

SCIENCE AND SCIENTIFIC TEMPER

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According to the Constitution of India (Article 51 A), it is our fundamental duty to inculcate ‘scientific temper’. National Curriculum Framework 2005 also looks at the development of scientific temper, as one of the aims of science education. Though scientific temper is not confined to science alone, the possibility of developing scientific temper seems higher in science, as it stands as the most reliable source of knowledge and understanding. We expect science teachers to help children to understand what is science and its influence on human life. So, it becomes important to understand what science teachers think of science. A teacher’s identity gets constructed based on her belief, perceptions, experience, values, and judgments. Because a teacher has a moral influence on the students, these need to be examined (Bukor, 2011).

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SCIENCE TEACHERS’ PERSPECTIVE ON SCIENCE AND SCIENTIFIC TEMPER

Science is a process of understanding the natural world, through the inquiry, in which one applies the methods of science such as – Observation, Induction, and deduction etc. Through inquiry, science explains the phenomenon/entity and provides justification for that for example by suggesting theories. Sarukkai writes scientific theories are unique because they not only describe but also explain and also do the job of unifying the diverse phenomenon (Sarukkai, 2012) “Explaining, categorizing, detecting causes, measuring and predicting are other aims of scientific activity” (Bird, 1998).

Science as knowledge is falsifiable (and verifiable to some extent) and changeable as the process— there is no fixed set of features, which makes something ‘science’. According to Popper, a theory is scientific if it is falsifiable (Popper, 1992).

By considering the nature and methods of science, science education has been assigned for an important role of developing scientific temper — according to the national focus paper on teaching of science, one of the aims of science teaching is to develop scientific temper (ST) in students. “*Aim of science education is to cultivate ‘scientific temper’- objectivity, critical thinking and freedom from fear and prejudice.*” (National Focus Paper on Teaching of Science, 2006).

Scientific temper is an attitude, where one applies the methods of science in the day to day life, to solve the

problems of individual and of society by taking the ethical/moral, social and epistemic values into consideration (Sharma, 2018). To have a scientific temper, one does not necessarily need to go through science education. But science education can help to inculcate scientific temper as the process of science education helps in internalizing the methods and value of science.

In India firstly Pandit Jawahar Lal Nehru introduced the term ‘Scientific Temper’ in 1946 in his book ‘Discovery of India’. He referred to scientific temper as “*a way of life, process of thinking, a method of acting and associating with fellow men*”. Nehru also believed that if India wants to develop strong and vibrant societies like European societies then it had to learn and behave scientifically. He mentioned scientific temper as one of the national goals. By scientific temper, Nehru meant “*fostering the empirical and rational way of thought and life*” (Parekh, 1991). According to article 51(A) of the Indian constitution, it is the fundamental duty of the citizens of India to develop scientific temper and having the spirit of inquiry.

The first statement on scientific temper (1981), given in a conference by Dr Raja Ramanna, Dr. PM Bhargava, and PN Haskar, also explains that it is important to have scientific temper for the survival and future of the nation. According to this statement, scientific temper (ST) should be fostered with care at the individual, institutional, social and political level (Pre-Proceeding from International Conference on Science Communication for Scientific Temper, 2012). In this conference, the need for developing scientific temper was identified and some areas were selected to develop scientific temper, education was one of them. According to the statement, scientific temper is neither an accumulation of knowledge nor rationalism, but rather it is an attitude of mind or the way we approach our problems.

METHOD

The purpose of the study was to understand science teachers, as well as teacher educators’ understanding of science and scientific temper. Regarding science, the focus was on nature, methods, and values of science. In education, teachers play an important role — we expect science teachers to help students to understand what is science and its influence on human life. So, it becomes important to understand what science teachers think of science. A teacher’s identity gets constructed based on her belief, perceptions, experience, values, and judgments. Because a teacher has a moral influence on the students, these need to be examined (Bukor, 2011). So, this study was an attempt to get an insight of science teachers and teacher educators’ understanding of science and scientific temper.

