CHAPTER – I

Back Ground of the Study

1.1 Introduction

The present age is the age of explosion of knowledge. It is the century of science & technology. Science and technology is a great human enterprise, not only endless and faceless but also stable and fluid. It is a self-accumulating, self-accelerating, self-growing, self-pervading and self-correcting. It attempts to provide a body of knowledge through procedures that are demonstratively objective but often done in a subjective context. Open mindedness, curiosity, inquiry, collection of data, demand for verification and proofs, statistical reasoning, suspended judgement, acceptance of warranted conclusions and willingness to change one’s opinion in the light of new evidence is the ferments which characterise the scientific enterprise.

Science has several rewards, but the greatest, is the most interesting, difficult pitiless, exciting and beautiful pursuit that mankind has devised so far. In fact, if one were to consider the best art produced in the last century it can be termed as “Science”. Science education has an important role to play in the all-round cultural and societal development of human kind and for evolving a civilized society. The essence of scientific spirit is to think globally and act locally, since scientific knowledge is universal in nature while the fruit of science have some site specificity. Science untangles the threads that create the tapestry of our living world. It tries to work out how the threads merge in the overall ecological networks creating and maintaining the human
kind and also contributes to the thought process of human beings. Probably, it can also be the spirit that can possibly reverse the steady downward trend of our world’s health and wealth.

    Education is the foundation for scientific and technological advancements and personnel training of human beings. In the midst of overall anxiety of the modernization drive, Education especially Science Education should automatically get a strategic priority. One can at this stage ask why should we foster the spirit of enquiry and creativity among our students and that too a scientific enquiry and scientific creativity?

    Looking deeply into the nature of science, two aspects of education and its aims of teaching at school, it becomes quite clear that, as far as possible, teaching of science to the students should included proposing problems, refining and defining them more productively, setting up hypotheses and their testing with the help of controlled experiments, thinking out new solutions, discarding personal opinion in the light of new evidence and suspending judgement in case of conflicting evidence, discarding even the principle of authority, if found necessary, and in short, distinguishing among scientific information, popular information and beliefs etc. These initiations and expectations should be brought down to the children’s level of experience, comprehension and followed up later on to promote the quality of reasoning as the children go up the school ladder. These visualized and expected behavioural changes among the children are referred to as the outcomes of science teaching or education.
Thus, principle goal of science education is to create a man who is capable of thinking for himself and the world in which he is living. Further, science as a subject has three very important virtues peculiar to it. The study of science imparts training in scientific method and develops scientific temper, scientific aptitude & creative thinking. These qualities viz. scientific temper, scientific aptitude & scientific creativity are the major aspects of an individual to live as an efficient citizen in the present day of scientific society.

According to National Policy of Education, 1986 -

“Science education will be strengthened, so as to develop in the child, well developed abilities and values such as the spirit of inquiry, creativity, the courage to questioning and our aesthetic sensibility. Science education programmes will be designed to enable the learner to acquire problem solving and decision-making skills and to discover the relationship of science with health, agriculture, industry and other aspect of daily life.”

Thus, our science education programmes should be such to develop the qualities of scientific creativity, scientific aptitude & scientific temper among its learners. These qualities or outcomes of learning must be achieved to develop national as well as individual personality.

It is quite evident that processes that take place as part of formal school education have a significant role to play in development or achieving these outcomes. Yet, it is common to find that children undergoing similar kinds of curricular inputs grow up with different frames of mind in terms of degree of rationality and empirical orientation that characterises their life style. The reasons for this lie
perhaps in the fact that children are not exposed only to school experiences but they subjected to a variety of experience at home and a number of factors outside the home as well as such the mass media. Yet, the role of school in development of qualities – scientific temper & scientific creativity cannot be underrated. The uttermost need and importance of fostering scientific temper and scientific creativity among the students of our nation is stressed by our Honourable Prime Minister, in the inaugural session of Indian science congress

“I sincerely hope your deliberations will contribute to the fostering of scientific temper among our people. Science is not merely an instrument of economic and technological progress; it is also a means to acquiring a more rational approach to life.

