify leaves and flowers with (a) just observation (b) reading as well as observation and compare your results? How have scientists' thinking about the evolution of life changed from Lamarck to Darwin? What do they think about the inheritance of acquired characteristics today?
- Aristotle said that a hundred pound ball falling from a height of one hundred cubits hits the ground before a one-pound ball has fallen one cubit. Galileo said they would arrive at the same time. Students' and teachers' take off points from the above: How would you find out who is right? Why do you think one of them erred?

- Just by contemplation and by virtue of his social status, Aristotle (384-322 BC) propounded the theory that the Earth was at the centre of the Universe, the Sun and all other planets moved around it and everyone accepted this. It was common sense that the solid Earth could not be moving. Copernicus came along in the sixteenth century and tentatively suggested the reverse, i.e. that the Sun was at the centre and that the Earth and other planets revolved around it. But Copernicus, too, did not arrive at this conclusion through observation. He did so by thinking. Students' and teachers' take off points from the above: Then, in the latter half of the sixteenth century, even when Galileo had proof with his telescope that Copernicus was right, why did he meet with opposition and imprisonment? What are the cherished beliefs we hold onto, that we hate to let go of, even in the face of sufficient evidence to the contrary?
- Van Leeuwenhoek's discovery of tiny moving creatures in droplets of water: until then, people assumed that water drops did not have any living things in them. Students' and teachers' take off points from the above: Like this, what are the assumptions we make about things around us? How can we prove them wrong/right?

With examples like the above serving as a launch pad, the teacher can move on to exciting classroom processes, which will undoubtedly provide rich learning experiences for both the teacher as well as the taught.

It is said that while testing the right material for the filament of the bulb, Thomas Edison had to try thousands of different filaments to select the right materials to glow well and be long-lasting. Eventually, he hit upon the right one. When asked by a news reporter how it felt to fail thousands of times before he finally succeeded, he replied: "I did not fail even once! My experiment simply had thousands of steps."

Neeraja Raghavan, Ph.D., is Consultant, Academics and Pedagogy, Azim Premji Foundation, Bangalore. She can be contacted at neeraja@azimpremjifoundation.org

WHY I CHOSE SCIENCE?

A Quest for Understanding

Usha Ponnappan

When I tried to introspect as to why I chose Science as a career path, it was truly the very first time that I had delved into my past as a student, trying to search through my memory bank for that one special moment in my life that was a turning point. However, while it became clear that no one specific event set the stage for my future in science, it was, I think, a series of unrelated events that shaped my thinking that ultimately led me down this adventurous path, that I so cherish today.

Unlike writing a scientific manuscript, where one outlines the experimental design and a series of results that are leading to outcomes, this exercise of writing about my choice of Science as a career, largely relies on my memory and perhaps on some anecdotes of events in my early life. I cannot state with certainty whether it was my flair for life sciences or if it was the influence of my mentors along the way, that made it second nature to me, but I always gravitated and did well in biology.

The turning point, if I could call it that, was when I received the National Science Talent scholarship at the completion of high school. This merit scholarship provided by the Government of India fostered building future scientists on the path of basic science. One