CHAPTER I
INTRODUCTION

1.0.0 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 human beings. A human mind is a curious mind- from the discovery of fire to the 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. The modern era is of science and technology where scientific knowledge is no longer confined to only the person belonging to that particular stream, but everyone has got access to it. Science has now become a requirement for everyone because existence in the modern world necessitates, to varying degrees, an understanding of scientific truths and laws. Science education has become an inescapable feature of all general education programmes, and that's why it has been accepted into the school curriculum as a core subject. Various committees have been formed from time to time so that problems faced by Indian Science education can be sought out.

In the supervision of the Late Shri Lal Bahadur Shastri, an Indian parliamentary committee for science was constituted in 1961 to investigate the challenges that science faced in the Indian school system. Finding the relationship between central and state government policies surrounding Science education policies, as well as studying the courses offered in different schools under different state educational systems, were two other issues that were seriously considered. The Indian Education Commission, chaired by Dr D.S. Kothari, stated in 1964 that the situation of science in India is abysmal and that the system cannot keep up with the growth of knowledge in science. It was suggested that projects be carried out to solve this current challenge. To address this issue, it was proposed that initiatives be made to improve school curricula and textbooks. A National Policy of Education (NPE) was established in 1968 to link national development, citizenship education, and science education. It placed a strong emphasis on social rebuilding as well as on regional inequalities in educational growth. In this approach, an educational strategy was linked to the expansion of scientific literacy, scientific awareness, and scientific temperament in society, which functioned to encourage the various education subsystems in order to generate the qualified labour that the economy required. NPE (1986) has also emphasised scientific temper, which is apparent in

the following line. “In our national perception, education is essentially for all. This is fundamental to our all-round development, material and spiritual. Education has an acculturating role. It refines sensitivities and perceptions that contribute to national cohesion, a scientific temper and Independence of mind and spirit, thus furthering the goals of socialism, secularism,and democracy enshrined in our Constitution”. Even NEP 2020 has recognised it as a skill which is needed most in the 21st century.

All of these programmes show that the government is really serious about improving science education in India. The material world of men has been drastically altered by science. It has resulted in the development of both material and nonmaterial things. Scientific temper is a new intellectual temperament that has emerged as a result of advances in science and technology. It is not a bigot's or a closed-minded person's attitude but rather an open-minded person who may inquire about attaining a unique way of thinking. In India, science education policy is built on the notion that scientific thought is a prized product of human striving and desire and fights against a fear-based culture.

Thus, a scientifically tempered society is the need of the hour, as it has also been noted by the (AAAS) American Association for the Advancement of Science (1985), “Without a Science- literate population, the outlook for a better world is not promising.” 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 for the truth but is an integral part of one's overall thinking and action. It typically refers to accepting the truth in its purest form without allowing it to be influenced in any way. (Kaur and Vadhera, 2018). It is the most crucial factor in the nation's growth; this is the reason that Pt. Jawahar Lal Nehru, in 1946 introduced this term in India and put forth all the efforts in this same direction. 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, insanitation and illiteracy, of superstition and deadening custom andtradition, of vast resources running to waste, of a rich country inhabited by starving people. Who indeed could afford to ignore science today?” At every turn, we have to seek its aid*." In this way, it can be said that scientific temper is essential for any country, especially India, where the spread of superstations and dogmatic beliefs is at large. Pseudoscience, religious intolerance and dogmatic views, superstition, and astrology are all enemies of Nehru's scientific temperament (Mahanti, 2016). Realising its importancein nation-building and achieving this

aim of scientific temper, it has been added to the fundamental duties in the 42nd Amendment to the Constitution, Article 51A (h). It 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".* As a result, a decent Indian citizen must have a scientific temperament. In a multilingual, multireligious, and multiracial society like India, the growth of scientific temper among the people might encourage communal unity. The dissemination of scientific knowledge is just a precursor for the development of a scientific temperament (Raza, 2015). Hence if it should be adequately spread, then the necessity of getting scientific knowledge to all is fundamental. When any person solves any problem that occurs in their day-to-day life by analysing it logically and critically, they are said to be having a tempered scientific mindset. Inthis way, we can say that the essence of this very temper usually lies in its method, i.e. scientific method.

1.1.0. SCIENCE AND SCIENTIFIC METHOD

Humans have been from always been curious about nature. By continuous inquisitiveness, they have been able to evolve and have become the most intelligent organism on earth. The evolution started with the very discovery of fire, and from then, the enterprise of inquiry has never stopped. Science and technological (S & T) advances have had profound effects on human life. Earlier, when travel and communication used tobe months-long endeavours and stars, the moon and other celestial body used to be far from human reach; now, with the advancement in S & T, human has landed on the moon and tried to inhabitants the other planets of the solar system. 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 understood mainly 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, 1931).

