Appendix I

Scientific Temper Scale

Aditi Pandey (Researcher)
Prof Ashutosh Biswal (Guide)
Department of Education (CASE, IASE, IUCTE)
The Maharaja Sayajirao University of Baroda

Please fill the following information:

Name -……..…….**Age -**……..

Class -……...**Gender -**……

School name -……..

INSTRUCTIONS

This is a scientific temper scale. In this, some situations are given below which are related to your daily life and the probable responses you will perform in that particular situation under option a, b, c, d, e. Read each statement carefully and mark your response in a separate sheet provided with this booklet. Do not mark anything on the question booklet. After reading the question record the selected option in a separate sheet provided to you with this booklet. There are no right or wrong answers so record only that response which suits you the most or what you will do in that situation. There is no time limit to complete it but you are requested to fill it as fast as possible. All your responses will be kept confidential.

1) On WhatsApp, your friend had shared a message on the availability of artificial cabbages in the local market as a vegetable. Which of the given actions is best suitable for you?
    a) I will share the message with others without knowing the reality about it
    b) It might be true as it is shared by many people
    c) I will believe it but will have with little doubt in my heart
    d) I will see the possibility of it being true by talking to my elders
    e) I will consider the message after verifying the genuineness from the proper authority

2) You saw a TV interview wherein an astrologer tells that the earth is going to destroy after 20 years. What will be your reaction to this from the following?
    a) I will find this news as a threat to future
    b) It may be possible in the future so I will partially believe in it
    c) I will think to believe the news by collecting some more evidence
    d) I will be surprised by such news and will try to find the source of the news

e) I will critically see the logic given for such news and relate with the other sources.

3) You are sick and are being treated by some qualified doctors. One of your friends suggested to you about some miraculous home remedies as a cure for your illness. What will you do from the following?
   a) I will stop taking the prescribed medicine and start using that home remedy
   b) I will take the home remedy along with the prescribed medicine
   c) I will question my friend about its usefulness and will use it if I get satisfied by his/her claim
   d) I will use it along with my regular medicine taking suggestions from some experts
   e) I will cross check the usefulness of the home remedy thoroughly and will use it if needed

4) Your friend told you about a healing stone given by a spiritual guru that heals general illness. What will you think?
   a) I will believe in it
   b) I will ask if it really works or not and then use it
   c) I do not believe in such things but sometimes it works
   d) I will doubt on its healing power
   e) I will find it funny and doubt its existence

5) As a monitor, you were asked to choose five members from your class as a cleanliness monitoring team. How will you select them?
   a) I will select from my friends first if they are interested as I know they will do better
   b) I will ask who are interested and then choose from them
   c) I will select the members by chit method from the class
   d) I will select the people having abilities with whom I can work easily
   e) I will select those having capabilities along with the attitude, to do the task

6) You are doing a science experiment but getting unexpected findings while the rest of the friends are getting the expected result. What will you do in such a situation?
   a) I will do little change so that I can get required findings
   b) I will adopt some other methods of an experiment to get anyhow the expected findings
   c) I will report whatever findings are coming
   d) I will check the findings again and report the finding whatever would come
   e) I will check the findings thoroughly with some other methods and will report the findings

7) 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?

a) I will choose my friend as I trust him/her more
b) I will try to choose the suitable candidate having some concern for my friend
c) I will go with the majority as they must have decided properly
d) I would consider the choice of the majority along with my thinking
e) I will select the most suitable person having clarity in my mind

8) 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?
   a) I will copy the report from a friend who has a good report
   b) I will see the observation table of others and will prepare a report in that pattern
   c) I will prepare the report based on a few changes in the observation
   d) I will not prepare the report and ask for a second trial
   e) I will prepare the report based on actual observation

9) One day while you were cutting nail in the evening, your friend told you that its inauspicious (*ashubh*) to cut nails after sunset. What will be your reaction?
   a) I agree with my friend and stop cutting my nail
   b) I will do it but then think that it may bring something bad
   c) I will be confused about what to do
   d) I will not do it as a respect to my friend
   e) I will do it as I do not believe in this and say sorry to him

