What is Scientific Temper?

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A FUNDAMENTAL DUTY of all Indian citizens, as enshrined in Article 51A(h) of the Constitution of India, is "to develop the scientific temper, humanism and the spirit of inquiry and reform." The 'Science, Technology, and Innovation Policy–2013' also declares as one of its objectives "promoting the spread of scientific temper amongst all sections of society." Yet, we are currently seeing attempts from various quarters to promote and propagate ideas that run counter to scientific temper. That is why one of the main demands of the 'India March for Science' was to stop propagation of unscientific and obscurantist ideas and to develop scientific temper, in conformance with the Article 51A of the Constitution.

But the problem is, most people do not have a proper understanding of the term. It is not taught at any stage of the education system. Using this loophole, anti-science forces are spreading various shades of unscientific beliefs, while at the same time speaking eloquent about the need for scientific temper. The purpose of this article is therefore to clarify the issue, to explain what constitutes a scientific bent of mind.

Going through our education system, most people get the impression that science is just a collection of different subjects like physics, chemistry, zoology, botany, etc. It is definitely not so. Science is a way of thinking—a way that is completely different from the prevalent modes of thinking in our society. That is why it has to be learned. And in that process one has to shake off the wrong ideas and prejudices that one inherits from the society.

Physics studies the *general* properties of matter and the laws governing the interaction between bodies. Chemistry studies the *particular* properties of matter and the laws governing interaction between specific atoms and molecules. Biology studies the properties of and interactions among *living* matter. These are particular branches of science. If you leave out the particularities studied by these branches of science, what remains? It is that science asks questions about different forms of matter and its motion, and seeks answers to those questions following well defined procedures.

Everybody faces different questions in their lives. If one adopts the method followed by science to obtain the answers to his or her own questions, *that* reflects a scientific bent of mind. And then one has to conduct one's life conscientiously adhering to the truths found this way, and by systematically weeding out the unscientific notions and beliefs that one may have inherited from the society. In fact, this can be taken as the process of developing scientific temper.

Therefore, to develop scientific temper, one has to understand how science teaches us to *think*.

The dominant mode of thinking prevailing in our society is to believe and not to question. Ideas and notions that have been believed by people around us for

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generations are generally believed without question. In contrast, science teaches us to question everything and not to believe anything without evidence. This calls for a drastic change in the way we are used to thinking.

People naturally have questions in their minds. But what is the right way of seeking answers to these questions? In ancient times, each individual would think and speculate on a question at hand and would arrive at some answer. That would be the answer for him. Another person could speculate on the same question and might arrive at a different answer. Thus, on any question, there could be a number of possible answers. Most people would trust the wisdom of this or that man and tend to believe in his view of the world or events. Thus, there would be plural answers to every question, and there would be several schools of thought. Most importantly, nobody bothered to check if an idea was right or wrong. This mode of thinking is called 'subjective' thinking.

In contrast, Galileo introduced a new method of thinking that considered the possibility that one's ideas could be wrong, and therefore every idea has to be tested against reality. The way to test the correctness of any idea, according to him, was through observation and experiment. This way of thinking is called 'objective thinking'.

Science believes in objective thinking. That is why, in science every idea has to be tested. An idea is accepted only when it passes all the tests. In science nothing is accepted without evidence. The role of the person who is doing the thinking—the subject—is secondary, while that of the material world—the object—is primary.

In science there is no infallible *guru*. However eminent a scientist may be, his or her idea will not be accepted unless one can obtain evidence in support of it. Even after a theory passes such a test, scientists keep on checking and rechecking it in different conditions. If one finds a situation where a theory does not give satisfactory results, that indicates the need for a new theory.

That is why, in science there is no plurality of truths. On every question there is one correct answer. If many answers are proposed by different scientists, the objective tests will eliminate the wrong ones and the remaining one will be the correct answer. It is also possible that the experimental or observational tests might contradict all the theories proposed up to that point of time. In that case scientists would realize that an entirely new theory is needed to explain the observations. When such a theory is proposed, scientists would again perform tests to check if that one gives the correct answer. That is how science works: progressively approaching the correct answer to every question, checking against objective reality at every step of the process.

What do we learn from all this? Scientific bent of mind implies thinking in an objective way. Faced any question, a person with scientific bent of mind would not believe outright in what other people say. He may speculate, let his imagination soar but even then would be inspired to seek evidence, and would believe in an idea only when he or she finds evidence in support of it. All the while he would keep his mind open to the possibility that his own ideas may be wrong, and would keep checking and rechecking.

If one says that the Vedic *rishis* flew in aircraft seven thousand years back, a person with scientific temper would simply demand evidence, possibly in the form of some broken piece of such a craft in an archaeological site. If one says that the *Mahabharata* war was a historical fact, a scientifically minded person would simply

demand evidence, possibly the remains of a chariot or a weapon like a *gada* in the archaeological excavations in Kurukshetra (a town in the state of Haryana). One can multiply examples, but the main point is that a person with scientific temper would demand evidence before believing anything.