The age of the scientific revolution started in the 19th century with the discovery of Galileo, who proposed that it is not the sun that revolves around the earth, but it's the earth that revolves around the sun, and the sun is at the centre, not the earth. For this discovery, he was executed and went through a tough court trial as his finding was in contrast with the Bible. It remained a pursuit of the learned for the first half of that brief era, with little impact on ordinary men's thinking or habits. It is only in the last 150 years that science has become a significant force in affecting the daily lives of ordinary people (Russell, 1931). It was an

earlier part of the natural philosophy, but with time the method involved in it also got evolved, and it 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. It is the criteria that make any subject or thing scientific.

From time to time, various scholars and philosophers have proposed various steps/stages of the scientific method. Russell (1931) proposed that there are three main stages in arriving at a scientific law: the first is observing significant facts; the second is arriving at a hypothesis that, if true, would account for these facts; and the third is deducing consequences from this hypothesis that can be tested by observation. If the implications are confirmed, the hypothesis is temporarily accepted as true, albeit it will almost always need to be modified later if new facts are discovered. National Focus Group of Teaching of Science (2006) has said that the scientific method involves various steps which are all interconnected with each other; the steps are: "observation, looking for regularities and patterns, making hypotheses, devising qualitative or mathematical models, deducing their consequences; verification or falsification of theories through observations and controlled experiments, and thus arriving at the principles, theories and laws governing the physical world." However, it suggested that there is no strict order in these various steps. Dhar (2009) proposed five steps of the scientific method, which are Observation, Hypothesis, Prediction, Verification and Rejection or acceptance of the hypothesis. His scheme is shown in figure 1.

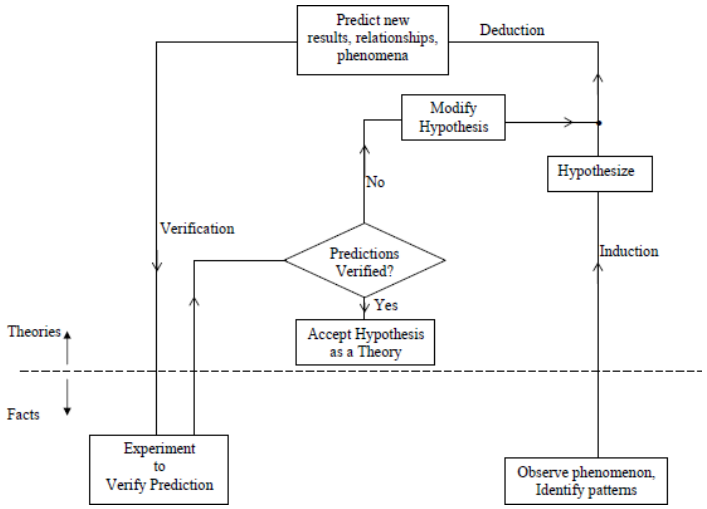

Figure 1.1: Scientific method (Source: Dhar, 2009)

Carey (2011) has proposed three-step processes involved in the scientific method, which are

Observing, Proposing an Explanation, and testing the explanation. Narlikar (2003) said that there are three steps in any scientific inquiry, which are: "experiment (E), observation (O) and deduction (D)."

In this way, we can say that no matter how many steps are involved in the scientific method, it has a basic three-step which start with the observation, followed by an experiment and then an analysis of findings for its verification. These steps are allinterconnected with each other irrespective of the order they are taking place. This very method forms the foundation of scientific temper.

1.2.0. MEANING AND DEFINITIONS OF SCIENTIFIC TEMPER

The term Scientific Temper is made of two words - "Scientific" and "Temper". According to the 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**:** practising 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 characterises and channels human actions (Bardapurkar, 2020).

It has frequently been assumed that it is essentially a question of an individual's unique emotional experiences. It's a mental condition or habit, especially when it comes to disposition. It's also used to describe the vigour, vividness, and other attributes associated with fundamental urges and senses. As a result, Scientific Temper reflects an inquisitive attitude. Scientific temper develops as a result of the capacity to think clearly, objectively, and analytically. Various educationists and scholars have defined scientific temper in various ways. Following are a few of the definitions of Scientific Temper:

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 process of thinking by inculcating certain habits and skills. These are to sharpen our observations, acquire a habit of quantification of our information, practice recording 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 thought of a possible explanation for the

observed phenomena, and finally, verify whether the explanation holds good in other similar situations."

Hemlata (1988) defined scientific temper as the "quintessence of the culture of the science. Scientific temper is the value as well as a method of attaining human rights under humanism as the only value worth striving for the trouble-torn social formation from domestic to international levels. Scientific temper includes scientific attitudes."

Krishnan and Bhuvaneshwari (1990) defined "scientific temper as one's reactions in his/her life situations as the practice of seeing cause and effect relationship appreciation of the 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 defined "scientific temper as an attribute of the human mind and of the social decision-making process than mere knowledge about scientific things. It is more related to the method of science than to the content of science."