10) You worked very hard to prepare a model in a competition. Some of your friends gave very critical comments on it. How will you react?
   a) I will remain quiet but will feel upset
   b) I will anyhow defend their comments
   c) I will feel unaffected as their comments don't matter to me
   d) I will accept a few comments only which I found are major
   e) I will consider all the comments wholeheartedly

11) Your teacher has given you a task to suggest measures to make your city clean. What will you do?
   a) I will give some basic suggestions which are general
   b) I will collect similar suggestions from different sources to prepare my own
   c) I will prepare my suggestions after a discussion with my friends
   d) Considering the major problems, I will make the suggestions
   e) I will prepare the suggestion after following a thorough study of the problems related to the issue

12) 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?
    a) I will solve the case by mutual agreement and will not report it to the principal
    b) I will report the principal making the complaints mild
    c) I will solve the matter with a mutual understanding and report the same to the principal
    d) I will report it to the principal with evidence and request to forgive my friend
    e) I will report it along with the actual evidence

13) There is online registration for some competition. Most of your friends have registered themselves online but you are unable to do it. What will you do?
    a) I think it's not possible for me so I will take my friends to help
    b) I will make the work done by someone else after a try
    c) I will take a few attempts to do it and then give it up if not done
    d) I will do it myself by taking the help of others
    e) I will keep on trying till I can't do it

14) You solved a mathematical question but you did not get the right answer. What will you do?
    a) I will leave it and solve some other question
    b) I will ask my friend to solve it for me and taught me
    c) I will ask my friend to find the error so that I can solve it
    d) I will try multiple times and will not give up until I get the right response
    e) I will try multiple times to get the right response otherwise, I will consult someone

15) 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?
    a) I will not appear in the examination
    b) I will appear the examination but I will not miss the holiday trip for that
    c) I will prepare for the examination during the holiday trip
    d) I will stay back and prepare for the examination but will feel sad for missing the trip
    e) I will happily stay back to appear for the examination

16) 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?
    a) I will look for the readymade summary and will write it
    b) I will prepare the summary by getting the overall idea of the book from someone
    c) I will read only the interesting parts of the book and will prepare the summary

d) I will try to read the book for the sake of reading and will somehow write the summary
e) I will do the work by reading the book thoroughly

17) 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 in school. What will be your reaction to this?
    a) S/he did the right thing otherwise it could have caused something bad
    b) It's better to take precaution as sometimes it really causes something bad
    c) There is nothing to react as it is a common practice among people
    d) One should think whether a cat as a living being should not cross the path
    e) It is a natural event and there is nothing much about it

18) There was no rain for a long period in a village. The villagers did a ritual (*yajna*) 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?
    a) It was due to the *Yajna*
    b) It might be due to *Yajna*
    c) It was due to the science of *Yajna* with the blessing of the rain god
    d) Fumes coming out from the *Yajna* might bring some changes in the climate that causes rain
    e) It was a coincidence

19) 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?
    a) I will not go for it as I know that I am not so lucky
    b) I will go for it to try my luck
    c) I will take it in the name of someone in my family who is considered to be lucky
    d) I will take it because it is free
    e) I will go for it as I have a chance (probability) to win it

20) 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 the goddess. What do you think about it?
    a) S/he is right It is due to the power of the goddess
    b) It may be due to the blessings of the goddess
    c) I think, It is a coincidence that the flame and the goddess are at the same place
    d) It is a more natural event and less magical
    e) It is due to some natural phenomena which are unknown to us

21) Bermuda triangle is an area in the Atlantic Ocean where everything including planes and ships gets disappears. What do you think about it?

a) It is an unexplained event as no one has been able to find the reason behind it
b) It may be the door to some unknown world
c) The phenomena are beyond my thinking
d) It might be due to some heavy geomagnetic forces
e) One day definitely this mystery will be resolved through science

22) 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?
a) I don't feel like knowing about it
b) I will try to discuss it with my friends to get their views
c) I will try to get the basic information about it
d) I will know more about it and how they come to this decision
e) I will know more about it through various sources