The National Common Minimum Programme of our Government underlines the importance of integrating science with society and fostering scientific temper among the people so that we are able to deal with challenges at hand in a rational and reasonable manner.

Are we creating the required environment for innovation, for experimentation, for risk and creativity in our institutions? Are our research laboratories exciting places for the young, encouraging creativity and experimentation?

We must encourage a new wave of creativity and experimentation among our youth, Indian science needs a boost, a new lease of life, a push into future.¹

Science education occupies a very eminent place in curriculum both at school and university stages of education in India. Continuous advances in scientific and technological research have led to the growth

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¹ P.M.’s inaugural speech at 92nd session of Indian Science Congress, Jan. 3, 2005
and greater application of science in contemporary society. Accordingly, science becomes a priority area in education, both at the compulsory education level as well as the level of specialization. Science education is supposed to perform a two-fold task. The prime objective, in individualistic perspective, is the cultivation of a scientific temper, which includes a spirit of enquiry, a disposition to reason logically and dispassionately, a habit of judging beliefs and opinions on available evidence, readiness to reject unfounded theories and principles, the courage to admit facts, howsoever, unsettling or disagreeable they might be, and, finally, recognizing the limits of reasoning power itself. It is also expected of science education that it would give individuals a firm grasp of the concepts and processes of science and impart to them the ability to use the scientific method of problem solving and the techniques of observation and experimentation in handling problem of comprehension or life.

At the societal level, one of the major objectives of science education is to equip individuals to participate in the creation of a society which is free from poverty, hunger, disease and evils such as violence, exploitation, oppression, etc. Researches in science education have to be reviewed in the context of these aims and objectives. In the world of today where knowledge is being multiplied exponentially, science education will not be able to justify itself by remaining merely contented with the objective of imparting a certain quantum of scientific knowledge, however large it may be the quantum. Since the rate at which knowledge in science today gets obsolete is very high compared to that in the forties or fifties, it is essential that the emphasis of science education should be on the development of abilities and dispositions of
mind rather than merely the transfer of dead subject matter. So, it is an uttermost need to study the two important learning outcomes of science education namely – scientific temper & scientific creativity.

1.2 Importance of the study

Science, engineering & technology have become the growing edges of society all over the world. No wonder, when it is being said so vociferously day in and day out that we live in the age of science, engineering & technology. There is hardly any village in the world where the fruits or products of science in one form or another have not yet entered. It is a fine human achievement, which became possible, largely speaking, on account of the intensive application or pure scientific research made in the nineteenth century.

Science has improved the conditions and qualities of living and has saved mankind from excessive toil and boredom. The technological advances have sought to explore and multiply the possibilities of affording more effective and responsible methods of providing substance and comforts of living creation. Thus, from cradle to the grave, scientific discoveries and inventions have inextricably woven themselves into the fabric of human existence. “Our environment, to a great degree, is influenced by science. The cloth we wear, the house in which we live, the agricultural methods which produce our food and necessities, our automobiles, our telephones or radios, the electric appliances which are used in home all are based upon scientific information.”

Science has specific applications in many of our lives’ activities. It is in operation, in the application of the statistical methods. Psychology is a science applied

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2 Teaching of General Science in Tropical Secondary Schools, 1959, P.2
for securing information regarding the working of the mind and without advancement of technology; we would not be, at present, having any industry worth the name. When one postulates into the contributions of science to the various branches of human progress, one can only marvel at the advances made in medicine, astronomy, agriculture, engineering, oceanography, biology, aeronautics, space travel, microbiology, biotechnology and other innumerable other branches and sub-branches of scientific study. The explosion of scientific knowledge has been so rapid in our age, that with the passing of every decade, our stock of knowledge on any subject has tended to become double or more.

In the era of this scientific knowledge, science education has no longer confined to a few seriously devoted persons. Since life in the present world invariably warrants, to variable degrees, knowledge of scientific facts and laws, science has now become a necessity for everyone. Teaching of science for everybody has become an unavoidable part of general education. Nobody can raise questions on its inclusion as a subject in the school curriculum.