Singh (1998) defined "scientific temper as a state or condition or bent of mind of a free man working on any problem, process, situation, incident arising in; and faced by an individual."

Kaur and Vadhera (2018) defined it as "a frame of mind that accepts the truth in its real form without subjecting it to any kind of influence."

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 that 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 is 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 of rational and logical thinking in a healthy sceptical way which eventually makes a person more humanistic in approach and raises 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. A scientific temper is a manner of living that approaches every issue with a scientific mindset. Scientific temper is not like any other human emotion which is temporary, but it is a disposition of mind that, once developed, remains permanent in the personality of an individual. It is a mixture of excitement, unpolluted, and incorruptible 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 have a direct or indirect relationship to one's personality (Kaur & Vadhera, 2018).

1.3.0. COMPONENTS OF SCIENTIFIC TEMPER

The scientific temper is a way of life that involves asking, observing, testing, hypothesising, analysing, and sharing using the scientific method. It calls for a scientific attitude and a scientific approach. Various scholars have identified various components of scientific temper. Some of them are as follows:

Pradhan (1996) has identified four components 1. Value Perspective, 2. Aversion to superstition, 3. A set of attitudes, 4. A worldview perspective.

Singh (1998) has identified the following characteristics that are associated with scientific temper 1. Spirit of inquiry, 2. Creativity, 3. Objectivity, 4. Courage to question, 5.Aesthetic sensibility, and 6.Experimentation.

Rajammal (2003) has identified 34 dimensions which are 1. Questioning 2. Curiosity 3. Observation 4. Analysis 5. Rationality 6. Reasoning 7. Creative thinking 8. Scientific approach 9. Intellectual Honesty 10. Scepticism 11. Experimental Bent 12. Suspended judgement 13. Open-mindedness 14. Objectivity 15. Cause and effect relationship 16. Cautiousness 17. Aversion to superstition 18. Self–confidence. 19. Appreciation of the utility of science in daily life activities 20. Respect for others' views 21. Innovation 22. Honest reporting 23. Problem-solving 24. Criticism 25. Humanism 26. Commitment 27. Patience 28. Awareness 29. Seeking evidence 30. The habit of accuracy 31. Tolerance 32. Consistency 33. Experimental verification 34. Generalisation.

Nadeem and Wani (2005) have identified the following characteristics that are associated with scientific temper –1. Healthy scepticism, 2. Universalism, 3. Freedom from prejudice or bias, 4. Objectivity.

As argued by **Dhar (2009)**, scientific temperament or temper is characterised by the traits like 1. Healthy scepticism, 2. Universalism, 3. Freedom from prejudice or bias, 4. Objectivity-Intellectual Honesty, 5.Open-mindedness and humility, 6. Willingness to suspend judgment without sufficient evidence, and 7. Rationality, and 8.Perseverance.

Bhatnagar (2011) has identified six dimensions which are as follows: 1. Scientific information, 2. Problem-solving ability, 3. Free from superstition, 4. Cause finding ability, 5. Reasoning and logical ability, 6. Curiosity

Anubuchlevi (2014) has identified five dimensions which are as follows: 1. Desire for knowing the truth and accepting the results courageously, 2. Facing failure courageously, 3. Attitude to accept the challenges, 4. Application of scientific principles in daily life, 5. Open-mindedness.

Joshua (2015) has identified six dimensions which are as follows: 1. Scientific Literacy, 2. The scientific method, 3. Scientific attitude, 4. Scientific perception, 5. Scientific thinking, 6. Scientific habit.

Singh, Dogra and Singh (2016) have identified four dimensions which are as follows: 1. spirit of enquiry, 2. rational thinking, 3. cause and effect relationship, and 4. scientific information.

After reviewing all the components of scientific temper stated by different scholars and analysing the nature and definition of scientific temper, the following components were found to be important and relevant by the researcher and are suitable for secondary students. These components of scientific temper were considered by the researcher while preparing the scale for measuring scientific temper and developing strategies for the same. These components are:

1. Healthy scepticism
2. Objectivity-Intellectual Honesty
3. Rationality
4. Perseverance
5. Curiosity

6. Free from superstition
7. Open-mindedness
8. Observation

The definitions of these traits are provided below, along with examples of behaviours that a person who possesses each trait might exhibit.

1.3.1. Healthy Scepticism

Healthy scepticism is an attitude that doubts anything before accepting it, applying reason and critical thinking to determine its validity, as it is believed that knowledge in any area is uncertain. It allows for taking better and more logical decisions based on shreds of evidence. Following four characteristics of healthy scepticism are identified which are as follows:

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

1.3.2. Objective Intellectual Honesty

Objective intellectual honesty is an unbiased and honest state of mind where one sees even outside of the subject's individual biases, interpretations, feelings, and imaginings that help one in the acquisition, analysis, and transmission of ideas in a truthful manner. Following four characteristics of ‘Objective Intellectual Honesty’ are identified which are as follows:

- 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 when it contradicts one's hypothesis.
- One does not allow any modifications according to present social, economic, or political situations.
- One's faith does not interfere with one’s pursuit of truth.