23) 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?
a) I will just enjoy seeing the machines and it is fun to operate it
b) I will discuss with my friends about machines shown there and its working
c) I will write down my observation and later on seek for the information
d) I will ask a few questions and enjoy the visit
e) I will put forward all my doubts to the resource person there only

24) 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?
a) I will just pretend like listening
b) I will listen to it superficially
c) I will try to listen to it carefully
d) I will listen to it very carefully having an attitude to learn
e) I will listen very carefully and also clear my doubts by asking questions

25) 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?
a) I will stick to my opinion and conclusion and defend it anyhow
b) I will agree to their suggestion in front of them but will not do any change
c) I will revise only a few of the opinions and conclusions based on their suggestions
d) I will revise my opinion and conclusions according to their suggestions
e) I will thoroughly analyze their suggestions and accordingly revise my opinion and conclusions

26) In a group activity of your class, you are paired with someone who is not very close to you. What will you do?
    a) I will see the chances if I can exchange the person with someone on common agreement
    b) I will do the activity by showing little resistance
    c) I will try to do the activity by pushing myself harder
    d) I will somehow try to complete the activity
    e) I will adjust and enjoy completing the activity

27) You have given a chance to prepare a team from your classmates for Kabaddi. What will you do?
    a) I will select only boys as they are physically stronger
    b) I will try to select from my friends as I am more comfortable with them
    c) I will select only from the interested persons
    d) I will give a chance only to players having the best abilities
    e) I will give a chance to all having the best abilities

28) 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?
    a) I will find the judgment partial as my logo was best and appreciated by everyone
    b) I will feel sad and think it is my bad luck
    c) I will accept it but will feel very sad and disappointed
    d) I will be happy as my logo was appreciated by everyone
    e) I will accept it entirely because the logo that got the first position must be better than mine

29) You have got a chance to observe different varieties of birds in a zoo. How will you enjoy it?
    a) I will like to see this much varieties of different birds
    b) I will feel amazed to see how they differ from each other
    c) I will notice the differences among birds based on outer appearances
    d) I will try to understand the differences among birds
    e) I will note down the minute differences among different birds

30) Your teacher has asked you to find the similarities between a tree and a car. What will be your thinking?
    a) There is no similarity between a tree and a car
    b) It is easy to find similarities than the differences
    c) There may be similarities between the two which I cannot think of
    d) I will try to find a few similarities between the two
    e) I will find as many similarities as possible between the two

31) You have gone to visit a botanical garden. What will you do?
    a. I will enjoy being there with the plants
    b. I will try to identify the plants I know already
    c. I will observe the plants I know in detail
    d. I will see each plant in detail and relate it with my knowledge about plants
    e. I will see each plant in detail and try to understand the differences

32) You have been given a task to see a film for ten minutes and then write a note on it. What will you do?
    a) I will enjoy watching the film without thinking much about the task
    b) I will appreciate the positive points of the film
    c) I will find the points to criticize pass judgement on the film
    d) I will find the points which need to be corrected
    e) I will consider both positive and negative points

Scoring Sheet

1	a	b	c	d	e	22	a	b	c	d	e
2	a	b	c	d	e	23	a	b	c	d	e
3	a	b	c	d	e	24	a	b	c	d	e
4	a	b	c	d	e	25	a	b	c	d	e
5	a	b	c	d	e	26	a	b	c	d	e
6	a	b	c	d	e	27	a	b	c	d	e
7	a	b	c	d	e	28	a	b	c	d	e
8	a	b	c	d	e	29	a	b	c	d	e
9	a	b	c	d	e	30	a	b	c	d	e
10	a	b	c	d	e	31	a	b	c	d	e
11	a	b	c	d	e	32	a	b	c	d	e
12	a	b	c	d	e						
13	a	b	c	d	e						
14	a	b	c	d	e						
15	a	b	c	d	e						
16	a	b	c	d	e						
17	a	b	c	d	e						
18	a	b	c	d	e						
19	a	b	c	d	e						
20	a	b	c	d	e						
21	a	b	c	d	e						

Name –……

Gender –……

Class –……

School –……

Appendix II

Reaction Scale

Dear Students,

This is a scale to know your reaction about your present teaching-learning in the subjects of Science, Social Science and Mathematics. This scale consists of 30 statements. Please read each statement thoroughly and give your degree of liking or disliking in the form of five alternatives viz. Strongly Agree (SA), Agree (A), Undecided (UD), Disagree (D) and Strongly Disagree (SD) by putting a tick mark in one of the column. Your truthfulness in answering to the statements would be valued and your cooperation will be highly appreciated. Your reaction will be kept confidential and only be used for research purpose.

