

Scientific Temper among Secondary School Students

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ABSTRACT

The skill of analysing and evaluating information is very important in the 21st century knowledge economy. Scientific temper is such a bent of mind which helps one in this skill by thinking rationally and logically. Scientific temper is considered as one of the fundamental duties which is also identified as the most important 21st century skill in the National Education Policy, 2020. Hence, it is expected that the present youth comprising school and college should have scientific temper as per the need of the time. It is also important to know the level of scientific temper among our school and college going students so that required measures can be taken up to develop this skill.

The present study is an attempt to find out the scientific temper among secondary school students. Descriptive survey method was adopted for this purpose. 272 IX standard students were taken as the sample from the schools of Vadodara District using convenient sampling method. A scale was prepared, validated and used by the researchers to measure the scientific temper. Mean, SD and Mann Whitney U test were used for statistical analysis of data. The findings of the study revealed an above average level of scientific temper among secondary school students as a whole and in all the eight components of scientific temper with high deviation. No significant differences were observed between the mean scores of secondary school boys and girls in scientific temper as a whole and in all the eight components.

Keywords: 21st Century skill, Scientific Temper, Secondary School Students, Gender.

Introduction

We are living in a society with overloaded information. In such a society, one must have a rational bent of mind to choose the right

and useful information. Scientific temper is a skill that logically analyses and questions everything before accepting them blindly. Hence, scientific temper is needed among the people, particularly among the youth.

The National Education Policy, 2020 has recognised scientific temper as a fundamental principle that guides the education system. It says “the purpose of the education system is to develop good human beings capable of rational thought and action, possessing compassion and empathy, courage and resilience, scientific temper and creative imagination, with sound ethical moorings and values”. Hence, a scientifically tempered society is the need of the hour (Yadav, 2018).

The term scientific temper was first used in the book called the Discovery of India in 1946. In this book, Pandit Jawaharlal Nehru defined scientific temper as “a way of life, a process of thinking, a method of acting and associating with our fellowmen”. He further called it the temper of a free man which makes it common for all and not just a trait to be possessed by the scientist or science personnel. Scientific temper could be characterised by main traits like Healthy Scepticism, Objective, Intellectual honesty, Rationality, Perseverance, Freedom from Superstition, Curiosity, Open-mindedness and Observation from the common characteristics identified by Singh (1998), Dhar (2009) and Bhatnagar (2014). So if a person shows these traits he/she can be considered as having a scientific temperament.

Considering the importance of this very notion many efforts have been made from time to time. To make it more general a resolution called Scientific Policy Resolution (SPR) was passed in 1958 by the Government of India. SPR was an expression of India's political leaders' faith in Science and the role that technology could play in national development. In 1976 it was added in the fundamental duties of the Constitution through the 42nd Amendment in the Article 51A (h) which says that “It shall be the duty of every citizen of India to develop the scientific temper, humanism and the spirit of inquiry and reform”. After this, a Statement on Scientific Temper, was released on 19 July 1981. This document articulated the need to inculcate the values of Scientific Temper in Indian Society and to get rid of the social ills prevailing at that time.

The importance of scientific temper is very clear from the mentioned initiatives. In 2011, through the Palampur declaration, this statement of 1981 was revisited and various strategies were suggested to develop scientific temperament among the mass. Since then many researchers have tried to find out the importance and status of scientific temper among students at various levels.

Çalik, Turan And Coll (2013) found that teacher education programmes need to help student teachers grasp better scientific thinking. Price and Lee (2013) have found that Astronomical Citizen Science Project helps in bringing positive changes in Participants' Scientific Attitudes and Epistemological Beliefs. Hyytinen, Toom and Shavelson (2019) suggested that Critical and scientific thinking is the most important skill for the 21st century which needs to be integrated into throughout the curriculum.