1.3.3. Rationality

Rationality means the quality of being agreeable to reason and utilitarian action and having a knowledge-seeking temperament. A person with rationality seeks logical argument as the basis for relying on objective observations and factual analysis in any given situation. Following four characteristics of 'rationality' are identified which are as follows:

- One tends to test traditional beliefs.
- One accepts 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 and focuses solely on facts.

1.3.4. Perseverance

Perseverance is the quality of making a continuous effort to attain the goal, despite difficulties, failures, or opposition. Following four characteristics of 'Perseverance' are identified which are as follows:

- One does not believe in giving up things if there is a scope to complete them.
- One pays attention to what's possible, which includes realising when to withdraw, let go or surrender.
- One feels motivated to move forward with the plans even when it seems that one might not be successful.
- One's Persistence and tenacity to do something and keep doing it till the end, even if it's hard.

1.3.5. Freedom from superstition

Freedom from superstition is a state of mind believing in knowledge based on reasons or scientific knowledge rather than knowledge connected with old irrational traditions, the act of magical, irrational belief about supernatural power, nature, superstitions about God, and false conceptions of causation. Following four characteristics of 'Freedom from superstition' are identified which are as follows:

- One rejects 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.

1.3.6. Curiosity

Curiosity is the eagerness, desire, and quest to know and learn about something and to understand various phenomena leading to inquiry and intellectual curiosity. Following four characteristics of 'Curiosity' are identified which are as follows:

- One's desire to understand 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.

1.3.7. Open-Mindedness

Open-mindedness is an attitude toward oneself as a believer rather than toward any particular belief, a willingness to consider new ideas or opinions, and receptiveness to arguments in an unbiased manner. Following four characteristics of 'Open Mindedness' are identified which are as follows:

- One's willingness to revise opinions and conclusions.
- One's approach towards all 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.

1.3.8. Observation

Observation is the ability to notice things or changes in the surroundings thoroughly using all five senses and gathering relevant data to have a conclusion. Following four characteristics of 'Observation' are identified which are as follows:

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

If the above-mentioned components are manifested by any individual, s/he is said to be having a scientific temper mindset. It is not necessary that at a time, all the behaviours manifest but as and when needed, these need to be used by a person. These components are

all interconnected, and they cannot be perceived in an isolated term. They constitute a cohesive, interrelated, and well-integrated whole. This very temper is not only helpful for individual growth but for a nation also; it is a prerequisite condition of development.

1.4.0. SCIENTIFIC TEMPER IN INDIA

Science and technology help tremendously in the development of any nation. Realising the importance of this very fact Pt. Jawaharlal Nehru, as India got its Freedom started the movement of scientific advancement. He knew that it was only science that could help India to become self-reliant. While he was in jail in 1946, he wrote a book named *Discovery of India* in which he mentioned the term scientific temper. He found that even this very temperament was lacking in the leaders of that time and wrote that "We are informed that we live in a scientific age, yet there is little indication of this temper in the people or even in their leaders" (Nehru, 1946). He advocated for scientists to take a more active role in instilling a scientific mindset in the country. (Mahanti, 2016). 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 1923, in his book "On education", 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 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, Nobel Laureate Prof. Amartya Sen also noted this characteristic, stating that scientific temper has always been a trademark of Indian philosophy (Sen, 2006). It refutes the notion that it is something that colonists bring.

Hence it can be said that the tradition of scepticism, humanism and rational and logical thinking, which are the important components of scientific temper, is not new to Indian people. Such notions go back to antiquity, and from time-to-time various philosophies of Jain, Sankya, Nyay, Vaisheshika, and Buddhists have repeatedly emphasised the spirit of inquiry. In the Vedic age also, questioning and logical thinking of the mind were always given due credit to be developed through education. Even in the most popular book, the Bhagavad Gita, in Indian culture, the notion of reflection has been given due importance in which. "Lord Krishna, when finished telling the Gita to Arjuna, he ended by saying: Reflect

over what I said fully and then do what you wish" (Narlikar, 2003). Besides this, the Buddha's admonishment in the *Kalama Sutta* also gave importance to the encouragement of a rational attitude which states*:* "Believe nothing merely because you have told it or because you imagined it; do not believe what your teacher tells you merely out of respect for the teacher. But whatsoever, after due examination and analysis, you find to be conducive to the good, the benefit, the welfare of all beings that doctrine believe and cling to, and take it as yourguide." (Bhargava and Chakrabarti, 2010).