Thanking You,

(Researcher)

Name…… Class……School……

Father's occupation……..

Mother's occupation……..

Number of siblings……

S.No.	Statement	SA	A	UD	D	SD
1	Teaching was interesting in this approach					
2	I understood the concepts taught in Science, Mathematics and Social Science					
3	All the activities were exciting					
4	I liked to participate in all the activities					
5	I found the content appropriate in all the subjects					
6	The teaching aid used were interesting					
7	Instructions given during the classes were clear					
8	Teacher was cooperative throughout the teaching					
9	Teaching was connected to the real life situation					
10	Questions asked during the presentations were interesting					
11	Questions asked during the presentations were thought provoking					
12	It helped me to think critically					
13	It helped me to ask question without fear					
14	It helped me to be logical in my thinking					
15	It aware me about various superstitious beliefs and its reasons					
16	It helped me to take decision without any biasness					
17	It has provided me the scope to express in alternative modes like drawing, flowchart, timeline etc.					
18	It doesn't affect negatively in completing the syllabus					
19	I would love to learn through this approach in future classes					
20	It developed my interest towards learning different subjects					
21	Learning through Power Point Presentation and videos of different subject was interesting to us					
22	It helped me to expand my learning out of the classroom and textbook					
23	I came to know about some interesting facts about nature and society					
24	We were encouraged to participate in each and every activity in the class.					
25	I liked the present classroom environment					
26	Enough time for discussion was provided					
27	Concept mapping, time line and flowchart making helped us to remember difficult things easily					
28	It has helped me to become more aware towards various events happening around me					
29	It helped me to increase my confidence level					
30	I realized the importance of scientific temper in our daily life					

Appendix III

SAMPLE LESSON PLAN - 1

SCIENCE - ATOM AND MOLECULES

PRIMARY INFORMATION:

Name of the Teacher	Aditi Pandey
Name of the school	Experimental English medium school
Class	IX
Subject	Science
Chapter name	Atom and Molecules
Topic	Law of chemical combination and Dalton's atomic theory.
Date	23/11/19
Entry Behaviour	Students have prior knowledge about basic knowledge of matter and its components.
General Objective	1. Students will be able to develop observation. 2. Student will be able develop freedom from superstition. 3. Students will be able develop objective intellectual honesty. 4. Students will be able to think critically and logically.
Method	1. Lecture cum demonstration 2. Question Answer method 3. Discussion method
Media	Projector Power point Presentation balloon, duster and water bottle
Approach	Integrated approach

INTRODUCTION:

Teacher: Teacher will start the class by showing the different forms of matter (air in balloon, duster and water in a bottle) and asking what is the basic component which gives shape, volume and density to these matters.

Students: students will answer the questions asked and will say that molecules are responsible for it.

Teacher: teacher will give basic information about atom and declare that today we will learn about atoms and molecules.

PRESENTATION:

Teaching points	**Specific objectives**	**Teacher's activity**	**Students' expected activities**	**Evaluation**	**Media**
• Law of chemical combination and Dalton's atomic theory.	• Students will be able to explain the importance of atoms in daily life. • Student will be able to explain the difference between law of conservation of mass and law of constant proportion. • Students will be able to	Teacher will start describing about historical aspects of atoms through PPT and then ask **few questions** like *How many things are made of atoms in your surroundings?* *If atom is the fundamental unit of universe then how has actually this earth or universe been originated?* *(here the component **freedom from***	Students will listen carefully and answer the question asked by the teacher.	• What is the difference between law of conservation of mass and law of constant proportion? • Give some example of each laws. • What is the importance of atom in daily life? • Explain the Dalton's atomic theory.	PowerPoint Presentation Video