Erdogan (2017) found a high correlation between scientific attitudes and science teaching attitudes. Although Sari *et al.* (2018) found that no significant correlation exists between science process skill and scientific attitude. This means it is not necessary that if a person knows the content and process and science he/she would be having scientific attitude as well. Besides that various intervention was found to be effective in developing scientific attitude (Budiharti and Waras, 2018; Suastra and Ristiati, 2019; Gumilar, Wardhini and Lisdiana 2020; Dewi *et al.* 2020). Pradhan (1996) did a cross-cultural study to investigate the understanding of Science and Scientific Temper and found the existence of differences in scientific temper among different cultures. Singh (1987), Kapri (2017), Yadav (2018), Singh (2019), Thakur and Bhan, (2019) tried to find out the scientific temper of secondary school students. Singh (1987) and Yadav (2018) found that secondary school students possessed an average level of scientific temper. Kapri (2017) found that there was no difference in scientific temper among secondary school students with respect to gender while Yadav (2018) and Thakur and Bhan (2019) found the contrast result that difference existed in scientific temper between boys and girls. Chakraborty (2015) found that most of the students had a low level of scientific attitude. Tripathi (1999) and Bagavathy (2015)

found that there was no difference in scientific temper among high school students with respect to their gender. Aezum and Wani (2013) found the difference in scientific temper between girls and boys students.

Review of all these studies showed mixed results with respect to the status of the scientific temper of secondary students and the effect of gender on it. Even a large number of these studies were reported from a specific demographic region. Hence, the present study is an attempt in this direction to find out the status of scientific temper among secondary school students of Vadodara district in Gujarat state and to see the effect of gender on it.

Objectives of the Study

The study was conducted with the following objectives:

1. To study the levels of scientific temper among secondary school students.
2. To study the scientific temper of secondary school students with respect to their gender.

Hypotheses of the Study

Following null hypotheses were formulated and tested at the 0.05 level of significance:

- H₀₁: There is no significant difference in mean score of Healthy Skepticism of scientific temper between secondary school boys and girls students.
- H₀₂: There is no significant difference in mean score of Objective Intellectual honesty of scientific temper between secondary school boys and girls students.
- H₀₃: There is no significant difference in mean score of Rationality of scientific temper between secondary school boys and girls students.
- H₀₄: There is no significant difference in mean score of Perseverance of scientific temper between secondary school boys and girls students.
- H₀₅: There is no significant difference in mean score of Freedom from Superstition of scientific temper between secondary school boys and girls students.

H₀₆: There is no significant difference in mean score of Curiosity of scientific temper between secondary school boys and girls students.

H₀₇: There is no significant difference in mean score of Open-mindedness of scientific temper between secondary school boys and girls students.

H₀₈: There is no significant difference in mean score of Observation of scientific temper between secondary school boys and girls students.

H₀₉: There is no significant difference in mean score of scientific temper between secondary school boys and girls students.

Delimitation

The proposed study was delimited to English medium school following GSEB (Gujarat Secondary and Higher Secondary Education Board) syllabus in Vadodara city. In the proposed study Secondary School is delimited to standard IX only.

Methodology

A descriptive survey method was adopted for the present study. Secondary school students studying in Gujarat district was the population of the study. From the population total of 272 IX standard students studying in four private schools of Vadodara District were taken as the sample through a convenient sampling method. A scale was prepared to measure the level of scientific temper.

Eight components of scientific temper *viz.* Healthy Scepticism, Objective Intellectual honesty, Rationality, Perseverance, Freedom from Superstition, Curiosity, Open-mindedness and Observation were identified from related literature and used to develop the scale. The scale consisted of 32 questions, four from each component based on some real-life situations and shown in table 1.

Each question had five alternative responses that were scaled from one to five based on the degree of scientific temper. Respondents were asked to choose one alternative for each question. Hence, the maximum score and the minimum score in the scientific temper scale were 160 and 32 respectively. Similarly, the maximum score and the minimum score in each

component of the scientific temper scale were 20 and 4 respectively.