It is included in the school curriculum for the same reasons as any other subject, but in addition science inculcates certain special values peculiar to it and which no other subject can provide. But besides satisfying the usual needs for its inclusion as a subject in the curriculum such as intellectual, cultural, moral, aesthetic, disciplinary, utilitarian as well as vocational values-science learning provides training in scientific method and also helps to develop scientific temper, scientific aptitude & scientific creativity among the learners. These qualities imbibed by the
learner through learning science are of great value to a citizen living in the present society of science.

It has been rightly observed that the individual’s cultural and educational background will be incomplete if he does not possess the knowledge, which provides the foundation of moral culture. But according to Sukhonomosky “he is no longer willing to be a passive consumer of cultural riches and values. He feels the need to create; creative inspiration through work that produces cultural value is a vital condition for a full intellectual and emotional life.”

Thus, for proper and purposive use of the scientific creative inventions, the scientific temper based judgment is very essential. For advancement of culture and civilization in the adequate direction, the development of scientific temper and scientific creativity among younger generation is now considered as a vital task in our New Education Policy.

The Founding Fathers of the Indian Republic gave a great importance to the cultivation of “Scientific Temper” among the citizens of this country by suitably incorporating it in our constitution. This has to be contrasted with the views of the Founding Fathers of the American Republic where the emphasis is mainly on the political freedom of their country and individual freedom of their citizens. The European constitutions mainly concentrated towards the threat to freedom in the name of the religion. Probably, we have a lesson to learn from the background of the formulations of these constitutions. Even though, the

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common Indian felt that the European institutions and culture are alien to them; they recognized the need for modern western institution of Science and Technology, if the country were to achieve progress. This may be the reason why the concept of “Scientific Temper” was built-in in our constitution.

In the modern Indian context, the idea of inculcating scientific temper has been argued most forcefully by Pt. Jawaharlal Nehru-almost as a panacea for all the ills of India and the sine qua non for development of India. Nehru ji places two major arguments in support of giving such a primordial importance to the task of imparting scientific temper in every Indian citizen. These are: (a) protection against the superstitious beliefs of the traditional Indian society (b) It is only with the changed way of thinking that Indians can imbibe the scientific and technological capabilities essential for building an industrially developed society in India.

Nehru ji, strongly believed in reorienting Indian minds to adopt new ways of thinking and liberating the Indian mind from the clutches of superstitious beliefs which work against ‘modernisation.’ He was explicit in stating that we need to bring a ‘new set of values’ to Indian life. Development of ‘scientific temper’ is at the core of any such effort to usher in the ‘new set of values.’ These ideas of Nehru have set the tone of all our educational policies thereafter, which consistently ‘extol’ the value of inculcating scientific temper as a core value in all children through educational process. Successive governments also took necessary steps to establish scientific institutions that would foster such a temper and lead to technical excellence in this country.
Similarly, the importance & significance of scientific creativity in the present education system has been felt by the educationists of our country. Reports of Education Commission (1964-66), National Policy on Education, Programme of Action (1986,1992) and NCERT Curriculum Framework (1987) have all along emphasized the need to develop spontaneity, curiosity, independence in thinking, originality, courage to ask questions, in short, creative thinking skill and abilities. The child centred approach of education, as articulated by the National Policy on Education, implies creative approaches of teaching and learning, which are natural ways of learning for younger children to think, feel, imagine, inquire, play around with numerous possibilities, test ideas against the facts and so on. A creative teaching-learning process is friendly, informal, non-threatening, accepting and motivating. These make the teaching-learning process more responsive to children’s potentialities and thus may enhance among other things ‘learning to learn.’

There are also additional reasons, why it is important to develop scientific creativity in children. We are living in an age of increasing rates of change. The unprecedented changes will undergo, as we move to the second decade of the 21st century, demands that we must equip our children with such skill, abilities and temper so as to creatively meet the future problems of life. They should be trained to think creatively at the same time when they are being trained to think logically. Keeping in view, the type of abilities that we need to develop in children to live successfully in the years to come, knowledge alone is not sufficient. They must learn to apply acquired knowledge in novel ways in a range of situations and on a variety of subjects to meet the future challenge of
life creatively which are more complex than the problems with a single right answer mostly found in the examination.