	explain the Dalton's atomic theory. • *Students will be able to develop observation.* • *Student will be able develop skill of* ***freedom from superstition***. • *Students will be able develop skill of* ***objective intellectual*** **honesty**	***superstition*** *and* ***objective intellectual honesty*** *will develop in students when teacher will explain the origin of universe is nothing else but through the atom and the origin will be explained by showing pictures)* *If this is so then Is it likely that there are atoms in your body that have travelled from other side of the planets, solar system or universe?* *What would happen if atom doesn't exist?(****discussion*** *to realize the importance of atom will be performed) group of students will form and they will present their ideas after 5 minutes of discussion.* Teacher will show the experiment of law of	Students will present their ideas. Students will draw some points from observing the experiments shown		

		combination virtually and then derive the Dalton's theory by asking students *if you have to line down the points from the above observation what can you draw?* *(here the component **Observatio**n will develop in students)*	and description of atoms.		

RECAPITULATION: Brief points of Law of chemical combination and Dalton's atomic theory were present through PPT.

HOME ASSIGNMENT: Find the possibility of splitting of an atom in future is possible or not?

Appendix IV

SAMPLE LESSON PLAN - 2

MATHEMATICS - QUADRILATERAL

PRIMARY INFORMATION:

Name of the Teacher	Aditi Pandey
Name of the school	Experimental English medium school
Class	IX
Subject	Mathematics
Chapter name	Quadrilateral
Topic	Concepts of Quadrilateral
Date	16/01/2020
Entry Behaviour	Students have prior knowledge about basic knowledge of Triangles and basic knowledge of polygons.
General Objective	1. Students will be able to develop Healthy Scepticism. 2. Student will be able develop Rationality 3. Students will be able develop Perseverance. 4. Students will be able to develop Observation.
Method	1. Question Answer method 2. Discussion method 3. Concept map

Media	Projector Power point Presentation Paper cut outs
Approach	Integrated approach

INTRODUCTION:

Teacher: Teacher will start the class by showing some dots on the blackboard and tell students to from shapes as many as they can draw with those points.

Students: they will form the shapes.

Teacher: teacher will ask them to categorise those shapes.

Students: they will categorise it.

Teacher: teacher will ask one by one names of each shape and what they group it belongs to?

Students: they will answer the question

Teacher: why the four dots' shapes are called quadrilateral?

Students: Because it has four lines.

Teacher: Right so today we will learn more about this form and its concept.

PRESENTATION:

Teaching points	**Specific objectives**	**Teacher's activity**	**Students' expected activities**	**Evaluation**	**Media**
Definition of Quadrilateral	Students will be able to define the quadrilateral. *Students will develop Observation skill.*	Teacher will explain the concept of quadrilaterals in detail with the help of PPT and ask studies to list down the shapes in the surrounding which has quadrilateral shape. (Observation)	Students will list down the names	What is quadrilateral?	Power Point Presentation
Angle Sum Property of a Quadrilateral	Students will be able to explain the angle sum property. *Students will develop Healthy Scepticism skill.* *Students will develop rationality.*	Teacher will use question answer method to explain this concept. Teacher will show two triangle shapes to the students and ask what is the sum total of this shape.	Students will respond to the question asked. Student will respond to the question asked.	Explain the angle sum property of Quadrilateral.	Video

		Teacher will join both the shapes and ask students again that what shape does it form? and now what is the sum total of angles? Teacher will deliberately say the wrong sum total and tell students to find out the answer what it is and how did they arrive to the answer? Teacher will show these two shapes joint to form a quadrilateral and form 360 degree by demonstration with 3D shapes in video presentation. *(As a result of doing task by their own self and doing experiment*	Students will do the task in their notebook and respond		

		students will develop ***Healthy Scpeticism*** *and* ***Rationalty****)*			

RECAPITULATION: The concepts were recapitulated verbally.

HOME ASSIGNMENT: List down the importance of quadrilateral shapes in construction and development.

