DEVELOPMENT OF STRATEGIES TO ENHANCE SCIENTIFIC TEMPER AMONG SECONDARY SCHOOL STUDENTS

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A SYNOPSIS OF THE THESIS

INTRODUCTION

Education is an essential aspect of a person's life. It not only aids in the acquisition of knowledge, but also incepts curiosity in the human beings. A human mind is a curious mind- from discovery of fire to discovery of Artificial Intelligence, curiosity has always helped in pivoting our lives for a better tomorrow. It is this curiosity that has aided the birth and progress of science; the era of science and technology began. In the modern world, science has radically changed men's material environment. It has led to material and non-material development. The development of science and technology has fostered a new intellectual temper known as Scientific Temper. Scientific temper is one of the abilities which helps human beings in rational and logical thinking by following the scientific method and makes an individual scientifically literate. Scientific temper not only helps in searching the truth but is an integral part of one's overall thinking and action. It generally means to accept the truth in its real form without subjecting it to any kind of influence (Kaur and Vadhera, 2018). It is the mostimportant factor in the nation's growth this is the reason that Pt. Jawahar Lal Nehru in 1946 has introduced this term in India and put forth all the efforts in this verydirection. He has quoted well the importance of science and scientific temper in the following lines – "*It is Science alone that can solve the problems of hunger and poverty, of in sanitation and illiteracy, of superstition and deadening custom andtradition, of vast resources running to waste, of a rich country inhabited by starving people"*. Scientific Temper is something that follows the scientific method in its investigation of truth which majorly include observation followed by experiment and then analysis of findings for its verification. Various educationists and scholars have defined scientific temper in various ways from time to time (Pattnaik, 1986; Kalbag, 1991; Hemlata, 1988; Krishnan and Bhuvaneshwari, 1990; The Seventh Five Year Plan, 1985-90; Singh, 1998; Kaur and Vadhera, 2018; Draft Scientific Social Responsibility Policy, 2019). The conclusion of all the definition imply that scientific temper is an individual's ability to use the scientific method as an important part of their thinking process in all the day-to-day activities. It is usually an affective construct and has a direct or indirect linkage to one's personality (Kaur and Vadhera, 2018). Based on related reviews and analysing the nature and definitions of scientific temper, the researcher had identified a total of 8 components which are Healthy Scepticism, Objective Intellectual Honesty, Rationality, Perseverance, Freedom from superstition, Curiosity, Open-Mindedness, Observation of scientific temper. These all

components are interconnected and they cannot be perceived in isolated terms. They constitute a cohesive, interrelated, and well-integrated whole.

Pt. Jawaharlal Nehru had introduced the term scientific temper in his much-acclaimed book named Discovery of India in 1946. Although Bertrand Russell in 1923 in his book On education had mentioned it for the very first time as one of the major aims of education. Even the Indian civilisation has been known for its scientific advancement in the world from ancient times. Nobel Laureate Prof. Amartya Sen's book The Argumentative Indian also mentioned this very fact by mentioning that scientific temper has been the hallmark of Indian thoughts since long (Sen,2006). The very first policy catering to this very notion called the scientific resolution policy was launched in 1958. Realising and witnessing its advantagesin 1976, India became the first country to include in its Constitution 'ScientificTemper spirit of inquiry and reform [Article 51-A (h)]. Four years later, in July 1981 at the Nehru centre Bombay the statement of scientific temper was released. This document articulated the need to inculcate the values of Scientific Temper in the Indian Society to rid the country of its socio-economic ills at that time. The Statement had invoked a lot of criticism in the certain circle of academia (Prasad, 1982; Chadha, 2005). In 2011, an attempt was again made to revisit the 1981 Statement of ScientificTemper named Scientific Temper Statement Revisited 2011: The Palampur Declaration'. It recognised that the Scientific Temper remained largely confined to rhetorical statements. Sadly even social scientists did not make an effort to refine this concept or operationalise the concept for measuring/gauging Scientific Temper. All the policies after independence Viz. University Education Commission (1948-49), Secondary Education Commission (1952-53), Education Commission (1964-66), Science and Technology Policy 2003 and 2013 and National Education Policy (2020) have identified the importance of scientific temper. NEP 2020 has identified it as one of the most important 21st century skill. …

It is said that we are living in the age of scientific advancement and the technological era. However, calling this age a scientific age just on the basis of the bulk of scientific information gained will be a mistake. When folks with a scientific temperament can address and solve society's problems, age can be considered scientific. (Jahagirdar, N.A.). It is witnessed time and again that India fails to show the characteristics of scientific temperament and easily falls into the trap of believing in godman, magical beliefs, superstition-related activities. This makes us think that besides all these advancements and development India has yet to reach Nehru's desired scientific temper. (Mahanti, 2016). Along with these problems of rising misinformation and fake news is also one of the key factors why there is a need for the resurgence of scientific temper. Akbar and Pal (2020) found that there was a sudden expansion of misinformation

during this Pandemic in India and false claims that affected people emotionally also increased greatly. These are all issues that, in the long term, impair the country's scientific and technical base and function as a major impediment to the development of scientific temper.

There are many hurdles on the way of developing scientific temper like multiple religious beliefs, fight with religion and sprituality, rising intellectual design movement etc. but it is the duty of citizen and policy makers to save this very temper and ensure ist developemtn in the young generation for proper growth of nation. The secondary education stage is the most critical stage as the students start tot think in an abstract term in this stage of life. Secondary education strives to develop the intellectual, social, and moral traits necessary for democratic citizenship, as well as to prepare young people for job or further study (Secondary Education Commission Report, 1952; Report of Education Commission, 1964-66). The attribute of scientific temper shows children's inherent proclivities, but as they grow older, the usefulness of this feature tends to wane due to ongoing shaping through school science, which has been the major vehicle for spreading NOS (Nature of Science) beliefs (Kaur and Vadhera, 2018). Hence it is Teachers responsibilty to ensure that the innate inquisitiveness nad critical mindset is not hampered due to any cause.

Usually, scientific temper is considered to be developed through science and Mathematics subjects but even another subject has the potential to inculcate this very domain in an individual. The same is suggested by the Kothari commission (1964-66) and Statement of scientific temper (1981) which said that scientific temper can be developed not only through science but social science as well. Even University Education Commission (1949) has considered language as the most powerful tool for imparting scientific thinking. NCF 2005 has also emphasized the nature of Social Sciences and said that the social sciences, like the natural and physical sciences, offer themselves to scientific inquiry. Hence in the present study researcher has taken all three subjects to develop a scientific temper.

SCIENCE AND SCIENTIFIC METHOD

Science and technological advances have had profound effects on human life. The name science is derived from the Latin word Scientia, which means "knowledge." After 1300 AD, science became widely used in the western world, and it was largely understood as information gained through study, but it also included the study of art. (Sarukkai, 2012). "Science as its name implies, is primarily knowledge, by convention, it is knowledge of a certain kind, the kind, namely, which seeks general laws connecting a number of peculiar facts" (Russell, 1954).