The discussion over the value of contemporary science, scientific education, science popularisation, and science-society links began in India during the early nineteenth century. (Venkateswaran, 2013). If we analyse the movement started by various eminent personalities at that time, we'll see that it gives us proof of the presence of scientific temperament. Like Raja Ram Mohan Roy's effort to abolish social evils prevalent at that time like Sati pratha, polygamy, and child marriage, likewise, Ishwar Chandra Vidyasagar's effort to pass the widow remarriage act, etc. are nothing but a live example of scientific temper. Narlikar (2003) stated that Raja Rammohan Roy made a great contribution to India's modernisation. In the eighteenth and nineteenth centuries, Roy's social reforms bridged the gap between India and Europe in terms of attitudes toward science and technology. "A word that is prevalent these days but was not used in the Raja's time, although he promoted it in many of his speeches and publications, is scientific temper," he wrote in response to Rammohan's endorsement of scientific temper. Even Vivekananda was against religion based on dogmas and blind beliefs. He was a staunch supporter of rational and scientific thinking, and he called upon mankind to shun superstitions and fight against the authority of such a society. He said that following society and public opinion blindly would be idolatry. He also considered blind beliefs and superstitious practices as one of the biggest reasons for war and bloodshed happening every time and in every society (Ray & Sethy, 2020). Rajendralal Mitra (1822/23- 1891), the first modern Indian-born Indologist and a significant player in the Bengal Renaissance, took up the mantle of societal transformation via rational thought. (Mitra, 1978, cited in Mahanti, 2013). In the recent past, Nehru, Ambedkar, Prof. Yash Pal, Dr A.P.J. Kalam and others were people who believed that the future belonged to those who cultivated science. Modernism, according to Ambedkar, is dedicated to reason, rationality, scientific knowledge, and democracy (Sahoo, 2020).

In this way, we can say that in our Indian society, this term was always prevalent, which only declined after it came under British rule. But once India got Freedom, the resurgence of this very notion was started by the then prime minister Pt. Jawaharlal Nehru. The very first policy catering to this very notion in focus, named scientific resolution policy, was launched in 1958. The Scientific Resolution Policy Resolution (SPR) of the Government of India symbolised the national goal on which Nehru was able to build the notion of scientific temper (SPR, 1958). It was a reflection of India's political leaders' belief in science and technology as a means of achieving national progress and self-reliance. The primary goal of this programme was to build the agricultural and industrial basis, as well as scientific personnel, that was exceptional in terms of quality, quantity, and skill set. The Society for the Promotion of Scientific Temper (SPST) was founded in 1964 as a result of Satish Dhawan, Abdur Rahman, and P. M. Bhargava's efforts. Its main purpose was to instil a scientific temper in society. (Mahanti, 2013).

After Nehru's death, the Nehru Centre in Bombay, which has been hosting Nehru memorial lecture series since 1966, continued his legacy of scientific temper. (Kaur and Vadhera, 2018). In the development of the nation's socioeconomic plan S&T plan was recognised as an integral part and led to the creation of the National Committee 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 state 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)].

In 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 instil Scientific Temper ideals in Indian society in order to cure the country's socioeconomic issues at the time. Haksar called it the second renaissance of the country after the freedom struggle. It stated that "The spirit of inquiry and the acceptance of the right to question and be questioned are fundamental in scientific temper." It was accepted by academician all across India with open arms, but still, few people discarded this very notion and criticised it. The statement had raised strong responses in the academic circle;

while some appraised it, others opposed it (Chadha, 2005; Prasad, 1982). The strongest amongst all was the counter statement put forward by Ashish Nandy, who criticised the proposed humanistic temper instead. He considered this statement packaged in Pseudo empiricism and called it a posthumous child of colonialism (Nandy, 1981)

After three decades, in 2011, the need to revisit the 1981 Statement of ScientificTemper was felt, resulting formulation of a document titled '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." The statement clearly states the fact that science has helped us to find out the reality of life, the working of the whole universe, as well as the human mind in the most objective way without relying on supernatural or revealed knowledge. This declaration also affirmed that merely the availability of scientific information should not take as an increase in scientific temper. It called upon the vanguard of scientific temper among people by enlarging scientific spaces over extra-scientific spaces. It had also given some the strategies like forbidding the use of religious symbols and ceremonies in any of the government-run institutions, establishing a national monitoring system for controlling the spread of scientific information through media, transparent working of science personnel and scientific institutions, starting a television channel for the scientific temper spread etc. to inculcate scientific temperament in the masses.

Even the document "Science Technology and Innovation Policy 2013" of the Government of India also maintains the vision of advancing scientific temper in all the citizens of India. Science and technology policy 2003 recognised the importance of scientific temper and included the promotion of spreading the scientific temper among all the sections of society as one of the key elements of the policy. Recently on January 1 2021, the draft of the Science, Technology, and Innovation Policy was launched. It has set a very ambitious goal to achieve by considering all the drawbacks of previous policies and emphasis on *the Atmanirabharta* (self-reliance) of India in this field. To improve science teaching, science communication and science pedagogy will be told to facilitate, and for this entertainment platform, social media and NGOs will be involved at the national and local levels. It did recognise that "there is a disconnection between science and society at large with limited scope for citizen engagement in the STI ecosystem." Science training as a science

communication skill set will be launched from school to the professional level. Forfunding, PPP (Public-Private Partnership) model will be used. It also put forward the development of SSR (Social scientific responsibility) policy so that scientific temperament can develop in the masses to a great extent.