Now let us come to another aspect. There are two major lines of philosophical thought—idealism and materialism. Materialism says that the world is made of matter, and that there is nothing supra-matter in the material world. From that perspective, a materialist directs all his enquiries into the properties of different forms of matter and their interactions. On the other hand, idealism believes in the existence of some primordial idea from which all matter is born. So an idealist's queries are directed at that supra-matter entity whose existence he supposes, and not at the material world.

Materialists say that mind, thought, etc. are products of matter. Thought exists in the human brain, which is a material entity—a very high form of organization of matter. Therefore idea is a product of matter. For the materialist, matter is primary and idea is secondary. In contrast, the idealist would contend that idea is primary and matter is secondary. More importantly, a materialist would maintain that matter exists independent of our consciousness while an idealist would say that matter exists in our consciousness. According to the idealist, matter is what we perceive it to be, while for a materialist, the character of matter does not depend on our perception.

After much debate, science has become firmly rooted in the position of materialism. All developments in science have resulted from inquiries into the character of different forms of matter and their interaction. That is why a person wishing to acquire a scientific bent of mind has to come to terms with the fact that the material world exists independent of our consciousness. Our task is to try to know it as best as we can, following some well defined procedure that avoids the pitfalls of subjective thinking.

One of the basic stepping stones of science is the law of causality: the understanding that behind every event there must be a cause. Much of science is directed towards trying to find the causes behind different events or phenomena. Therefore, one of the stepping stones of scientific temper is also the understanding that nothing happens without a cause. And a scientifically minded person tries to locate the causes of the events that happen around him.

But where to look for the cause? Here comes a major difference between the two major philosophical lines of thought mentioned earlier. Materialism demands that the cause of an event must be found in the material processes and phenomena, while an idealist contends that there may be a supernatural hand behind the event. On this issue science strongly sides with materialism, because all the cause-and-effect relations found by science so far can be explained by material processes and phenomena.

Therefore, scientific temper demands that whatever events one may encounter in one's life, however strange these may appear to be, the causal explanation must be found in material processes and phenomena, not in supernatural intervention.

Let us give an example. In the year 1996, one day there was a rumour that *Ganesha* idols were drinking milk. Thousands of people queued up at temples with pots of milk in hand, and spoonful of milk was found to be disappearing when the spoon touched the idol's mouth. For most people it was a miracle, a *chamatkar*, which defied explanation. How would a person with

scientific temper approach the issue?

He would have to say, "even though I cannot immediately figure out how this is happening, there must be a material process causing the disappearance of milk." And then he would set about investigating what is really happening.

But how does he investigate? That also must be learned from the way a scientist approaches a question. Faced a question, a scientist first guesses what the underlying cause might be. A scientist's guesses are not wild guesses or fanciful imaginations. They are firmly rooted in what is already known regarding the properties of matter. Moreover, they must satisfy the initial clues that are obtained by first-hand observation. Such scientific guesses are called hypotheses. After having formed a few such hypotheses, the scientist sets about testing these, so that the wrong ones can be eliminated.

A person with a scientific approach would also proceed in the same way, by guessing at possible explanations. And the guesses would have to satisfy what he already knows about the properties of matter. For example, he might know about the law of conservation of matter. So he would argue, if the milk is disappearing from the spoon, it must be found somewhere else. He might have learned about capillary action that causes liquid to rise in narrow tubes and causes sap to flow to the top of a tree. He might also know that liquids may travel upwards through porous substances, the way chalk can absorb ink. So he might guess some of these processes individually or together may be in action. Then he has to test his hypotheses. For example, to test his first guess, he might simply check if the water flowing into the drain has turned white, implying that the milk hasn't really disappeared; it is actually flowing out of the drain. To test the other guesses, he might have to perform some simple experiments. Through these, he would be able to eliminate the wrong guesses and would be able to home on to the correct explanation.

Important is the fact that on the first day he may not be able to provide an explanation. But that should not deter him from insisting that there must be an explanation based on material processes and phenomena. That is the most important element of scientific temper.

Many *babas* and *yogis* often perform simple tricks to convince people of their supernatural powers. Mostly these are sleight of hand that is difficult to see at the first go. Professional magicians do the same thing. The only difference is that the magician would plainly say that I have fooled you with a trick, while a charlatan posing as a god-man would claim to have supernatural powers. But in both cases the viewer may not be able to catch the trick. A scientifically minded person should nevertheless confidently say that there must be a materialistic explanation of the event.

Thus, in a nutshell, scientific temper is nothing but following the same thought process in one's daily life that a scientist is supposed to follow in his laboratory. One has to practice thinking this way, to make it one natural style of thinking when faced with a problem. One acquires scientific temper when, through practice in daily life and thinking in a scientific way, it becomes part of one's personality, so that one behaves in a certain manner and one approaches every issue with a particular outlook. Scientific temper is a way of life. Unfortunately our education system does not train a student to think this way. That is why the cultivation of scientific temper has to happen outside the classroom also, in course of a science movement.□