The age of scientific revolution actually started in the 19th century with the discovery of Galileo who proposed that it is not the sun that revolves around the earth but its earth that revolves around the sun and the sun is at the centre, not the earth. It was an earlier part of the natural philosophy but with time the method involved in it also got evolved and it had adopted a more robust, strong, and refined approach to finding the solution to a problem. This very method of arriving at the solution is known as the scientific method. The whole essence of science lies in this very aspect of it. Dhar (2009) had proposed five steps in the scientific method which are Observation, hypothesis, predictions, Verifying and Modification. Carey (2011) has proposed three-step processes involved in the scientific method which are Observing, Proposing Explanation, and testing Explanation. Narlikar (2003) had said that scientific investigation consists of three steps: "experiment (E), observation (O), and deduction (D)". These all steps are interconnected with each other irrespective of the order they are taking place. This very method forms the foundation of scientific temper.

MEANING AND DEFINITIONS OF SCIENTIFIC TEMPER

The term Scientific Temper is made of two words - "Scientific" and "Temper". According to Merriam-webster dictionary scientific means " relating to or exhibiting the methods or principles of Science; conducted in the manner of Science or according to results of an investigation by Science**:** practicing or using thorough or systematic methods". While the term temper is a cast of mind or state of feeling, high quality of mind or spirit, and usually refers to making something stronger and more resilient through hardship. It is something that defines and animates a state of being;it characterizes and channels human actions (Bardapurkar, 2020). Various educationists and scholars have defined scientific temper in various ways from time to time. Some of the definitions of Scientific Temper are as follows:

Pattnaik (1986) defined "scientific temper as the making of the basic methods, values, and norms of Science along with humanism as a process of thought and action".

Kalbag (1991) described "scientific temper involves refining the natural processof thinking by inculcating certain habits and skills. These are to sharpen our observations, acquire a habit of quantification of our information, practice of recording of all relevant data in a systematic way, organise the information to recognise any patterns; think about why and how those patterns arise; make a hypothesis that is think of a possible explanation for the observed phenomena; and finally verify whether the explanation holds good in other similar situations".

Krishnan and Bhuvaneshwari (1990) defined "scientific temper as one′s reactions inhis/her life situations as practice of seeing cause and effect relationship appreciation of utility of science in daily life functions, adventurousness, experimental bent, intellectual honesty, objectivity, open mindedness challenging blind faith and receptivity to change".

The Seventh Five Year Plan (1985-90) document of the planning commission defines "scientific temper as an attribute of the human mind and of the social decision- making process than mere knowledge about things which are scientific. It is more related to the method of science than to the content of science".

Draft Scientific Social Responsibility Policy (2019) defined "scientific temper as an approach to human and social existence that rejects dogma or assertion, that contradicts empirical evidence or lacks a scientific basis, that habitually questions everything, that privileges logic and rationality, and is consistently self-critical".

In this way, after analysing these definitions it can be said about the term 'scientific temper' means an individual's ability to use the scientific method in thinking analytically and rationally about all the day-to-day activities. Although it does not mean using advanced scientific techniques which are used by scientists, to demonstrate easy phenomena or to use sophisticated mathematical reasoning in coming to any conclusions. As stated by Pattnaik (1986) in his definitions it is an affective domain that helps in developing values. These values are the product ofrational and logical thinking in a healthy sceptical way which eventually makes a person more humanistic in approach and raise him/her above all the discrimination with respect to religion, caste and creed. In short, it helps in the development of humanistic values in the individual with a scientific, rational, and logical approach. Scientific temper is a way of life that uses a scientific attitude to solve any problem. Scientific temper is not like any other human emotion which is temporary but it is a disposition of mind which once developed remains permanent in the personality of an individual. It is a mixture of excitement, unpolluted, and uncorruptible zeal for seeking the truth, despite the fact that the genuine truth is out of grasp. The scientific temperament is concerned with what one sees, hears, and feels in the real world, or with intellectually pursuing the truth in the real world. It's generally an affective construct that deals with emotion and has a direct or indirect relationship to one's personality. (Kaur & Vadhera, 2018)

COMPONENTS OF SCIENTIFIC TEMPER

Scientific temper is something that calls for a scientific attitude and a scientific approach. Based on related reviews and analysing the nature and definitions of scientific temper, the researcher had identified a total of 8 components of scientific temper. The descriptions of each of these components are given below with the behaviours which will be reflected in the person possessing that particular component of scientific temper:

Healthy Scepticism

- One does not accept others' assertions unless those are logical, rational, and supported by proper evidence
- One sees everything with the critical mindset
- One believes in redoing the experiments by own self and determine whether the evidence is trustworthy
- One questions everything for its trustworthiness

Objective Intellectual Honesty

- One judges fairly, without partiality or external influence by considering all pros and cons
- One does not purposefully omit the relevant facts and information even whenit contradicts one's own hypothesis
- One does not allow any modifications according to present social, economic orpolitical situations
- One's faith does not interfere with one′s pursuit of truth

Rationality

- One tends to test traditional beliefs
- One accepts the criticism wholeheartedly
- One follows the systematic and logical way of finding a solution to the problem.
- One removes all emotional components from the decision-making process andfocus solely on facts

Perseverance

- One does not believe in giving up things if there is a scope to complete it
- One pays attention to what's possible, which includes realising when towithdraw, let go or surrender
- One feels motivated to move forward with the plans even when it seems that itmight not be successful

- One′s Persistence and tenacity to do something and keep doing it till the end,even if it's hard

Freedom from superstition

- One rejects the superstitions and false beliefs
- One believes in cause and effect relationship
- One does not believe in good or bad luck
- One does not believe in magic or supernatural events

Curiosity

- One′s desire for understanding new things that are not explained
- One′s desire for completeness of knowledge
- One asks a lot of questions to seek answers
- One listens to things very carefully

Open-Mindedness

- One′s willingness to revise opinion and conclusions
- One′s approach towards all the things without pride and prejudices
- One rejects the singular and rigid approach to people, things and ideas.
- One recognises that there may be better ideas

Observation

- One tries to identify differences between similar objects or events
- One tries to identify similarities between different objects or event
- One is attentive in observing things
- One notices the odd one out

These all components are interconnected and they cannot be perceived in isolated terms. They constitute a cohesive, interrelated, and well-integrated whole. This very temper is not only helpful for an individual's growth but for a nation also it is considered as a prerequisite condition of development.