1.5.0 GOVERNMENT INITIATIVES FOR THE PROMOTION OF SCIENTIFIC TEMPER

Various science exhibitions take place from time to time. Other than many NGOs are also working in this direction. Mobile science labs, Olympiads, science parks, science museums etc., are also there to promote scientific temper among the community as well as students. The Indian National Research Academy (INSA), which was founded in 1935, catalyses and supports science through recognising, cultivating, and developing scientific potential as well as providing scientific advice. It has created a framework that encourages scientific temper while catalysing thought and evolving ideas on current concerns such as higher education in science, women in science, and ethics. On February 28 2014, the national science day theme was dedicated to "Fostering Scientific Temper". Just after that, Former President Dr A. P.J Abdul Kalam Azad, on July 10 2015, launched 'Rashtriya Avishkar Abhiyan (RAA)' for developing scientific temper among school students under the Ministry of Human Resource Development. The key objective of this program is to instil in school children a sense of inquisitiveness, rationality, creativity, and a love of science and mathematics. In 2018 on the demand of the All India People's Science Network (AIPSN), August 20 was declared national scientific temper day in memory of Rationalist Narendra Dabholar, who died fighting for scientific temper. On August 1 2019, the Council of Scientific and Industrial Research - National Institute of Science, Technology and Development Studies (CSIR-NISTADS) launched the Knowledge And Awareness Mapping Platform "KAMP" as one of its major initiatives to identify and capture students' Scientific and Technological temperament. KAMP must be implemented in all Indian schools, with a focus on pupils aged 10 to 18. It will assess children's existing levels of scientific temper, advise students, parents, teachers, and schools on how to increase it, and assist schools in creating environments that encourage scientific temper in students through Junior Scientist groups across India. Students will also be able to participate in the India International Science Festival (IISF) through KAMP. Other than these, The National Teachers' Science Congress (NTSC) was founded by the National Council for Science & Technology Communication (NCSTC) to offer a platform for teachers around the country to improve their scientific

awareness. It has since evolved into an NCSTC biannual event. Even several science community city centres have been established for the spread of this very scientific temper among the masses as well as students. Science city centres have also been established for the reason of dissemination of science and development of scientific temper. There are currently 18 such community centres in Vadodara, which are run by various trusts as non-governmental organisations and are under the purview of the Gujarat Council on Science and Technology (GUJCOST), Department of Science and Technology, Gujarat Government(Atman, 2017).

There is one Community Science Centre (CSC) in Vadodara, which was founded in 1982 by senior technocrats, citizens, and business houses of Vadodara and has been recognised by GUJCOST as a Regional Community Science Centre for Central Gujarat (Gujarat Council on Science and Technology). The centre's mission is to promote and popularise science and technology (S & T). Its objective is to instil a scientific temper and attitude in society by bringing science to their doorsteps. There is even an Internet-based science Over-The-Top (OTT) TV channel called India Science (www.indiascience.in). It is a project of the Indian government's Department of Science and Technology (DST), which is executed and administered by Vigyan Prasar (VP), an autonomous departmental organisation. This 24-hour video platform is committed to the diffusion of science and technological information, with a significant focus on increasing scientific understanding, particularly among Indian viewpoints, ethos, and cultural context. DST's National Council of Science and Technology Communication (NCSTC) has endorsed the programme.

From the above discussions, it can be said that the concept of scientific temper has been promoted by the government through various initiatives from time to time. Even many non-government organisations also take part in these initiatives so that the citizen of India can become a scientifically tempered society.

1.6.0. 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 (1931), who said that the “scientific attitude is in some degree unnatural to man; the majority of our opinions are wish-fulfillments, like dreams in the Freudian theory but Scientific method

sweeps aside our wishes and endeavours to arrive at opinions in which wishes to 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 document about education released after Independence. The University Education Commission (1948-49) was the first commission formed after Independence. Recognising 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." Likewise Secondary Education Commission (1952-53) 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". Education Commission (1964-66) also 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 an integrated approach to school education. It recognised the importance of science in 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." Even the newest National Education Policy (2020) had recognised scientific temper as the aim of education and states that "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 is the most important value to be included in education. Hence it can be said that scientific temper is the value that makes people future ready and is the need of the hour. It is one of the very important skills for the

21st-century learner for their continuous growth.

1.7.0. 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.d.). 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 godmen, magical beliefs, and 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 (2003), 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 wellbeing."

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 three 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, a 33-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 overemphasised 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 shows the lack of a secular mind. "The notion of 'secularism' transmuted in content

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 this 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 & 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.