Appendix V

SAMPLE LESSON PLAN - 3

SOCIAL SCIENCE - MOVEMENT TOWARDS INDEPENDENCE

PRIMARY INFORMATION:

Name of the Teacher	Aditi Pandey
Name of the school	Experimental English medium school
Class	IX
Subject	Social Science
Chapter name	Movement towards Independence
Topic	Freedom movements from 1920-1931 and Dandi March
Date	09/12/2019
Entry Behaviour	Students have prior knowledge about basic knowledge major movements happened for India's independence.
General Objective	1. Students will be able to develop Open Mindedness. 2. Students will be able develop Perseverance. 3. Students will be able to develop Observation.
Method	1. Use of Media (Video, PPT) 2. Story telling 3. Question Answer method 4. Discussion method

Media	Projector Power point Presentation
Approach	Integrated approach

INTRODUCTION:

Teacher: Teacher will start the class by showing some pictures of freedom fighters and ask students what is common is all pictures.

Students: they will respond to the question.

Teacher: Teacher will ask students to tell their contribution in freedom struggle movements.

Students: Students will respond.

Teacher: Teacher will ask students about various movements to line down.

Students: Students will face little difficulty in answering

Teacher: Teacher will declare that today we will learn about the different movements of freedom struggle.

PRESENTATION:

Teaching points	**Specific objectives**	**Teacher's activity**	**Students' expected activities**	**Evaluation**	**Media**
Freedom movements from 1920-1931	Students will be able to list down names of freedom movements from 1920-1930.	Teacher will tell the freedom movements from 1920 to 1930 in brief through the power point	Students will listen to it carefully.	List down the freedom movements from 1920 -1930.	Power Point Presentation

Dandi March Movement	Students will develop observation skill. Students will be able to explain Dandi March. Students will develop Perseverance skill. Students will develop Open Mindedness.	presentation. *(Observation)* Teacher will explain the the struggle of Gandhi ji in Dandi march in detail through story. (*while explaining Dandi march emphasis was given that all type of people were there in the march irrespective of caste and creed and besides all the hurdles they made it through, Open mindedness, Perseverance)* Teacher will ask few questions on the basis of story and discussion will take place about the failure of various movements.	Students will listen to it attentively. Student will respond to the question asked and will take part in discussion	Describe the Dandi March Movement.	Video

RECAPITULATION: The concepts were recapitulated through a story method.

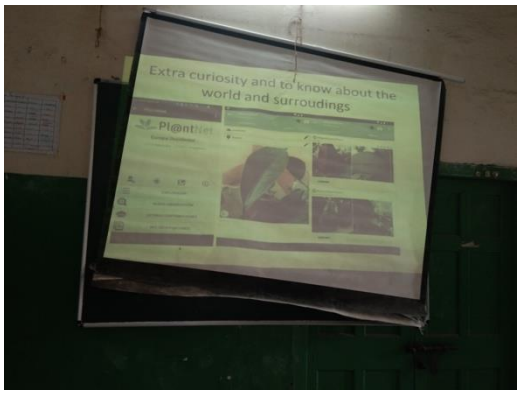
HOME ASSIGNMENT: Write a brief note on what could be the other ways to get the freedom