This qualitative study, which spanned for six weeks, was conducted at the Homi Bhabha Centre for Science Education (HBCSE), Tata Institute of Fundamental Research (TIFR), Mumbai. The study was done with eight school science teachers and two teacher educators, from an institute in Mumbai. All the science teachers are actively engaged in science teaching. Out of eight teachers, seven teachers hold a degree of master in science, and one teacher holds a degree of bachelor in science.

In the initial part of the study, teachers were asked to fill a questionnaire. The questionnaire responses were followed by semi-structured interviews. The questionnaire engages with nature and aims of science and

attempts to understand science teachers' standpoint on various current socio-scientific issues. The interviews were more focused on the nature of science, methods, values of science and scientific temper.

The interview questions are given below. Other than these questions, the question 'when do you call something scientific?' or something similar to this was being asked, as almost all the participants (except one teacher) used the word 'scientific' in either interview or questionnaire.

Some of the interview questions were -

- 1 How is science important?
2. Does science help you to make life better? How?

According to you what are the objectives of science teaching?

Do you think science (as taught in the schools) has the potential to develop values in students? What values? What made you think so?

Do you think science is different from any other domain? How?

According to the constitution, it is our fundamental duty to have a scientific temper. What is scientific temper according to you?

Why there is a need to develop scientific temper? Do scientific temper plays any role in the development of society? How?

PARTICIPANTS' RESPONSES

The responses of the participants were quite different in some aspects and common in others – there were different kinds of understanding. On one end, a teacher, who has a good understanding of nature, methods, scientific temper and believed that science is influencing humans positively. On the other end, participants who had confusion about the impact of science on human lives and looked at science as a school subject, which has some information about the world.

Science teachers' perspectives on different themes

Nature of science: Most of the teachers think that science gives us 'facts' or description that of truth about the natural world. Only a few of the participants (two teachers and teacher educators) understood the falsifiability of science. Also, on a question "when do you call something scientific"(almost all the participants used this word, either in the questionnaire or in the discussion, except one participant). Five out of seven teachers answered "*something is scientific if, it can be proven*", the other two participants answered, "*If something follows a particular sequence and goes step by step*". It wasn't clear here if they were pointing at any regularity here. Most of the teachers look at description and justification as the crucial thing about science.

So, according to most of the science teachers, the nature of science is descriptive, where it tells us facts about the natural world and provides justification for these facts. Only two science teachers in the study mentioned that science also does the job of explaining the phenomenon.

Methods of science: Most of the participants considered observation and/or experiments as the methods employed in science. Only a few of them (two teachers) could identify induction, prediction, and heuristics as some other methods of science. Also, most of the participant thought that there is one particular sequence we follow in science, which is the scientific methodology. Some of the science teachers in the study thought that by doing activities we get to learn the scientific methods because students internalize the process.

Also, participants' understanding of the nature and method of science and scientific temper seems to be correlated. Participants who have shown scientific attitude towards some of the issues included in the questionnaire had a comparatively clearer understanding of the nature and methods involved in Science — they could identify prediction, heuristics, detailed and careful observations (rather than mere observations).

For example a teacher who understood about falsifiability of science. During the discussion on Sabarimala issue participant mentioned – “*we should allow around hundreds of women to go into the temple then only we can conclude something.*” The participant thinks, by experimenting we will get to know about cause and effect.

While another teacher, who believed that science tells us the truth only. On Sabarimala issue the participant mentioned – “*women should be focusing on work, there is no need to go to the temple.*”

Scientific Temper: According to the participants, scientific temper is an attitude/behaviour/ perspective/ ability, which can be developed through science education but science education is not necessary to have scientific temper. Some of the science teachers in the study believed that doing science and history of science helps in inculcating scientific temper. However, they could not explain how doing science helps in inculcating scientific temper.