1.8.0. HURDLES IN THE DEVELOPMENT OF SCIENTIFIC TEMPER

In a country where superstitious beliefs and illiteracy are on the rise, the development of scientific temper becomes a big task, and many hurdles come their way. One of the biggest hurdles relating to the effective development of scientific temper is multiple religious beliefs. It is usually considered incompatible with theological and metaphysical beliefs Singh, Dogra, and Singh (2016), although they both are different and 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 & Singh, 2004). Even spirituality is considered 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 different purposes and are needed equally in an adequate amount. Panchapakesan (2006) has 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 of 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, 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, it is still seen that when it comes to implementation, we lack 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 it most cautiously, it is required that a teacher, while teaching in a class, focuses specifically on the intelligent design movement's current problem and provides an opportunity for the 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 deliberate efforts by everyone.

1.9.0. 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 abstract andrational terms. 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 about 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 the 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 practices, 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 in 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 & Vadhera, 2018). While we all know that in secondary school, students are at the 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 with 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 emphasised 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

instil the scientific temper in the population at large". The development of scientific temper and scientific creativity among the younger generation, as well as the promotion of culture and civilisation on the right path, is now regarded as 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 essential to develop a scientific temper to cope with the future world as in this ever-fast evolution we are gradually moving from mechanical to electrical and then to electronic likewise we are moving at an 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 possession of 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, and no 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 belongs to a 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, Swami Vivekananda, 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 taught 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 other research has also been conducted whose result indicates that Social Science can

also develop open-mindedness, rationality, and aversion to superstition dimension of scientific temper (Maqbool & Sofi, 2013). In this way, it can be said that Social Sciences also have the scope to develop a scientific temper like the Science and Mathematics subjects.

1.10.0. DEVELOPMENT OF SCIENTIFIC TEMPER THROUGH VARIOUS SUBJECTS

Usually, scientific temper is considered to be developed through science subjects only. But if we see the introduction of science subjects in the school curriculum in India, it gives us a great idea of 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 rather than three separate disciplines (Environmental Studies, science, and social studies), as had been the practice in the past.

If we see the above argument, it clearly shows that social studies were part of the science, and it was later only that it emerged as a separate discipline. Although now, this is also changed, and the name is changed to social science itself, depicting that it is nothing but a part of science. Even mathematics subject is considered to develop logical thinking; hence in the present study researcher has taken these three subjects to develop scientific temper among secondary school students. For the present study, the researcher has taken GSHSEB schools, but from 2019, the Gujarat government has the mandate to follow the NCERT books from class 9 onwards; hence the aim and objectives of these three subjects suggested by NCF 2005 are listed below in Table 1.1:

Table 1.1: Objectives of Science, Mathematics and Social Science as per NCF 2005

Science	Mathematics	Social Science
• know the facts and principles of science and its	• Children learn to enjoy mathematics rather than fear it.	• Understand the processes of economic and

applications, consistent with the stage of cognitive development, • acquire the skills and understand the methods and processes that lead to the generation andvalidation of scientific knowledge, • develop a historical and developmental perspective of science and enable her to view science as a social enterprise, relate to the environment (natural environment, artifacts and people), local as well as global, and appreciate the issues at the the interface of science, technology, and society, acquire therequisite	• Children learn important mathematics: Mathematics is more than formulas and mechanical procedures. • Children see mathematics as something to talk about, to communicate through, to discuss among themselves, andto work together on. • Children pose and solve meaningful problems. Children use abstractions to perceive relationships, to see structures, to reason out things, and to argue the truth or falsity of statements. • Children understand the basic structure of Mathematics: Arithmetic,	social change and development with examples from modern and contemporary India and other parts of the world. • Critically examine social and economic issues and challenges like poverty, child labour, destitution, illiteracy, and various other dimensions of inequality. • Understand the rights and responsibilities of citizens in a democratic and secular society. • Understand the roles and responsibilities of the state in the fulfilment of constitutional obligations. • Understand the processes of change and

theoretical knowledge andpractical technological skills • to enter the world of work, • nurture the natural curiosity, aesthetic sense, and creativity in science and technology, • imbibe the values of honesty, integrity, cooperation, concern for life and preservation of the environment, and • cultivate 'scientific temper'- objectivity, critical thinking and Freedom from fear and prejudices	algebra, geometry and trigonometry, the basic content areas of school • Mathematics, all offer a methodology for abstraction, structuration and generalisation. Teachers engage every child in the class with the conviction that everyone can learn mathematics.	development in India in relation to the world economy and polity. • Appreciate the rights of local communities in relation to their environment, the judicious utilisation of resources, as well as the need for the conservation of the natural environment.

In this way, it can be concluded that 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 the statement of scientific temper (1981), which said that scientific temper could be developed not only through science but through 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 emphasised 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 this evidence, if we also analyse 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.