The scale was validated by experts for the content and language appropriateness. The reliability of the scale in terms of stability and internal consistency were found to be high as the Split half and the Cronbach alpha reliability coefficient were found to be 0.75 and 0.79 respectively. The scale was used to collect data from the sample. The collected data were analysed with statistical techniques like, Mean, SD and Mann Whitney U test.

Table 1: Questions in the Scientific Temper in all the 8 components.

Components	Questions
Healthy Scepticism	On WhatsApp, your friend had shared a message on the availability of artificial cabbages in the local market as a vegetable. What will be your action?
	You saw a TV interview wherein an astrologer tells that the earth is going to be destroyed after 20 years. What will be your reaction to it?
	You are sick and are being treated by some qualified doctors. One of your friends suggested some miraculous home remedies as a cure for your illness. What will you do?
	Your friend told you about a healing stone given by a spiritual guru that heals general illness. What will you think?
Objective Intellectual Honesty	As a monitor, you were asked to choose five members from your class as a cleanliness monitoring team. How will you select them?
	You are doing a science experiment but getting unexpected findings while the rest of your friends are getting the expected result. What will you do in such a situation?
	What will you do if you are given a chance to select the class monitor from two classmates of whom one is your close friend?
	Your science teacher has given your class an assignment to grow and observe the growth of a gram seed for two months and to write a report. Unfortunately, your plant failed to grow properly. What will you do?
Rationality	One day while you were cutting nail in the evening, your friend told you that its inauspicious (<i>ashubh</i>) to cut nails after sunset. What will be your reaction?
	You worked very hard to prepare a model for a competition. Some of your friends gave very critical comments on it. How will you react?
	Your teacher has given you a task to suggest measures to make your city clean. What will you do?

	As a class monitor, you received complaints about one of your very close friends and you are supposed to report it to the principal. What will you do?
Perseverance	There is online registration for some competitions. Most of your friends have registered themselves online but you are unable to do it. What will you do?
	You solved a mathematical question but you did not get the right answer. What will you do?
	There is a scholarship examination after the vacation and your family has planned to go on a holiday trip at that time. Although you know that there is a very rare chance to qualify it. What will you do?
	You are asked to read a book thoroughly and to write a summary of the book. What will you do if you found the book boring?
Freedom from Superstition	Your friend told you that when he was coming to school, a cat crossed his path. So he changed his path because of which he was late for school. What will be your reaction to this?
	There was no rain for a long period in a village. The villagers did a ritual (<i>yajna</i>) at a large scale to please the rain god and there was rain on the last day of this ritual. What will be your reaction?
	When shopping in the mall, a shopkeeper told you to fill up the form to be a part of a lucky draw. What will you do?
	There is a temple of Jwala Devi in Himanchal Pradesh where a sacred flame comes from a hole continuously. Your friend told you that it is because of the power of a goddess. What do you think about it?
Curiosity	Bermuda triangle is an area in the Atlantic Ocean where everything including planes and ships gets disappears. What do you think about it?
	There is a robot called Sophia who has been given the citizenship of a country as it is considered very equal to a human being. What is your reaction?
	You have gone to visit Science Park from your school where various types of motions and forces have been shown through various models. What will you do?
	At your house, one of your father's friends visited and he shared his success story at the time of dinner. What will you do?
Open-mindedness	You have presented a topic with some opinions and conclusions. You have been given some suggestions to revise your opinion and conclusions. What will you do?
	In a group activity of your class, you are paired with someone who is not very close to you. What will you do?
	You have been given a chance to prepare a team from your classmates for Kabaddi. What will you do?

	In a logo making competition, your logo was appreciated by everyone. But on the day of declaration of the result, your logo got the second position whereas someone else's logo got the first position. What will be your reaction?
Observation	You have got a chance to observe different varieties of birds in a zoo. How will you enjoy it?
	Your teacher has asked you to find the similarities between a tree and a car. What will be your thinking?
	You have gone to visit a botanical garden. What will you do?
	You have been given a task to see a film for ten minutes and then write a note on it. What will you do?