Now, opportunities provided by the school for the development of creativity depend on a number of factors. Research is replete with evidences that teacher’s behaviour, attitudes, skills and classroom strategies contributes to the development of creativity in children. Implications of such research studies by and large are not known or available to school teachers of our country. The first document, challenge of Education – A policy perspective (1985) also expressed its concern on this point.

It has been noticed that vast majority of students are not exposed to the challenge which would develop their potential for creativity and innovation because the whole system of education is characterized by class work and examinations which emphasise rote-learning and repetitive exercises. Undoubtedly, this will require the overhaul of pedagogic methodology as well as the curricula and textual materials. These, however, will not enough. Something will have to be done to change the orientation, work ethics, knowledge and skills of the teachers, who will have to function much more creatively in learning rather than a teaching environment, in which they will have to struggle continuously with new ideas as well as new technologies.

Though the country today can claim advancement in various spheres like atomic energy, space and telecommunication, technological excellence, it is a matter of regret that the scientific temper and creativity among the general public, more so with the educated public has not progressed to the desirable degree. This could be partly due to
the imitation and uncritical acceptance of the alien culture by many youth of this country. This could also result from the fact that Indian thinkers continue to borrow, probably continue to follow, the methodologies adopted by other cultures without developing independent methodologies that can bring out solutions to the problems facing this country in various spheres of activity. Science is mainly concerned with understanding nature and probably unrevealing its laws and in this sense it is beyond the realms of political, social and religious boundaries. Science is only the human activity which has built-in self corrective mechanism while all other activities of human race require external force to bring about corrective mechanisms in their fold. This is amply demonstrated in the recent years by the fact that many of the recent false claims in scientific achievements (for example cold fusion, memory effect at infinite dilution or the generation of fuel from water) have been automatically rejected for acceptance by the scientific community in spite of other intrusions. It should not be construed that science is the most harmless and highly acceptable activity of human beings. In a sense it is so when it enhances knowledge and produces useful applications.

However, the practitioners of science can also misuse it for authority and prestige. This places a condition that the true scientific spirit should not only aim at enhancing knowledge and producing useful applications but also recognize and avoid misuse with authority for political and social implications. This brings us to another important aspect of the practice of science. In our anxiety to defer to European or western authority in science, we have cultivated a lack of critical and creative spirit. The original inquiring and creative spirit of the Indians
which was responsible for much enlightenment towards truth in the past is today slowly fading away.

Our forefathers have attained enlightenment since their inquiring and creative mind was totally free of other influences and hence could give rise to many path breaking discoveries and revelations. Today, this spirit has lost its significance and is mostly replaced by a spirit that lacks critical analysis and creativity and attempts to look for solutions from outside. Scientific knowledge generated by such a spirit without self critical analysis and creativity is totally incomplete. It should be realized that our education, especially our school education has not generated this “spirit” in the scientific temper and creativity of our budding young potential scientists and this will lead to disastrous consequences to our scientific and technological temples of this country. Indian civilization has always revolved around great temples of learning and knowledge like Nalanda and Kanchi. These institutions have been attracting great minds from all over the world in the past and it must be painfully admitted that in recent years, we have successfully reversed this trend. Great minds of our land are forced to look for greener pastures elsewhere except in the mother land.

One of the reasons for this could be that the critical spirit in human beings are subjected to agony when they find that activities in knowledge creation can also be advantageously used for furthering personal authority and self-glory. An enquiring mind has to be always selfless if it were to be critical. Scientific temper and scientific creativity are the intrinsic qualities. They have to be imbibed and not merely imparted. But in our anxiety not to invest our best brains outside the
country, we seem to have resorted to imparting scientific temper and scientific creativity in our education curriculum and not inculcating this spirit in our young minds.