1.11.0. 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., better citizens of the future world. No matter how many media and educational technologies are present, the teacher holds a central position in teaching-learning (NCF, 2005). We know that the world is changing rapidly with unstoppable speed, and an everyday new piece of knowledge is evolving in 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 the 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.

This all happens because of the presence of much misinformation in the digital media and many other factors. In these circumstances, it becomes imperative for the teacher to be aware of these things and try to help students to keep up this spirit of inquiry. It can happen when a teacher uses other supplementary approaches of learning teaching besides the traditional approach and conduct healthy discussion among students regularly, not only about the subjects taught by them but other things happening around us as well. We are usually so fixated on 'correct answers' in classrooms that even in practical sessions, students are preoccupied with 'getting the desired reading or outcome' rather than monitoring changes

with an open mind. In any event, the feeling of awe with which youngsters arrive at school has long since vanished. 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 make all the effort in this direction and appropriately adapt the strategies for the teaching-learning process.

1.12.0. 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. Teaching tactics are the methods used by a teacher to actively engage pupils in their learning. Effective teaching tactics address the demands of students with various learning styles as well as the learners' developmental needs. 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. Usually, when activities areplanned for the lesson, it is seen as extra work, but when well-thought strategies are involved in such a process, it becomes smooth and seamless. In this way, it helps to arrange activity in a logical form and fit it appropriately in the lesson plan without giving the feeling of over or extra baggage in the learning. It not only caters the what is to be taught but also how the particular lesson has been taught and the interest, need, and developmental level of the lesson is well taken care of by it. It makes all the learning activities playful and enjoyable.

It was discovered through the review of related 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. Dhar (2009) has proposed some strategies to develop scientific temper by saying that to instil a scientific temperament in students, they must be placed in situations requiring critical and rational thinking – such as role-playing, quizzes, and model-making – and they must also be made aware of the impact of science on society by arranging visits to factories, hospitals, and research laboratories, showing appropriate video films, organising talks by eminent scientists and technologies, and encouraging them to participate in Science exhibitions.

Joshua (2015) has developed a scientific temper package for students of secondary level in

which she has developed the following 12 strategies Brainstorming, Project Method, Colloquy, Summarising and Note making, Cooperative Learning, Games, Role Play, Team Learning, Debate, Issue-based inquiry, Dramatisation, Reflective Discussion and for these strategies she has developed 62 activities. Raghul, Majumdar and Shukla (2020) have found Children's logical thinking may be influenced and developed through science games. Both digital and traditional games have an impact, but simple games with a science component have a greater impact than heavier games that simply speak about science.

Based on all the above studies and reviews, the researcher developed her own set of strategies to enhance scientific temper in secondary students in the greatest possible manner by covering scientific temper in all components. While forming the strategies, not only teaching-learning but environmental, children's interests and many other factors were kept in mind. Even they were allowed to take various perspectives on the same problem so that they could think critically, as suggested by AAAS (1993). Students cannot learn to think critically, evaluate information, convey scientific concepts, build logical arguments, work in a team, or gain other desired abilities unless they are allowed and encouraged to do so repeatedly in a variety of settings. Keeping these all things below listed strategies were formed.

- ICT enabled learning
- Story Telling
- Questioning
- Timeline
- Debate
- Discussion
- Role Play
- News/Movie Analysis
- Drawing
- Worksheet

On the basis of the review of related literature, the researcher developed the above-listed strategies to enhance scientific temper in an integrated approach with the three subjects viz. Science, Mathematics and Social Science among secondary school students.

1.13.0. 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.

1.14.0. STATEMENT OF PROBLEM

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

1.15.0. 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.

1.16.0. 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 who did not expose to the developed strategies.

1.17.0. 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.

1.18.0. 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.

1.19.0. 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 only. The scientific is temper delimited to eight components viz. healthy scepticism, objective intellectual honesty, rationality, perseverance, freedom from superstition, curiosity, open mindedness, observation.

1.20.0. SCHEME OF CHAPTERISATION

The present study follows the below listed scheme of chapterisation

Chapter I give details of the conceptual framework of the present study. The chapter helps to build the rationale for the present study. The appropriateness of the study and the reason for conducting the study is presented in this chapter. The chapter also presents the details of the objectives of the study, the hypothesis framed, terms explained and operationalised and the delimitation of the present study.

Chapter II gives a detail of the reviewed literatures in the field of scientific temper and the related terms. This helped the researcher to decide upon the sample and population, and methodology to be adopted for the present study.

Chapter III Details the methodology adopted in the present study and the plan and procedure implemented. This chapter details the design of the study, the population and sample zeroed down, the procedure followed to develop the package and the tools used for data collection.

Chapter IV provides details of the analysis and interpretation of the data collected. The chapter also provides the findings of the present study and the implications of the same.

Chapter V comprises the major findings of the present study and the discussion of the results arrived at after the analysis.

Chapter VI presents the whole study in a nutshell. It also consists of the implications drawn from the present study and suggestions.