Analysis and Interpretation of Data

Collected data were analysed objective wise. Analysis of data related to objectives 1 and 2 are presented in table 2 and table 3 respectively followed by the analysis.

Table 2: Mean, Standard Deviation and Standard Error of Mean wise distribution of Scientific Temper of secondary school students' component-wise and as a whole.

Components of Scientific Temper	Mean Score	Standard Deviation	Standard Error of Mean
Healthy Skepticism	14.18	3.07	0.19
Objective Intellectual honesty	14.06	3.18	0.19
Rationality	13.93	3.08	0.19
Perseverance	14.30	3.05	0.18
Freedom from Superstition	14.32	3.21	0.19
Curiosity	13.59	3.12	0.19
Open mindedness	14.47	3.37	0.20
Observation	13.31	3.11	0.19
Total	112.16	15.4	0.93

From table 2, it was observed that the mean score of the scientific temper of secondary school students in eight components was found to be 14.18, 14.06, 13.93, 14.30, 14.32, 13.59, 14.47, and 13.31 for Healthy Skepticism, Objective Intellectual honesty, Rationality, Perseverance, Freedom from Superstition, Curiosity, Open-mindedness and Observation respectively out of the total score of 20.

The highest and lowest mean scores were found to be 14.47 (72% of the total score) and 13.31 (66.5% of the total score) for Open-Mindedness and Observation respectively. The standard deviations from the means of all the eight components of scientific temper were found to be high and similar ranging from 3.5 to 3.37. The standard errors of means of all the eight components of scientific temper were found to be similar and very low ranging from 0.18 to 0.20.

This result showed the above average level of scientific temper among secondary school students in all the eight components of scientific temper. Similarly, the mean scientific temper as a whole among secondary school students was found to be 112.16 (70.1% of the total score) out of the total score of 160 with standard deviation and standard error of the mean of 15.4 and 0.93 respectively. This result also showed the above average level of scientific temper as a whole among secondary school students with high dispersion.

Table 3: Gender, Mean, Sum of the Ranks, U-Value, Z-Value and p-value wise distribution of Scientific Temper of secondary school students component-wise and as a whole.

Components of Scientific Temper	Gender	Mean	Sum of ranks	U-Value	Z-Value	p-value
Healthy Skepticism	Boys	14.43	19614	8198	-1.63	0.10
	Girls	13.93	17514			
Objective Intellectual honesty	Boys	14.19	19024	8788	-0.71	0.48
	Girls	13.93	18104			
Rationality	Boys	14.04	19247	8565	-1.06	0.29
	Girls	13.82	17881			
Perseverance	Boys	14.35	18855.5	8956.5	-0.45	0.65
	Girls	14.25	18272.5			
Freedom from Superstition	Boys	14.34	18600	9212	-0.05	0.96
	Girls	14.31	18528			
Curiosity	Boys	13.64	18593.5	9218.5	-0.05	0.96
	Girls	13.54	18534.5			
Open mindedness	Boys	14.47	18655.5	9156.5	-0.14	0.89
	Girls	14.47	18472.5			

Observation	Boys	13.24	18441	9125	-0.19	0.85
	Girls	13.38	18687			
Total	Boys	112.7	18985.5	8826.5	-0.65	0.52
	Girls	111.63	18142.5			

From table 3, it was found that the mean scores of all eight components (Healthy Scepticism, Objective Intellectual honesty, Rationality, Perseverance, Freedom from Superstition, Curiosity, Open-mindedness and Observation) of scientific temper for boys were found to be 14.43, 14.19, 14.04, 14.35, 14.34, 13.64, 14.47, 13.24 respectively. The same for girls were found to be 13.93, 13.93, 13.82, 14.25, 14.31, 13.54, 14.47, 13.38. The mean score of the whole of scientific temper of boys and girls were 112.7 and 111.63. These mean scores are very close and uniform.