This trend has to be reversed and teacher and the taught both have great roles and responsibility in this endeavor. Scientific temper and creativity have to be inherent qualities in our young minds and should be cultivated in them as a matter of routine and the curriculum based attempts will not be always complete and this has to be a societal responsibility also. Critical analysis is a quality which has to be cultivated and this quality is somehow missing in our education system due to our anxiety to impart formal knowledge fully at an early stage of the students career without even considering whether assimilation and acquiring have been accomplished. Great minds that our teachers are, they can contemplate this and devise methods to incorporate scientific temper and creativity in our young minds which will go a long way in the technological progress of this country. If India were to succeed and fulfill the visions of our great citizens of this country, we have to foster scientific temper and scientific creativity in our citizens with absolute capacity. It is easy to recognize, that these steps can be easily cultivated in our young minds so that they will blossom into worthy citizens of this great country in future.

1.3 Rationale of the Study

Creative students and particularly, creative science students have always been a subject of curiosity for researchers. However, only a few studies have been made, those too quite lately. Only after 1979, there are
now good quanta of work on creative children’s thinking, learning and working patterns.

Gopal, A.K. (1975), Jhag D.S. (1976) and Chauhan N.S. (1978) Sharma K. (1982) Yawalkar Y. (1986) Ray T. (1989) Ray D.K. (1990) and Sharma & Samidha (1992) investigated personality variables, personality correlates, personality traits and creative and found that creative science students were more suspicious and imaginative. Scientific creativity was normally distributed trait and the urban students were superior to the semi urban in scientific creativity. Creative students were significantly better in abstract thinking, emotional stability and intelligence; girls excelled boys in overall scientific creativity. High scientific creative adolescents differed markedly from the low scientific creative adolescents in terms of most of the personality traits and Datt K.L. (1989) and Srivastava, Veena (1992) finding also support the significant difference in scientific creativity of girls and boys but Shukla J.P. (1980) found that there was no significant difference among the students of different age group, different grade and sex as regards the various dimensions of scientific creativity.

Many researchers Golwakar, S. (1986), Ghosh S. (1986), Darchingpui (1989), Ghosh Shibani (1989), Rao, Digumarti Bhaskara (1990, Prasad Rajeshwar (2005), Bhaduaria M.B. & Jaiswal V. (2007) investigated scientific attitude, scientific aptitude, scientific interest and scientific creativity and found that non-tribal were be superior to tribal on three components of scientific attitude. Boys did not possess better scientific attitude than girls. There was a positive relationship between scientific aptitude and scientific attitude. The girls were more creative
than boys. A positive correlation between scientific attitude and scientific creativity was found. A significant role of scientific creativity was found in developing scientific aptitude of students. Bhaduaria M.B. & Jaiswal V. (2007) found that scientific creativity may be fostered by developing favourable attitudes towards science to some extent.

Agrawal, Kanta Prasad (1980) reported that few learning environment dimensions could predict creativity and its components. Some studies also conducted on scientific creativity and other cognitive and affective variables. Sansanwal D.N. & Sharma Deepika (1993) found in their studies that high self confidence students have high scientific creativity. Mottoo M.I. (1994) reported that high creative students had greater interest in scientific areas.

Padhi J.S. (1995) found strong positive relationship between creativity and academic performance. Raju S (1996) found in his study that there was a low positive correlation between creativity in science and social adjustment among ninth grade students. Sudhir M.A. & Khiangte Varpari (1997) in their study revealed that the high creative students were superior in abstract thinking. Agrawal S. Agrawal S (1999) reported that the intelligence was positively related to creativity.

Jo Son Mi (2009) showed that intrinsic motivation and context components did not predict scientific creativity. Marilyn Fryer & John A. Collings (1991) results indicate that creativity is perceived mainly in terms of ‘imagination’, ‘originality’ and ‘self-expression’. Marcelle A Siegel & Michael A. Ranney (2003) suggested through research work that it is possible to enhance students’ attitude about the relevance of science by using innovative and issue based activities. Stierna Johar &
Villalba Frnesto (2010) wrote in their research article that it was very difficult both conceptually and empirically to quantify scientific creativity in itself. Some researchers also investigated scientific creativity and problem solving ability of the students.