SCIENTIFIC TEMPER IN INDIA

Science and technology help tremendously in the development of any nation. This is the reason that Pt. Jawaharlal Nehru had introduced the term scientific temper in his much-acclaimed book named Discovery of India in 1946. He found that even this very temperament was lacking in the leaders of that time and wrote that "We live in a scientific age, so we are told, but there

is little evidence of this temper in the people anywhere or even in their leaders" (Nehru, 1946). While defining scientific temper he said that "The scientific approach and temper are, or should be, a way of life, a process of thinking, a method of acting and associating with our fellowmen" (Nehru, 1946). Although it's not that no one has talked about it earlier, Bertrand Russell in 1923 in his book On education had mentioned it for the very first time as one of the major aims of education. He said that on acting upon our beliefs we should be very conscious as a small error can also be hazardous and this very act needed an intellectual culture possessing the emotional entropy. He named this very entropy of judgment asscientific temper (Russell, 1923). Even the Indian civilisation has been known for its scientific advancement in the world from ancient times. From the Vedic times, argumentation and logical deduction were prevalent in Indian society. In his book The Argumentative Indian (2005), Nobel Laureate Prof. Amartya Sen also noted this characteristic, stating that scientific temper has always been a trademark of Indian philosophy (Sen, 2005). It refutes the notion that it is something that colonists bring. Raja Ram Mohan Roy's effort for abolishing social evils prevalent at that time like sati pratha, polygamy and child marriage, Ishwar Chandra Vidyasagar's effort to pass the widow remarriage act etc. are nothing but some live examples of scientific temper. In the recent past Nehru, Ambedkar, Prof. Yash Pal and others were the people who believed that the future belonged to those who had this scientific bent of mind. Modernism, according to Ambedkar, is dedicated to reason, rationality, scientific knowledge, and democracy (Sahoo, 2020).

The very first policy catering to this very notion called the scientific resolution policy was launched in 1958. Its main purpose was to instill a scientific temper in society. (Mahanti, 2013). In the development of the nation's socio-economic plan S&T plan was recognised as an integral part and led to the creation of the National commette on Science and Technology (NCST) in 1971. It brought out a National S&T Plan in 1974-1979 (Udagaokar, 1980). In 1976, India became the first country to add "Scientific Temper with Humanism" as a fundamental duty of all people in its Constitution, after realising and observing its benefits which states that "It shall be the duty of every citizen of India to develop the scientific temper, humanism and the spirit of inquiry and reform*."* [Article 51-A (h)].

At October 1980, a group of academicians and intellectuals met in Coonoor, near Ooty, for four days to discuss the condition of Scientific Temper in the country. P.N. Haksar, Raja Ramanna, and Dr. P.M. Haksar issued "the 1981 Statement of Scientific Temper" as a result of their discussions in July 1981 at the Nehru Centre in Bombay. This statement addressed the necessity to instill Scientific Temper ideals in Indian society in order to cure the country's

socio-economic issues at the time. The Statement had raised strong responses in the academic circle, while some appraised it, others opposed it (Prasad, 1982; Chadha, 2005). In 2011, an attempt was again made to revisit the 1981 Statement of ScientificTemper named Scientific Temper Statement Revisited 2011: The Palampur Declaration′. It recognised that the "Scientific Temper remained largely confined to rhetorical statements. Sadly even social scientists did not make an effort to refine this concept or operationalise the concept for measuring/gauging Scientific Temper".

Even the document Science Technology and Innovation Policy 2013 of the Government of India also by maintaining the vision of advancing scientific temper in all the citizens of India of Science and technology policy 2003, recognises the importance of scientific temper and included promotion of spreading the scientific temper among all the section of society as one of the key elements of the policy. Recently in December 2020 the draft of the Science, Technology and Innovation Policy 2020 was launched. It had suggested the improvement in science teaching, science communication and science pedagogy, for this entertainment platform, social media and NGOs will be involved at the national and local level. It also put forward the development of SSR (Social scientific responsibility) policy so that scientific temperament can develop in the masses to great extent.

IMPORTANCE OF SCIENTIFIC TEMPER

Scientific temper is something that helps us to think logically and rationally. This is the reason that one can judge things more clearly and bias-free holding on to their beliefs whatever they hold, the same is supported by the greatest philosopher Russell (1954) who said that the "scientific attitude is in some degree unnatural to man; the majorityof our opinions are wish-fulfillments, like dreams in the Freudian theory but Scientificmethod sweeps aside our wishes and endeavours to arrive at opinions in which wishesto play no part." In this way, scientific temper has a prominent role in building a good citizen of India. It is so important that it got mentioned in every policy and documentsabout education released after Independence. The recommendations by these various policies concerning scientific temper are listed below:

University Education Commission (1948-49): It was the first commission formed after independence. Recognizing the importance of scientific temper in a Nation's development, the commission stated that in the training of secondary school teachers the characteristics of scientific attitude should be given chief importance and how important it is for any nation. It

stated that “the scientific attitude, that is, the habit of free, critical inquiry, of looking into facts and causes, rather than credulous acceptance of rumour or tradition would put new life into India”. It further said that “it is a scientific attitude that makes a person ready for change while resistance to change is normally the attitude of defenders of tradition which is hostile to scientific progress.”

Secondary Education Commission (1952-53): It was formed under the chairmanship of Dr. A. L. Mudaliar. The commission didn’t mention the term scientific temper or related terms anywhere but it emphasized on making science subjects compulsory till middle school. It said by pointing out the importance of science that “it is desirable to formulate general science courses for the middle stage and pupils should be encouraged to explore every opportunity to develop the attitude of critical inquiry”. It also said that “science syllabus in the secondary school is not directed to the production of scientists. It aims to give a basic understanding and appreciation of scientific phenomena-biological and physical which may prepare the ‘non-scientists’ for a fuller and more complete life”.

Education Commission (1964-66): It was popularly known as the Kothari Commission appointed by the Government of India to get advice for the development of education at all levels. It emphasised the development of scientific temper as one of the important values for adapting democracy not only as a form of government but as away of life. It called for the integrated approach to school education. It recognized the importance of science in the national development and said "the quality of science teaching has also to be raised considerably to achieve its proper objectives and purposes, namely to promote an ever-deepening understanding of basic principles, to develop problem-solving, analytical skills, and the ability to apply them to the problems of the material environment and social living and to promote the spirit of inquiry and experimentation. Only then can a scientific outlook become part of our way of life and culture.” It also stated that “along with natural, if not to the same extent, social science can also be used to create a scientific outlook.”

National Education Policy (2020): The policy states that it will deal appropriately with the unfinished agendas of NPE, 1986 and the POA, 1992. It recognises scientific temper as the aim of education and states “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." It considers "scientific temper as needed skills,and capacities to be learned by all students to become good, successful, innovative, adaptable, and productive human beings in today's rapidly changing world." It says scientific temper as the most important value to be included in education and states that "Value-based education will include the development of humanistic, ethical, constitutional, and universal human values of truth (*satya*), righteous conduct (*dharma*), peace (*shanti*), love (*prem*), nonviolence (*ahimsa*), scientific temper, citizenship values, and also life-skills; lessons in service (*seva)* and participation in community service programs will be considered an integral part of a holisticeducation."

After seeing these documents it can be said that from independence due to its importance in nation building it has been given a prominent place in all these policy documents. It helps a lot in nation development.