To know whether this difference is significant or nor the z score has been taken out. The z scores for all eight components and the total of the scientific temper were found to be -1.63, -0.71, -1.06,, -0.45, -0.05, -0.05, -0.14, -0.19 and -0.65 respectively. The p values for all the components and of the total of scientific temper were found to be 0.10, 0.48, 0.29, 0.65, 0.96, 0.89, 0.85 and 0.52 respectively. All these p-values were found higher than the decided level of significance i.e. 0.05. Hence, the hypotheses from H_{01} to H_{09} were retained and it can be said that there is no significant difference in the mean scores of secondary school boys and girls in scientific temper as a whole and all the eight components.

Major Findings of the study

Following major findings were drawn from the analysis and interpretation of data:

1. Secondary school students of Gujarat were found to have above average level of scientific temper as a whole and in all the eight components with high deviations.
2. No significant differences were observed between the mean scores of secondary school boys and girls of Gujarat in scientific temper as a whole and all the eight components.

Discussion

One of the findings of the present study revealed that secondary school students of Gujarat possessed an above-average level of scientific temper as a whole and in all the taken eight components. It proved the equal contributions of all the taken components towards the scientific temper which helped to improve the validity of the developed scale. It also showed a good scenario about the scientific temper among secondary school students of Gujarat.

It shows that after years of effort and planning, secondary school students have surely raised in the level of scientific temper. It may be due to the efforts of the agencies responsible for curriculum design and implementation. The role of teachers and parents cannot be ignored in this direction.

This finding of the present study is also supported by previous studies like Pradhan (1996), Basu & Aslam (2015), Ridwana (2017), and Jahanger and Dar (2019) who also found above average level of scientific temper among school going students. The better status of scientific temper may be due to the changing socio-cultural climate in the society, the pattern of curriculum transaction in the school, changing thinking patterns and belief systems in the family.

The study conducted by Chakraborty (2015) contrast with this finding of the present study which stated that most of the school students had a low level of scientific attitude. This may be due to the demographic differences among the population parameters. The second finding of the present study revealed no significant difference between secondary school girls and boys in all the eight components of scientific temper and scientific temper as a whole. This finding is also supported by the findings of the studies conducted by Pradhan (1996), Tripathi (1999), Govindrajan (2014), Chakraborty (2015), Bagavathy (2015), Kapri (2017) and Singh (2019). The reason behind this finding may be due to the changing attitude of society towards girl children, governmental initiatives towards gender equality, minimizing the gender biases in the curriculum and its transaction.

Above and all, it may be due to the specific nature of the trait scientific temper. However, this finding of the present study

contradicts the studies conducted by Nadeem and Ridwana (2012) Aezum and Wani (2013), Yadav (2018) and Thakur and Bhan (2019) who found the differences in the scientific temper of girls and boys which may be due to the demographic differences among the population parameters.

Conclusion

The finding of the present study represents a good scenario in terms of the scientific temper of secondary school students in Gujarat. As the current situation demands a high level of scientific temper to accrue the 21st century skill among the youth, there is an urgent need to have a high level of scientific temper among secondary school students.

It has been proved time and again through various studies that the interventions help to increase the level of scientific temper among students (Rajammal, 2003; Anbuchlevi, 2014; Joshua, 2015, Budiharti and Waras, 2018; Suastra and Ristiati, 2019; Dewi *et al.* 2020). Hence, it can be integrated into the school curriculum for better output in terms of raising scientific temper. Along with that, bringing awareness among parents and providing proper training to teachers for imparting scientific temper among school children should also be taken care of. Due steps by the government should also be taken to prepare policies to improve scientific temper in the society by discouraging blind beliefs and taboos.

Specific programmes need to be launched in society and schools for this purpose. There is also a need to promote the quality of facilities in the schools along with the educational technological resources. All these efforts may help to bring changes in the present scenario to cultivate more scientific temper among the future citizens.

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