Raina K. Singh (1986), Radha Charan (1992) Mohanty S.K., Parida A.K. & Jena K.C. (2007) found that the problem solving ability was significantly related to three components of scientific creativity viz. fluency, flexibility and originality. Students who had high problem solving ability in science were more creative in science than their peers. Girls are superior to boys in problem solving abilities. There was a significant relationship between scientific creativity and problem solving. Scientific creativity has no effect on the development of problem solving ability as well as sex and locality does not play significant role in developing scientific creativity among students.

Lot of work has been found on scientific creativity but the researcher did not find so many studies on scientific temper and its related dimensions. Only one study on construction of scientific temper scale by Dubey K.K. (1992) was found. The mathematical structure of tools and tasks as used in this study showed that existence of two factors, namely curiosity and aversion to superstitions. Some other studies also conducted on different dimensions of scientific temper.

Bhushan R. (1985) investigated certain psychological correlates of belief in superstitions and found that superstitions were widespread among college students. Significant differences were found regarding beliefs in superstitions. Personality and attitudinal factors were closely related to belief in superstitions. Narayana U. Lakshmi & Suhame
Anjuli (2010) found that curiosity and open mindedness components of scientific attitude do contribute in developing environmental behavior among secondary school students.

This analysis might find acceptance among educationists and researchers in education but it is not enough, perhaps. Research in science education should be urgently addressed to the problem of developing a scientific temper and creativity in the students. Intensive studies will have to be directed towards these fundamental aspects of science education. What does the scientific temper consist of, precisely? How can it be assessed accurately? Which strategies are most appropriate to inculcate the spirit of scientific creativity in students? What steps should be taken to ensure that the temper of scientific enquiry is applied also to extra-scientific domains, including questions having socio-psychological import? Is there any relation between scientific temper and creativity? Do certain scientific values motivate creativity? Does scientific creativity work as guiding stars for temper? What are fundamental factors leading to correlate scientific temper and creativity? Research in science education awaits answers to these questions. To answer some of these raised questions on scientific bases, researcher identified the problem “An Investigation into the scientific temper in relation to scientific creativity of senior secondary science students.”

1.4 **Statement of the problem**

“A**n Investigation into the Scientific Temper in Relation to Scientific Creativity of Senior Secondary Science Students.”
1.5 Objectives of the study

Conceptual Objective

To construct a scale for measuring scientific temper of senior secondary science students.

Operational Objectives

1. To compare scientific temper of senior secondary science students in terms of group, sex and locality.
2. To compare scientific creativity of senior secondary science students in terms of group, sex and locality.
3. To compare scientific temper of high and low scientific creative senior secondary science students.
4. (a) To find correlation between scientific temper and scientific creativity of senior secondary science students.
   (b) To find the predicted value of scientific temper on the bases of scientific creativity as a predictor.

1.6 Hypothesis

1. There is no significant difference between scientific temper of senior secondary science students in terms of group, sex and locality.
   (a) There is no significant difference between scientific temper of PCM and PCB group of senior secondary science students.
   (b) There is no significant difference between scientific temper of senior secondary boy & girl science students.
   (c) There is no significant difference between scientific temper of senior secondary urban & rural science students.
2. There is no significant difference between scientific creativity of senior secondary science students in terms of group, sex and locality.
   (a) There is no significant difference between scientific creativity of PCM and PCB group of senior secondary science students.
   (b) There is no significant difference between scientific creativity of senior secondary boy & girl science students.
   (c) There is no significant difference between scientific creativity of senior secondary urban and rural science students.
3. There is no significant difference between scientific temper of high and low scientific creative senior secondary science students.
4. (a) There is no significant relationship between scientific temper and scientific creativity of senior secondary science students.
    (b) The value of scientific temper could be predicted on behalf of scientific creativity.