NEED OF SCIENTIFIC TEMPER

It is said that we are living in the age of scientific advancement and the technological era. However, calling this age a scientific age just on the basis of the bulk of scientific information gained will be a mistake. When folks with a scientific temperament can address and solve society's problems, age can be considered scientific. (Jahagirdar, N.A.). It is witnessed time and again that India fails to show the characteristics of scientific temperament and easily falls into the trap of believing in godman, magical beliefs, superstition-related activities. This makes us think that besides all these advancements and development India has yet to reach Nehru's desired scientific temper. (Mahanti, 2016). The same has been quoted by Narlikar (2013) who said that "this term was written during the British Raj, today we live in a free India that is feeling its way towards economic prosperity. Yet we are still a long way away fromachieving that scientific outlook that Nehru considered so essential for our future well-being."

In the recent past also many such irrational beliefs have been witnessed. Like the news where a 12-yr-old girl forced to keep 'god given' dreadlocks for 3 years who was rescued by a Pune-based NGO to 'cuts off' this superstition (Hindustan Times, January 22, 2019) and the news of increasing Witchcraft hunting in Assam where since 2011, 107 were killed in suspect of witch-hunting (The Hindu, December 1, 2019). In another case, a33-year-old woman died of alleged torture by an Exorcist (Times of India, March 1,2021). Not only are these but many such cases are full of irrational beliefs and superstitions. This type of cripple mindedness and prejudices come only when one lacks the very characteristics of scientific temper as Bhargava and

Chakrabarti (2010) said that “if one were to pick out three or four most important reasons for the country's backwardness or failure in many areas, the lack of scientific temper would be one of them.” Mahanti (2013) likewise emphasises the necessity for a scientific temper with respect to India, he said that “the role of scientific temper cannot be overemphasized in a country like India, where myriad dogmas and superstitions compete for one's attention. A scientific temper is an invaluable tool for the common people engaged in sound decision-making not only about science but various issues of social importance.”

Not only these problems but problems of community clashes have also increased which clearly show the lack of a secular mind. “The notion of ‘secularism’ transmuted incontent and form in Europe over the past three centuries. However, it was always closely linked to the idea of scientific inquiry, scientific method, and scientific rationality” (Raza, 2015). In daily news, we can see such instances which give pieces of evidence of existing community conflict. Not only these hatred feelings but in the recent past, the murder of four rationalists and science communicators named Dr. Narendra Achyut Dabholkar (a rationalist, a communicator of science), Govind Pansare and his wife (anti-superstition activist), MM Kalburgi, and Gauri Lankesh (a female journalist) is a proof of the resistance to change and rejection of rational thinking (Raza and Singh, 2018). Along with these problems of rising misinformation and fake news is also one of the key factors why there is a need for the resurgence of scientific temper. Akbar and Pal (2020) found that there was a sudden expansion of misinformation during this Pandemic in India and false claims that affected people emotionally also increased greatly. These are all issues that, in the long term, impair the country's scientific and technical base and function as a major impediment to the development of scientific temper.

HURDLES IN THE DEVELOPMENT OF SCIENTIFIC TEMPER

In a country where superstitious beliefs, illiteracy are on the rise the development of scientific temper becomes a big task, and many hurdles came in its way. One of the biggest hurdles relating to the effective development of scientific temper is multiple religious beliefs. It is usually considered as incompatible with theological and metaphysical beliefs Singh, Dogra, and Singh (2016) although they both are different which should not be compared with each other. The nature of both things is different thus “true scientific temper does not have to make any conscious attempt to delink itself from anything. The delinking from religion is automatic as it is verifiable” (Singh and Singh, 2004). Even spirituality is considered as part of religion which makes the acceptance of scientific temper tougher as well. It is a mistake to mixreligion

and spirituality as they both are different. Its comparison with a scientific temper is even worse as they both have a different purpose and are needed equally in an adequate amount. Panchapakesan (2006) have emphasised that “there is no conflict between science and spirituality as they belong to different areas, either outer or inner the world” he said further that although this inner spiritual world is not part of science, the scientific method, i.e. logic and reasoning, plays an essential role here.

As we all know that one of the causes for less logical thinking in underdeveloped nations is a low level of literacy, which impedes the development of scientific temper. (Raghul, Majumdar, and Shukla, 2020). In such a condition the political responsibility increases. For the successful development of scientific temper in mass, political support is needed the most other than many other things. Although many provisions are there in our constitution and even from time to time it is well talked about by various political leaders but still it is seen that when it comes to implementation we lack the rigidity.As also suggested by Mahanti (2013) “the transition towards a society guided by the spirit of scientific inquiry will not be an easy task. It will not be achieved merely by making people simply aware of the concept. It will be achieved only through ademocratic political process.”

Other than this rising intellectual design movement is also one of the emergent issues on the way of developing scientific temper although in India it's in a lesser amount yet itneeds to be taken seriously. It is a movement that discards Darwin's theory of evolution. To handle in most cautiously it is required that a teacher while teaching in a class focuses specifically on the intelligent design movement's current problem provides an opportune "teachable moment." It should not be taught as a Darwinian alternative, as its proponents insist. Students may learn the most about the nature of science by carefully examining why intelligent design is not science (Alberts, 2005).

In this way it can be said that these are some of the hurdles of scientific temper which need to be overcome by the deliberate efforts by everyone.

SCIENTIFIC TEMPER AND SECONDARY SCHOOL STUDENTS

Students who are learning in classes IX and X are considered secondary school students. In this stage, students are in their early adolescence period. Between childhood and adolescence, there is a distinct period of human growth and development known as early adolescence. It is a key time in their lives for the formation of self-identity and other values. It's a time of rapid

bodily transformation and identity formation. As we all know that till reaching this age students start to think in an abstract andrational term. Dorthy Rogers defined it as “a process than a period, a process of achieving the attitude and beliefs needed for effective participation in society.” In the same line, Jean Piaget has defined it as “the age of great ideals and the beginning of theories as well as the time of simple adaptation to reality.” In this way, it can be said that it is the right time to inculcate scientific temper in them which can help make them rational human beings who can judge what is right or wrong, inquire the truth and reason out the basis for what is being followed or to be followed. During this time, the ability to reason abstractly, think logically, and have a critical awareness of oneself in connection to society grows.

Because of these characteristics of adolescents, Secondary education strives to develop the intellectual, social, and moral traits necessary for democratic citizenship, as well as to prepare young people for job or further study. (Secondary Education Commission Report, 1952; Report of Education Commission, 1964-66). It makes a better citizen for the future world as well. In our country, where a huge portion of the population is still mired in the bog of superstitions and obscurantist practises, instilling a scientific mindset among all residents, particularly among the children who will be the nation's future leaders, is critical. "But during the past 30 years, there has been a marked increase in a public display of religious and sectarian identities, the ascendance of irrational cults, and glorification of obscurantist practices, religiosity, and wielding of religious symbols. This has provided the ideological basis for, at times, brutal unscientific actions in both public and personal domains. Discrimination based on caste, gender, and ethnic identities, perpetuated based on irrational beliefs and superstitions are still widely prevalent, and are a blot on our society” (Scientific Temper Statement Revisited 2011: The Palampur Declaration). Three ladies commit suicide over a superstitious belief at Karapa village (TOI, 2017). A woman was lynched by a mob in Jharkhand on suspicion of involvement in braid-chopping (Hindustan Times, 2017). These are some of the examples of the unscientific prevailing in our society. Thus, the scientific age is riddled with intriguing contradictions and human-made follies.