While explaining scientific temper, most of the participants correlated it (scientific temper) with methods of science. They mentioned:

“*True observation and then analyzing— and rationalizing it over there with that attitude, this attitude is nothing but scientific temper*”. (Teacher -1)

According to the participant we do careful observations when we have the scientific temper. (Teacher-2)
“*Lab work helps in developing scientific temper because we do experiments there*”. (Teacher-4)

Values of Science: Almost all the participants believe that science education has the potential to develop some values (epistemic or ethical or social). The participants identified some of the epistemic, social and

ethical values of science. In epistemic values, participants mainly looked at truthfulness, curiosity and scientific temper as some of the values. Also, most of the participants thought that Science makes us more sensitive towards the environment and social issues.

One participant had the belief that science is harming the existing value system. The participant mentioned – *“Now a days if you say something to the children, they ask many questions and do not listen and respect elders. Science and technology is harming our culture and values”*

Objectives of science teaching: Science teachers in the study mainly looked at constructing content knowledge as the aim of science teaching. Out of eight, five science teachers in the study mentioned that they taught Science to provide knowledge/ understanding of content to the students. Other two teachers mentioned that they teach science to develop scientific/ analytical thinking among students. While one teacher mentioned that by teaching Science, the teacher tries to develop certain skills in children— such as, the skills of doing activities (doing science).

Science and individuals’ belief: Participants seemed to be in dilemma with regard to their belief because of their education in science and belief they held. They tried to prove their belief as scientific; for example a participant mentioned - Science should not influence our life, because it is uprooting us from the culture but on the other hand, the teacher tried to prove religious beliefs and rituals as scientific.

Probably, it was because of the education they have gone through. Probably their science education contributed to the perspective that one needs to have justification to believe in something.

By keeping the practices of science in mind participants tended to prove their cultural and religious belief as scientific. To prove those beliefs as scientific, teachers try to co-relate it with the concepts of Science or scientific knowledge. It seems like dressing up religion as science, as some of the philosophers also regard creationism as ‘religion dressed up as science’ (Bird, 1998).

For e.g. - To prove astrology as scientific, a participant mentioned - *“may be like gravitational force, the magnitude of the star’s effect is very very less that we can’t notice that, but definitely stars have an effect on us, same as our neighbours have an effect on us”*.

One another participant mentioned; *“Scientific reason behind doing puja of the Peepal tree is that when we do puja we are spending more time under the tree, in that way women will get more oxygen, it is important because earlier women were cooking food on chulhas so, they were in contact of carbon dioxide for a long time”*.

According to four participants, whatever our rituals and traditions are, all have a scientific reason behind. It is probably that we are not aware of all those reasons. Another three participants thought that there are some wrong practices in our religion, ritual, and culture, which are ethically not good and they are not logically consistent; these had to be abolished, but not all. So, in a way, there was a range in participants’ opinions.

Some of the participants were being little diplomatic—politically correct in answering. For example, most of the teachers mentioned in the questionnaire that menstruation is a biological process, there is nothing impure in this. However, in interview some of them mentioned- “*why women want to go to temple during periods, they should better take rest*” or “*women should be focusing on work, there is no need to go to the temple.*”

CONCLUSION

Participants believed that science has the potential to develop some values, such as - scientific temper, which is an attitude/behaviour /ability/realization. But it's failing because we are more oriented towards content knowledge. So, they thought there is a requirement of something more apart from content knowledge.

Also, it was evident that science teachers in the study hold some alternate ideas and misconceptions about science and scientific temper and have not rationalized the aim of science education. This presents a need for emphasizing more on the nature and methods of science — the underlying philosophy of the subject in school science education and teacher professional development programmes along with the content knowledge. Additionally, the aims of science education needs to be explained/rationalized to science teachers.

The science teachers in the study tried to prove their belief as scientific — they tried to make some connections of their belief with the scientific knowledge they hold, even when science education is focused mostly on content knowledge. This indicates that there is some hope that by making adequate efforts (by focusing on the nature and methods of science along with content knowledge) our aim of developing scientific temper can be achieved through science education.

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