1.7 Definition of Terminology

It is worthwhile to define, operationally, some specific terms used in the study, these are as:

Scientific Creativity – Before defining the term “Scientific Creativity”, it is worthwhile to define the term ‘Creativity.’ There is no universally agreed definition of creativity. A great deal of mist surrounds the word ‘creativity.’ Since a person can behave creatively in numerous different ways, it is not strange that we have many definitions of creativity.
Torrance (1967) a leader in the development of tests to identity creative potential defines creativity as –

“The process of becoming sensitive to problems, deficiencies, gap in knowledge, missing elements, disharmonies and so on; identifying the difficulty: searching for solutions, making guesses or formulating hypothesis about the deficiencies, testing and retesting these hypotheses and possibly modifying and retesting them; and finally communicating the results.”

This attempt to define creativity in terms of the process of creativity is equally useful in all areas of the curriculum in mathematics, science, language, arts, etc. However, this definition is very much oriented towards the scientific dimension of creativity.

The definition of Torrance appears comprehensive and operational. He has emphasized the following aspects of creativity:

(a) Sensitive to problems.
(b) Identification of difficulty or problem.
(c) Formulating hypothesis as solution for the problem.
(d) Testing or verifying the hypothesis.
(e) Arrive at some conclusions or results.

This definition is based on the process of reflecting thinking, while reflective thinking involves awareness plus divergent thinking.

Torrance (1966) has explained creativity operationally, “creativity means those abilities measured by his tests of creative thinking and expressed accordingly by the subjects in verbal and three in figural (fluency, flexibility and originality) scores and also composite total verbal figural scores.”

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Back Ground of the Study

Lobart (1994) defined *scientific creativity as a dimension of sensitivity against scientific problems.*

Torrance (1962) defined “*creativity is an activity resulting in new products of a definite social value.*”

Barron F.X. (1969) defined “*Scientific creativity is the creativity in the specific field i.e. science*.” It is the process of formulating hypothesis in scientific situation, testing and retesting these hypotheses and modifying and retesting again and so on. A creative work in science requires experimentation, intuition, hardworking, insight and continuous involvement in thinking and rethinking.

The recent spurt in the critical study of human intelligence in general and creativity in particular, has culminated into the development of the Unified Theory of Intelligence by Prof. J.P. Guilford (1967), the Structure of Intellect (SI) model of which provides a sort of ‘Periodic Table’ for the basic ‘elements’ of the intellectual abilities of man. 120 such ‘elements’ or factors have been envisaged, each having three properties, taken one from each parametric group of qualities – Operations, Products and Contents – related to mental activities.

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Back Ground of the Study

**OPERATIONS** | **CONTENTS** | **PRODUCTS**
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Evaluation | Figural | Units
coNvergent production | Symbolic | Classes
Divergent Production | seMantic | Relations
Memory | Behavioural | Systems
Cognition. | | Transformations
| | Implications

Here, OPERATIONS means the type of mental operation required to solve a problem.

CONTENTS indicate the form in which the problem and its solutions are presented.

PRODUCTS are the ways in which the problem solving outcome, or products of the solution, are organised.

Creative activity of man consists of fluent production of items of information from memory, flexibility in utilizing them, elaboration upon what is given, and some novel, original transformation of the information matrix. Creative process come under the Divergent Production category – that of generating various logical alternatives. Creative performances depended upon a rich memory – store of information and ultimate operation of Divergent production, and the product of transformation with frequent mediate process of Evaluation.
While the Divergent Thinking abilities are generally considered to be responsible for creative responses, for scientific creativity, it is found that besides certain Divergent Thinking abilities, some factors under Convergent Thinking, Cognition and Evaluation categories are very essential.

The 29 SI-factors might be considered to be contributing largely to Scientific Creativity. Thus scientific creativity is a multidimensional attribute differentially distributed among people and includes chiefly the factors of fluency, flexibility, originality & elaboration.

**Scientific Temper** – It is difficult to give a universally acceptable definition of ‘scientific temper.’ The term is made of two words - “Scientific” and “Temper.” Moreover, the term ‘temper’ is closely related or derived from the term ‘Temperament.’

Although, temperament has sometimes been used synonymously with personality, there has been in the past as well as today considerable agreement among writers that temperament is one aspect of personality, namely, ‘the general affective nature of an individual as determined by his inheritance and life history’ (Warren 1934, P.273). In general, however, more emphasis has been placed upon innate factors than upon individual experiences as the determinants of temperament. Temperament has often been considered to be primarily, a matter of the characteristic, emotional experiences of an individual.