The attribute of scientific temper shows children's inherent proclivities, but as they grow older, the usefulness of this feature tends to wane due to ongoing shaping through school science, which has been the major vehicle for spreading NOS (Nature of Science) beliefs (Kaur and Vadhera, 2018). While we all know that in secondary school students are at their stage where they have fully developed abstract reasoning ability so this is the best stage where the

right kind of stimulus can be given to them to think rationally and logically. Thus, it should be an effort of the teacher to not lose the inquisitiveness of a child and channel their logical and rational thinking by proper guidance. Even NCF (2005) has recommended as one of the aims of secondary education to develop Scientific Temper, generative thinking, and creativity among them. "Ideally, education is supposed to encourage the students to analyse and evaluate their experiences, to doubt, to question, to investigate—in other words, to be inquisitive and to think independently" (NCF, 2005). It is emphasized in Science and Technology Policy (STP-2003) also that "Every effort will be made to convey the young for the excitement in scientific and technological advances and to instill the scientific temper in the population at large". For the development of scientific temper and scientific creativity among the younger generation, as well as the promotion of culture and civilization in the right path, is now regarded a critical job in our New Education Policy 2020.

Because the world around us is changing so fast, we must provide our children with the skills, abilities, and temperament necessary to creatively address future life difficulties. It is very essential to develop scientific temper to cope up with the future world as in this ever-fast evolution we are gradually moving from mechanical to electrical then to electronic likewise we are moving with the unstoppable speed so the necessity of the scientific temper has become more important now than ever before. Whatever may be the discipline or future profession scientific temper is now the need of an hour. It is assumed that Science and Mathematics being more factual helped to inculcate the scientific temper. That is why general Science and general Mathematics are subjects in every school curriculum in India as developing logical and rational thinking in a short scientific temper is one of the aims of these subjects, but it is not bound to any particular subject only. It is not that only Science or Mathematics students can possess the scientific temper but it is a temperament of a free man (Nehru, 1946) and it can be possessed by everyone. Wadhawan (2013) opinioned that "the scientific method is not the exclusive possessionof scientists, even a moderately intelligent child can develop a scientific outlook on life if brought up in an atmosphere in which all types of questions are encouraged, andno idea is treated as unchallengeable or taboo. The scientific method of interpreting information is the crowning glory of the collective human intellect and is available to all of us for applying in our day-to-day lives." It is not bound or belong to particular group of people every person can have this ability to guide him/her in his/her life like in ancient time Raja Ram Mohan Roy, Ishwar Chandra Vidyasagar, SwamiVivekananda, Jiddu Krishnamurty, Prof. Yash Pal, Dr. A.P.J. Abdul Kalam and many more person has shown their scientific temperament by their

deeds and thoughts. It is a generic trait of personality that should be present in every human personality so there should be some attempt made to develop the scientific temper through school education that could be through curricular, co-curricular, or extra-curricular activities.

As studies have been conducted it is assumed that Science and Mathematics are subjects that are logical and can develop critical and rational thinking including scientific temper but the other researches have also been conducted whose result indicates that Social Science can also develop open-mindedness, rationality, and aversion to superstition dimension of scientific temper (Maqbool& Akbar 2013). In this way, it can be said that Social Sciences has also the scope to develop scientific temper like the Science and Mathematics subjects.

DEVELOPMENT OF SCIENTIFIC TEMPER THROUGH VARIOUS SUBJECTS

Usually, scientific temper is considered to be developed through science subjects. But if we see the introduction and evolution of science subject in the school curriculum in India it gives us a great idea on whether this is the truth or not. So in the year 1986, the National Policy on Education (NPE) was developed under which the document 'National Curriculum for Elementary and Secondary Education – A Frame-Work 28 (NCF - 88) was framed and published. Before this time science was part of 'Environmental Studies' at the primary stage. Later on, the guidelines of NCF-88 were further elaborated in a document titled 'Science Education for First Ten Years of Schooling - Guidelines for Upper Primary and Secondary Classes'. This was the time when the teaching of science was conceived for the first time as a single subject at the secondary stage was rather than three separate disciplines (Environmental Studies, science, and social studies), as had been the practice in the past.

In this way it can be conclude that even another subject has the potential to inculcate this very domain in anindividual. The same is suggested by the Kothari commission (1964-66) and Statement of scientific temper (1981) which said that scientific temper can be developed not only through science but social science as well. Even University Education Commission (1949) has considered language as the most powerful tool for imparting scientific thinking. NCF 2005 has also emphasized the nature of Social Sciences and said that the social sciences, like the natural and physical sciences, offer themselves to scientific inquiry. Not only these reports but many researchers have proposed arguments related to this Panchapakesan (2006) has suggested that developing a scientific temper is similar to learning values and is an element of social science, whereas science education has nothing to do with it. Yadav (2016) Suggested Science

and scientific temper are not synonyms. Beyond content delivery, rigorous efforts have to be put into the development of scientific temper. Other than these evidences if we also analyses the objectives of other subjects we can realise that social science and mathematics have very good potential to develop this very temper. Hence in the present study researcher has taken all three subjects to develop a scientific temper.

ROLE OF TEACHER IN DEVELOPING SCIENTIFIC TEMPER

Teachers play a key role in education and also in student's life. They have the responsibility to make future scientists, engineers, doctors, etc., and better citizens of the future world. No matter how many media and educational technologies are present but the teacher holds a central position in teaching-learning (NCF, 2005). We know that the world is changing rapidly with unstoppable speed and everyday new knowledge is evolving at one or the other part of the country. So as the teaching-learning process is also evolving thus teachers should use such teaching-learning processes which can stimulate students to think, question, and inquire about the world around them. Those days are gone when teaching and learning relied just on chalk and books stored in a library; today, everything is digitised, including retrieving, storing, and transmitting information. Little children are born with a scientific temperament. They are bright, impulsive, and pleasantly unrestrained when they first approach the school gates, as well as unselfconsciously transparent. They are full of whys and hows and are always ready with their comments and answers, but as children advance through elementary, middle, and high school, we successfully and steadily damage their inquisitive brains.

A teacher should see learning as a search for meaning in personal experience, and knowledge generation as a never-ending process of reflective learning. Knowledge should not be viewed as an external reality enshrined in textbooks, but rather as something built in the shared context of teaching-learning and personal experience (NCF, 2005). Hence a teacher should do all the effort in this direction and appropriatelyadapt the strategies for the teaching-learning process.