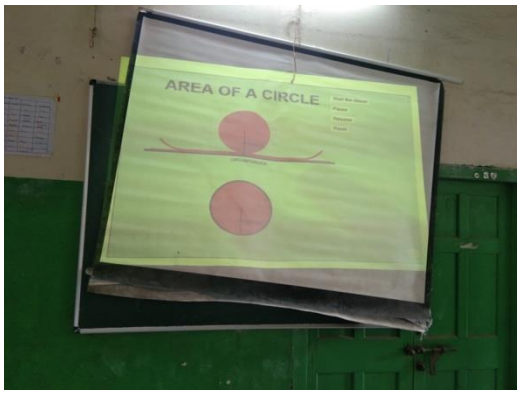
Appendix VI

Photographs of Experiment

Pre-test post-test

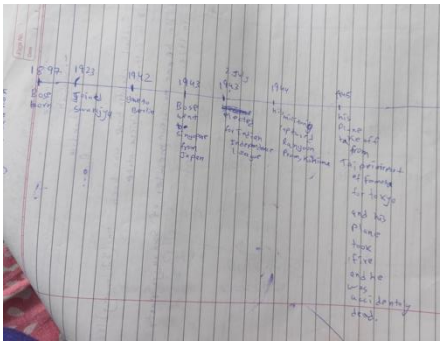
ICT enabled learning

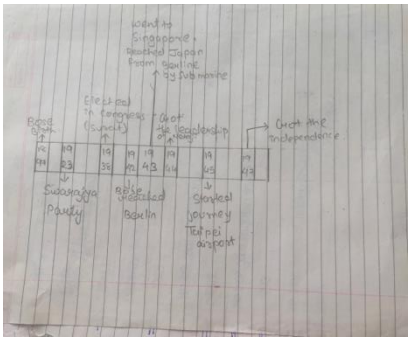




Story Telling

Timeline





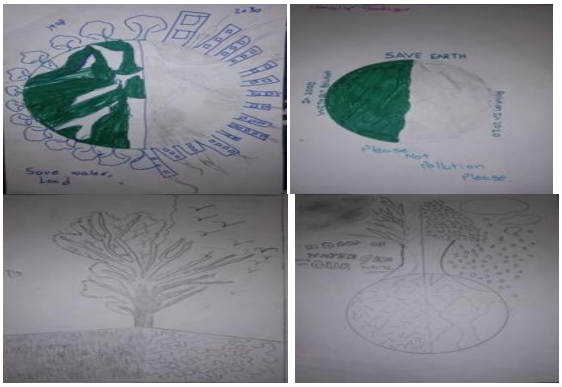
Debate

News/Movie Analysis

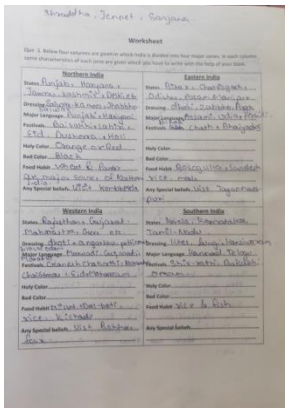
Discussion

Role Play

Drawing



Worksheet



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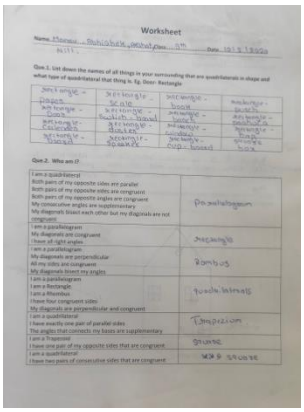

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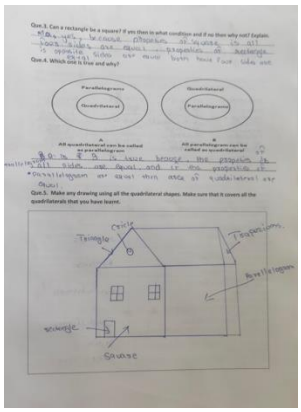

APPENDIX VII
RESEARCH PAPER PUBLISHED

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ARTICLE

Scientific Temper among Secondary School Students

[1]PROF. ASHUTOSH BISWAL [2]ADITI PANDEY

Department of Education (CASE)
The Maharaja Sayajiro University of Baroda, Vadodara, Gujarat
Email: [1]ab9825668982@gmail.com, [2]aditipandeymsu@gmail.com

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:

H_{01}: There is no significant difference in mean score of Healthy Skepticism of scientific temper between secondary school boys and girls students.

H_{02}: There is no significant difference in mean score of Objective Intellectual honesty of scientific temper between secondary school boys and girls students.

H_{03}: There is no significant difference in mean score of Rationality of scientific temper between secondary school boys and girls students.

H_{04}: There is no significant difference in mean score of Perseverance of scientific temper between secondary school boys and girls students.

H_{05}: There is no significant difference in mean score of Freedom from Superstition of scientific temper between secondary school boys and girls students.

H_{06}: There is no significant difference in mean score of Curiosity of scientific temper between secondary school boys and girls students.

H_{07}: There is no significant difference in mean score of Open-mindedness of scientific temper between secondary school boys and girls students.

H_{08}: There is no significant difference in mean score of Observation of scientific temper between secondary school boys and girls students.

H_{09}: 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 (*ashubh*) 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 (*yajna*) 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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