Thus, temperament is one of the most important dimensions of personality. It is a composite of several individual traits. To describe a person’s temperament is to describe such qualities abstracted from his
behaviour. Temperament is also used to demote the strength, vividness and other qualities attached to senses and to basic drives.

The word ‘scientific’ needs perhaps some explanation. In common words, there are two connotations: (a) what is done by scientists and how do they do, what they do viewing ‘scientist’ as the archetypal figure for being scientific. This is obviously a narrow definition. (b) It is also often considered that ‘to be scientific’ is the same as ‘to be systematic.’ This is a broad spectrum characterisation which cuts across disciplinary boundaries and perhaps pervades the whole of life going beyond academic persuasions. Even though, this is only a circular definition of what is being ‘scientific.’ It implies that to be scientific is to follow certain ground rules in approaching any issue or problem, whether in academics or elsewhere.

If one takes the latter as the guiding principle in describing scientific temper, one has to further analyse the ground rules that one commonly acceptable and, therefore, considered to constitute being scientific.

Generally, three elements seem to characterise the actions that are deemed scientific. These are (a) Observation: (b) Empirical or Experiential validation; and (c) Logical Reasoning or Rationality. In fact, these are considered to be the essential characteristics of a scientist expressed as, “what we can see, touch and measure is real, and that through a study of those real things we can arrive at an understanding of our world.”
Hence, it can be said that scientific temper is a personality dimension of a person associated with his/her basic derives to think or work in a systematic and scientific way.

Dr. S.S.Kalbag\textsuperscript{9} (1991) described that 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 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.

Perhaps the most important characteristic associated with scientific temper is untiring search for truth but with an open mind and a spirit is of enquiry. As Pt. Jawaharlal Nehru highlighted, "the scientific spirit is essentially, one of tolerance, one of humility, one of realisation that somebody else also have a bit of the truth." It is the basic conviction that objective reality can be perceived and understood with empirical explorations by any one and no one can claim monopoly of the truth in understanding the world. What is at the heart of this, open-minded enquiry is the respect for truth and for the approach adopted for exploring the truth. Exploration of the world with a scientific temper would invariably involve foretasting the outcome of the enquiry in the form of a hypothesis but without any dogmatism; and with a readiness to change one’s own expectations based on what is revealed through empirical experience.

\textsuperscript{9} Talk on AIR, Pune, 17.7.91 at 8.15p.m.
A person with scientific temper holds objective and empirical knowledge in esteem but without any disrespect to knowledge explored through other means. Scientific temper should help us to differentiate between knowledge acquired through strictly ‘personal experience’ and that, which is publicly verifiable. It helps us to differentiate between facts and opinion but without clearing the value of opinions in human life.

Generally, the following characteristics are associated with scientific temper-
1. Open-mindedness.
2. Curiosity.
3. Reasoning and Logical Thinking.
4. Judgement based upon scientific facts alone.
5. Willingness to test and verify conclusions.
7. Accuracy in Reporting.
8. Rejection of the principle authority.

**PCM and PCB Group** – In Rajasthan state, each student of science group has to choose a group of subjects at senior secondary level. In the present study, two science groups are considered. PCM, also known as non-medical group, consists of Physics, Chemistry and Mathematics as the optional subjects. PCB, also known as medical group, consists of Physics, Chemistry and Biology as the optional subjects.
1.8 Delimitations

The following are the delimitation of the present study –

1. The study is limited only to the senior secondary science students belonging to three divisions of Rajasthan State – Jaipur, Ajmer & Bikaner.

2. The study is limited to science students of PCM (Physics, Chemistry & Mathematics) & PCB (Physics, Chemistry & Biology) group only.

3. The study is limited to only urban & rural senior secondary science students.

4. The construction and standardisation of scientific temper scale is delimited to senior secondary science students in the age group 15-20 years in three divisions – Jaipur, Ajmer & Bikaner of Rajasthan state.

5. The sample of the study is 600 subjects both boys and girls students only.
REFERENCES