STRATEGIES FOR DEVELOPING SCIENTIFIC TEMPER

A strategy is a plan or programme that is widely utilised to guarantee that a certain message or lesson is communicated from the instructor to the students. A good strategy helps a teacher to create such an environment where the needed learning goals can be achieved to themaximum extent without any hurdles and problems. It not only caters the whatto be taught but also how the particular lesson has been taught. In this, the interest, need and developmental level of the student are well taken care of. It makes all the learning activities playful and enjoyable. From

the review of related literature, it was found that various studies have been done from time to time where different programs or activities are formed to get the best result in the development of scientific temper. Based on all the related review of literature the researcher had developed her own set of strategies to enhance scientific temper in the secondary students in the greatest possible manner by covering scientific temper's all the components (Dhar, 2009; Joshua, 2015; Raghul, Majumdar and Shukla, 2020). While forming the strategies not only teaching-learning but environmental, children's personal interests and many other factors were kept in mind. The formed strategies are ICT enabled learning, Socratic questioning, Debate, Discussion, Worksheet, Timeline, Analysis of movies/images/news, Concept map, Roleplay, drawing. The said strategies to enhance scientific temper were formed in an integrated approach with the three subjects viz. Science, Mathematics and Social Science among secondary school students.

REVIEW OF RELATED LITERATURE

Total **78** Studies have been reviewed for the present study. Out of these total 78 studies, **41** studies (Pattnaik, 1986; Singh, 1987; Dubey, 1992; Pradhan, 1996; Singh, 1998; Tripathi, 1999; Rajammal, 2003; Nadeem & Wani, 2005; Gupta, 2007; Nigam, 2007; Vyas, 2010; Bhatnagar, 2011; Nadeem & Ridwana, 2012; Plessis, 2013; Aezum and Wani, 2013; Aasia and Akbar, 2013; Mudasir and Yatu, 2013; Anbuchlevi, 2014; Bhatta, Netragaonkar, 2014; Maqbool, Mudasir and Zehta, 2014; Anand and Kumar, 2015; Joshua, 2015; Basu & Aslam, 2015; Andrabi, 2015; Kaur, 2015; Nagarathinam & Kumar, 2015; Bhat and Kapri, 2017; Bhat, 2017; Ridwana, 2017; Nautiyal, 2017; Yadav, 2018; Dar& Ghani, 2019; Thankkur and Bhan, 2019; Jahanger and Dar, 2019; Eswari and Manickavasagan, 2019; Sharma, 2020; Priya, 2020; Nisa, 2020; Gopalkrishnan & Galande, 2021; Kaur and Vadhera, 2021; Biswal and Pandey, 2021) were directly related with the **scientific temper** while the rest of the studies were related with the terms used synonymously with the scientific temper like scientific thinking, scientific habit of mind and scientific attitude. Total **7 studies** (Pritchard, 2005; Thitima & Sumalee, 2012; Foss, 2014; Causey, 2016; Dey, 2017; Singh, 2019; Hyytinen, Toom & Shavelson, 2019) were related to the **scientific thinking**, **4** studies (Coll and Taylor, 2004; Coll, Taylor & Lay, 2009; Çalik, Çalik & Coll, 2012; Turan and Coll, 2013) were related to **scientific habit of mind** and **26** studies (Julius, 2016; Yadav, 2011; Patel, 1997; Choukade(2014; Budiharti & Waras, 2018; Bagavathy, 2015; Sari, Sudargo & Priyandok, 2018; Price & Lee, 2013; Erdogan, 2017; Panneerselvam&Muthamizhselvan, 2015; Suastra and Ristiati, 2019; Gumilar, Wardhini & Lisdiana, 2020; Dewi Saputri, Nurkhalissa & Akhlis, 2020; Govindrajan, 2014; Sreekumar, 2015; Chakraborty, 2015; Meenakshi and

Vasimalairaja, 2016; Ahuja, 2017; Revati and Meera, 2017; Singh and Bai, 2017; Kundu, 2018; Thory, 2018; Shetty, 2016; Rasani S., 2017; Ahmed, 2007; Pyari, 2009) were done in the area of **scientific attitude**. Out of all these, very few studies have been done in qualitative type while most of the studies are of survey type and a considerable amount of studies have been done in experimental type.

After the substantive and methodological analysis of review, it can be concluded that the majority of the studies were done of survey type which revealedthat students have an average level of scientific temper/attitude although few studies alsofound high and low levels. It further revealed that demographic variables like gender, type of school, locality, board of school, medium of instruction, Parents occupation, Parents education, Parents income, religion and home environment did not really affect the scientific temper while presence of grandparents, school environment and family size did affect the development of scientific temper hence it should be taken care of while teaching. Scientific temper is usually considered to be developed through science and mathematics but the analysis of reviews showed that social science also has the capacity to do the same as well. The studies further showed with the increase of scientific temper/attitude, the academic achievement, extraversion personality, scientific creativity, scientific aptitude also increases while science process skill has a negative correlation with the scientific attitude which suggests that it is not necessary that if a person holds a good knowledge of scientific processes, s/he will also have a good scientific temperament. Out of 76 studies, very few studies havebeen done in qualitative type while most of the studies are of survey type anda considerable amount of studies have been done in experimental type. Most of the researchers have developed their own tool which was of a five-point rating scale. In the sampling method, random and in analysis mean, SD and t-test were mostly used.

Further, the analysis showed that the intervention program did help in the development of scientific temper but most of the research was done either in science or a separate program is developed for this. The researcher couldn′t come across any study in which the program is implemented in an integrated way thattoo by taking up social science as well. Hence the researcher has taken up this study wherein the researcher will try to develop certain generic strategies in an integrated approach to develop scientific temper among secondary school students as in thisstage students started to think critically and rationally. For this, the researcher has taken up three subjects of class 9^{th} viz. Science, Mathematics and Social Science

as various studies suggested that social science has the potential to develop scientific temper as well.

RATIONALE OF THE STUDY

The goal of instilling scientific temper is critical to the advancement of science and its application in the development process. There is a need to develop a scientific atmosphere in which people may participate in discussions about diverse science and technology concerns that touch their lives. Knowledge about natural occurrences and technological advancements must be disseminated through popular science publications and other media. There is also a need to encourage public debate on important issues that are detrimental to the nation's progress. The whole extent of scientific knowledge must be applied to the elimination of illogical attitudes that tend to keep the country from progressing.

Since the dawn of time, science and technology have been an intrinsic element of Indian culture. In terms of modern scientific knowledge and comprehension, India has always been at the forefront. Scientific temper is critical for a nation's progress in all sectors, including political, economic, and social (Saxena, 2014). It is a way of life that involves inquiring, observing physical reality, testing, hypothesising, analysing, and communicating using a scientific approach. The term "scientific temper" refers to an attitude that is based on rationality. The scientific temperament requires debate, argument, and analysis.

Keeping in mind the importance of scientific temper, it has been included in the fundamental duties, and many efforts through science education and other activities have been taken. Despite these attempts, a scientific temper did not pervade society enough to have an influence on the national psyche. Regardless of the fact that today's Indian populace is more scientifically temperate than it was under the British Raj, creating a scientifically temperate society remains a faraway dream. (Nanda, 2013) but still, the aim of a scientific temper society is far away from achieving. As Mahanti quoted Narlikar (2003), "Today we live in a free India that is feeling its way towards economic prosperity. Yet we are still a long way from achieving that scientific outlook which Nehru considered so essential for our future wellbeing". Similar concerns were expressed by Bhargava and Mahanti (2013) quoted by Mahanti: “If one were to pick out three or four most important reasons for the country's backwardness or failure in many areas, the lack of scientific temper would be one of them”, so it can be concluded that despite India's enormous progress in science and technology, the climate of scientific temper that Nehru envisioned for the country has remained largely unrealised.

Scientific temper also helps in carrying out good citizenship qualities with a rational and logical outlook. Blind obedience to religious and judicial authorities is not only against the spirit of science and value education but also a great obstacle to achieving the constitutional goals of India as well as international peace and cooperation. Realising the importance of scientific temper, Former President Kalam has also said, "Children must inculcate a Scientific Temper for pursuing knowledge to contribute towards making India one of the most developed countries in the world. An ignited mind is the most powerful resource on the earth, above the earth and under the earth. The current teaching methods need to be revamped with more practicals and experiments to inculcate Scientific Temper among students" even the present prime minister Narendra Modi has also, in the departmental meeting of Science and Technology, asked the Council for Scientific and Industrial Research (CSIR) to develop toys which "inspire and develop scientific temper in children" (Livemint, 2017).

The purpose of education is not to produce the next generation of scientists only but the person who can have a scientific bent of mind. In today's world, we all are facing issues on a global scale that are fundamentally technical, like changes in climate conditions, energy resources, food production, genetic transformations and many more. Such conditions demand basic scientific temper throughout our population, not only by the scientists or elitists, so; those wise decisions can be reached about how to address them. Scientific temper should be instilled in all students, not only science students because scientific temper is not limited to science disciplines or rules, hypotheses, and formulae. Instead, it is what we refer to as a state of mind in which one constantly examines everything, seeks information, and is satisfied only when supported by sufficient evidence. Scientific temper is generic in nature, and it may be instilled through any subject, such as social science, mathematics, languages, physical education, painting, art and craft, and so on. However, subjects that are more factual in nature will be more convenient and easier for the development of a scientific temper. Hence in this study, subjects based on factual information and logic, like Science, Social Science and Mathematics, were selected. In a nutshell, scientific temper is the ability to comprehend the fundamental processes of scientific knowledge that follow the logical and reasonable investigation. Scientific knowledge can be verifiable, repeatable and falsifiable. It is always changing, and there is no absolute truth.

Secondary schooling is, as we all know, a critical period. It serves as a connection between primary and secondary education. Primary education is designed to meet the bare minimum for survival, but secondary education prepares a person to participate fully in a complex

society. This stage provides students with a clear insight into their ability, and its completion ensures that the child has attained all the basic aims to live a life and to go toward the specialisation in the interested area. Good wholesome development of the students at this stage has a very crucial role in the future of any student. Hence, the researcher has considered secondary students for the present study. As class 10^{th} students are going to face the board examination so this time is very important for them, which may be one of the factors for the authorities for not allowing the experiment at that stage, especially since the researcher has taken only 9^{th} standard for the experimentation.

From the review of related literature, it was found that very rare studies have been done on scientific temper, and in that also most of the study was related to measuring scientific temper that too by considering very few components of scientific temper. The researcher could come across only one study that was done to develop a package that too in science subjects only. But as scientific temper is considered a temper of a free man so it can be inculcated by using any subject; with this assumption, the researcher has decided to develop strategies to enhance the scientific temper among secondary school students by taking Science, Mathematics and Social Science subjects of GSHSEB schools.

STATEMENT OF PROBLEM

Development of Strategies to Enhance Scientific Temper among Secondary School Students.

OBJECTIVES

1. To develop strategies to enhance scientific temper among the secondary school students.
2. To implement the developed strategies on the secondary school students to enhance their scientific temper.
3. To evaluate the effectiveness of the developed strategies in terms of enhancement of scientific temper among secondary school students.
4. To evaluate the effectiveness of the developed strategies in terms of the reaction of secondary school students towards the strategies.

HYPOTHESES

The following null hypotheses were tested at the 0.01 level of significance.

H_{o1}: There is no significant difference between the mean pre-test and post-test scores of scientific temper between secondary school students those did not expose to the developed strategies.

H_{o2}: There is no significant difference between the mean pre-test and post-test scores of scientific temper between secondary school students those exposed to the developed strategies.

H_{o3}: There is no significant difference between the mean post-test score of scientific temper between secondary school students those exposed and whose did not expose to the developed strategies.

EXPLANATION OF THE TERMS

Secondary school students – It includes students who are studying in classes IX and X.

Strategies – In this study strategies were referred to the prepared plan involving a sequence of steps designed to enhance the scientific temper considering the components of scientific temper through the instructional process.

OPERATIONAL DEFINITION OF THE TERMS

Scientific temper: Scientific temper is the score secured by a student in the scientific temper scale developed by the researcher.

Enhancement of Scientific Temper: It is a significant difference between the pre-test and post-test scientific temper scores of the experiment and control groups.

Effectiveness: Effectiveness is the significant difference in the post-test scores of the experiment and control groups in scientific temper.

Effectiveness in terms of reaction: Effectiveness in terms of reaction is the overall positive reaction (3.5 and above) of students towards strategies to develop scientific temper in a Likert type 5 point reaction scale developed by the research.

DELIMITATION

The study is delimited to English medium school following GSHSEB syllabus in Vadodara city. In this study, Secondary School is delimited to standard IX only. The study is also delimited to Science, Mathematics and Social Science subjects. The scientific is temper

delimited to eight components viz. healthy scepticism, objective intellectual honesty, rationality, perseverance, freedom from superstition, curiosity, open mindedness, observation.

METHODOLOGY

The present study was experimental in nature. The methodology includes design of the study, variables of the study, population, sample, tools of data collection, procedures of data collection and data analysis.

DESIGN OF THE STUDY

The present study was experimental in nature and the researcher has used the quasi-experimental research design. Considering the typical nature of the study, a pre-test post-test non-equivalent group design of the quasi experiment research design has been selected for the study. Further, the experimental and control group were made equivalent on the basis of pre-test scores in scientific temper. The design of the study is presented as follow (Campbell and Stanley, 1966).

O_1 X O_2

.....

O_3 C O_4

Where O_1 and O_3, - pretests

O_2 and O_4 - post-test

X stands for experimental group and

C stands for control group

Following the design, two groups were selected conveniently as experimental and control group. The initial level of scientific temper had been checked prior to the experimentation by using self-made scientific temper scale. On the basis of the obtained score in the scale the experimental and control group were made equivalent. The treatment i.e. teaching through developed strategies to enhance scientific temper was done in the experimental group while the control group was taught through the traditional method without applying any kind of specific interventions.

POPULATION

The population for the present study was composed of all the students of the English medium secondary schools in Gujarat state affiliated to GSHSEB (Gujarat Secondary and Higher Secondary Education Board) during the year 2019-20.

SAMPLE

Two English medium GSHSEB affiliated secondary schools were selected with convenience from Vadodara district for the experimentation. Both the selected schools were considered equal in standards as both the schools were affiliated to the same board and located within the city area. The selected schools were University experimental English medium school and Vidyakunj High School in Vadodara. Out of these two schools, the former one was selected for the experimental group and later one was selected for the control group. Standard IX classes of both the schools had the strength of more than 45 students. These two groups were made equivalent on the basis of pre-test score of scientific temper scale. In this way, total of 64 students, 32 from the experimental and 32 from the control group formed the sample of the study. Students of the experimental group were taught through developed strategies in an integrated way while the students of the control group were taught through the usual traditional method.

VARIABLES OF THE STUDY

In the present study independent variable is the developed strategies to enhance scientific temper and the dependent variable is scientific temper.

TOOLS OF DATA COLLECTION

Following tools were prepared by the researcher and used for the collection of data.

Scientific temper scale: The scientific temper scale was developed and standardised by the researcher herself which was meant for the secondary school students exclusively. Total of eight components of scientific temper were identified after a thorough study of the topic and analysing the review of related literature. It had 32 items. All the items in the scale have been arranged in the sequential order with eight components viz. healthy skepticism, objective intellectual honesty, rationality, perseverance, freedom from superstition, curiosity, open mindedness, observation from 1 to 32 having four items in each component respectively. Each items having response ranging from 1 to 5. The response which shows the highest level of scientific temper was assigned the value of 5 while the lowest level represented with 1. In this way the minimum and maximum score in the scientific temper scale varies from 32 and 160. For validity content and factor validity were taken out. The reliability of the scientific temper scale was established by using two types of reliability methods which are Split Half reliability and Cronbach Alpha reliability. In both the reliability methods the tool was found to be highly reliable with a score of 0.75 and 0.79 respectively.

Reaction scale: The researcher has prepared a five-point Likert type scale to know the reaction of students towards the developed strategies to enhance scientific temper. There was total 30 statements in the scale related to different aspect of their experiences during the execution of strategies and teaching learning. Each statement has five-point ratings Viz. strongly agreed to strongly disagreed. The weightage for ratings of the scale are 5,4,3,2,1 respectively for the SA, A, UD, D, SD. In this way the highest score one could get was 150 and lowest was 30. The students were asked to read each statement carefully and mark a tick on a suitable option for each statement.

DEVELOPMENT OF STRATEGIES

In the present study, strategies were developed by the researcher to enhance the scientific temper among secondary school students by teaching Science, Mathematics and Social Science subjects. For this purpose first of all the identification of chapters to be taught was done of these three selected subjects. After that content analysis was done and the researcher has divided the chapters into various topic and subtopics so that the each recognised scientific temper components can be assign exclusively to subtopics. Then the researched has developed integrated strategies for all these selected topics. The strategies included ICT enabled learning, story telling, Questioning, Timeline, Debate, Discussion, Role play, News/Movie analysis, Worksheet. Once all the things have decided the researcher has prepared the final lesson plan to be used for teaching learning by using Herbatian steps.

IMPLEMENTATION OF STRATEGIES

The developed strategies were implemented in the experimental group for the teaching of Science, Mathematics and Social Science subjects with the chapters common in both experimental and control group. The selected topics those could develop scientific temper in all the subject were taught by the researcher in the allotted classes that varies 3-5 classes in a week.

DATA COLLECTION PROCEDURE

For the purpose of data collection two tools scientific temper scale and reaction scale was developed by the researcher. As the study is pre-test post-test non-equivalent group design hence the data were collected at the beginning and at the end of experimentation. First of all, scientific temper scale was implemented and both the groups as a pretest to know the initial level of their scientific temper and to make them equivalent. After that the developed integrated

strategies were implemented in the experimental group whereas the control group were taught through regular teaching learning process. At the end of second semester scientific temper scale as a post test was administered again on both the groups. To know the reaction of developed strategies reaction scale was also administered on the experimental group.

DATA ANALYSIS

Considering the nature of the Sampling method, collected data were analysed using mean, SD, Mann whitey U test, frequency percentage and intensity index. All the analyses were done using SPSS 20.0 (Statistical Package for Social Science) and MS Excel.

MAJOR FINDINGS

Following major findings were drawn on the basis of data analysis and interpretations.

1. No significant difference was found among the mean pre-test and post-test scores of Scientific temper of control group those were taught in traditional method of teaching. This was also found in case of all the eight components of scientific temper viz. healthy scepticism, objective intellectual honesty, rationality, perseverance, freedom from superstition, curiosity, open mindedness and observation. In other words, traditional method of teaching did not help in enhancing scientific temper either as a whole or in any of it's components.
2. Post-test score of Scientific temper of experiment group those were taught through developed strategies was found significantly higher than their pre-test score in scientific temper. This was also found in case of all the eight components of scientific temper viz. healthy scepticism, objective intellectual honesty, rationality, perseverance, freedom from superstition, curiosity, open mindedness and observation. In other words, teaching through developed strategy helped in enhancing scientific temper as a whole and in all the eight components.
3. Post-test score of Scientific temper of experiment group those were taught through developed strategies was found significantly higher than the post-test score of Scientific temper of control group those were taught in traditional method of teaching. This was also found in case of all the eight components of scientific temper viz. healthy scepticism, objective intellectual honesty, rationality, perseverance, freedom from superstition, curiosity, open mindedness and observation. In other words, teaching through developed strategy was found superior and effective in enhancing scientific temper among secondary students in comparison to the traditional method of teaching.

4. The developed strategy was found effective in enhancing scientific temper among secondary students in terms of favourable reaction of students towards different aspects of strategies.

CONCLUSION

A scientific temper is a scientific bent of mind that not only opposes rigid thinking but also motivates one to ask questions in order to find logical and rational answers. It is so critical that it is included in our fundamental duty; even the recently released NEP 2020 recognised it as one of the most important 21st-century skills. The present study was conducted by keeping this very perspective in mind. The study revealed that the implementation of developed strategies proved useful in the enhancement of scientific temper among secondary school students. The differences in the level of scientific temper were clearly visible in the scores of students who were taught by the traditional vs. integrated method. Usually, it is considered that this very temperament can only be developed through science subjects, although this study advocated that it is not the case. This task of the development of scientific temper can be done using any subject. In this case, the researcher used three subjects to accomplish the same goal: Science, Mathematics, and Social Science. Even the reaction of students towards the developed strategies was found to be favourable, which showed that they love to learn in new ways. According to the students' reactions, the strategies encouraged them to think scientifically and aided in the development of their natural inquisitiveness. It made them more confident and fearless in asking the question. At the end of the course, it was also observed that students started to find new information on their own and started discussing it in the class. Overall, the response was very positive and the result proved to be significant in enhancing the scientific temper of secondary students. The result of this study could be beneficial for all the stakeholders of the education system, be it a teacher or policymakers. It proves that even with very little conscious effort, improvement can be witnessed.

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