Chapter 1
Introduction

*Men are all inventors sailing forth on a voyage of discovery* - Emerson
INTRODUCTION

There is a great importance of education in our life. A man starts learning in one form or the other right from his birth to death.

According to Swami Dayanand, the child starts getting education right from the womb of his mother. The beauty of life looks ugly without education.

According to T. Raymont “Education is that process of development which consists the passage of human being from infancy to maturity, the process whereby he adapts himself gradually in various ways to his physical and spiritual environment.”

1.1) Concept of Education

Education is a dynamic concept. Its meaning is always in the process of changing from time to time. Different Philosophers, Social Scientists and Educationists have defined education in different ways.

The word ‘Education’ has been derived from the Latin word ‘Educare’, which means to bring up or to nourish, the nourishment of the child from the point of his physique. The word education has also been derived from another Latin word ‘Educere’, which means to bring forth or draw out which means drawing out of the best in the child or providing guidance to him. Education is also viewed to be derived from another latin word ‘Educatum’ also which means the act of teaching or training.

The origin of the word Education is considered from E and Duco that is Duco means I lead and E means out of. Thus, education is that process which draws out the intrinsic powers of an individual.

1.1.1) Education according to Indian concept

According to Rigveda, Education is that which makes a man self reliant and selfless whereas in Upanishads, Education is that whose end product is salvation.
According to Gandhi ji, Education means an all round drawing out the best in child’s and man - body, mind and spirit.

According to Vivekanand, “Education is the manifestation of divine perfection already existing in man. He said, that education is needed, by which character is formed, strength of mind increased, the intellect is expanded and by which one can stand on one’s own feet”.

According to Tagore, “Education makes man’s life in harmony with all existence”.

According to University Education Commission Report (1948-49) In Indian tradition, “Education is not merely a means of earning a living, nor is it only a nursery of thought or a school for citizenship. It is initiation into the life of spirit, a training of human soul in the pursuit of truth and the practice of virtues. It is a second birth (divitiyam janma) i.e., “education for liberation”.

According to the report of Indian Education Commission (1964-66) “Education ought to be related to the life, needs and aspirations of the people and should be made powerful instrument of social, economic and cultural transformation”.

1.1.2) **Education according to western concept**

The western thinker Aristotle says “Education is the creation of a sound mind in a sound body”.

According to Pestalozzi, “Education is the natural harmonious and progressive development of man’s innate powers”.

According to John Dewey, “Education is the development of all those capacities in the individual which enable him to control his environment and fulfil his possibilities”.

According to Redden – “Education is the deliberate and systematic influence exerted by the mature person upon the immature, through instruction, discipline and harmonious development of physical, intellectual, aesthetic, social and spiritual powers of the human being according to their essential hierarchy, by and for the individual and
for the social uses and directed towards the union of the educand with his creator as the final end”.

There are many points of merit in the definition of Education of Redden because all the aspects of life of the individual have been taken into account in this definition.

1.2) **Constitutional bases of education**

After independence, the most significant achievement of the people of India is to give to themselves a new constitution. The constitution of India –the Charter of India’s Freedom-is a unique and rare blue print of democracy. As it embodies India’s full self-expression and mirrors the hopes and aspirations of the people.

Education finds an honoured place in this great document. The constitutions provisions related to education in the Constitution of India, The Preamble has a great bearing on educational policies and programmes. In the Democratic Republic Indian constitution, the various prominent features are:

a) Justice-social, economic and political contexts.

b) Liberty-of thought, expression, belief, faith, and worship.

c) Equality-of status and opportunity, and to promote them all.

d) Fraternity - assuring the dignity of the individual and the unity of the Nation.

e) Education - a state subject, according to entry 11 of List 2\textsuperscript{nd} - State List, of the seventh schedule of the constitution.

1.3) **Aims of education in India**

At the time of independence 85% of the population was illiterate. The condition of education was shaky .Education was reviewed in social, economic and politically contexts, reforms and policies formulated as education significantly contributes in social, economic and political stability and development of any nation.

The Indian government appointed various commissions to bring qualitative and quantitative improvements in education. They give much thought to aims and sources of education.
In 1964-66, the Kothari Commission laid down certain important aims of education, which are follows:

i- Increasing productivity

ii- Social development and national integration

iii- Language Policy

iv- Development of National Consciousness.

In Kothari Commission, in the aim of linking education with productivity, the commission emphasised Science education and also viewed the importance of science in productivity. The commission takes a pivotal stand on science education.

It visualises science as a basic component of education and culture. It not only necessitates making science as an integral part of education but also stressed the urgent need to raise the quality of science teaching to promote an ever-deepening understanding of basic principles, to develop problem solving analytical skills and to foster the spirit of enquiry and experimentation.

The scientific outlook is to become a part and parcel of our daily living. The commission in the chapter on ‘Science Education and Research’ states that the progress, welfare and security of the nation depend critically on a rapid, planned and sustained growth in the quality and extent of education and research in science and technology.

1.4) **Science and technological process**

In the line with the strategy of Kothari Commission, UNESCO's International Education Commission recommended as under:

"Science and technology must become essential components in any educational enterprise; they must be incorporated into all educational activity intended for children, young people and adults, in order to help the individual to control social energies as well as natural and productive ones—there by achieving mastery over himself, his choice and actions—and finally, they must help man to acquire a scientific turn of mind so that he becomes able to promote science without being enslaved by it".
The science education is inevitable for technical progress. Without the knowledge of science, the advantages of modern methods of agriculture cannot be achieved. Moreover, no industry can also be developed.

The teaching of science also proves useful for developing scientific attitude among the students which has a lot of importance in modern life. In the suggestion of importance of science in productivity—the commission says that in order to introduce new scientific methods in production in different areas, modern industries and technology in work experience should be included in place of old methods of production, the students should learn through machines and it should be considered a scientific basis for every activity.

**1.5) Science Education and National Policy on Education**

The resolution on National Policy on Education 1968 lays down the following principles in respect of science education and research: “With a view to accelerating the growth of the national economy, science education and research should receive high priority. Science and mathematics should be an integral part of general education till the end of the school stage”.

In National Policy on Education-1986 (NPE8.18), it is stated that the Science education will be strengthened so as to develop in the child well-defined abilities and values such as the spirit of inquiry, creativity, objectivity, the courage to question and an aesthetic sensibility.

**1.6) Concept of Science**

In the modern age of science, the knowledge of science considered to be superior to the knowledge of other subject. Science is the systematic knowledge of a particular thing. Man is curious by nature and always indulges in discovering the mysteries of nature which lead to accumulation of the body of knowledge about the nature through experiments and reasoning called science. Etymologically, the word ‘Science’ has been derived from the Latin word “Scientia”, which means to ‘know’. In the literal sense, science means the pursuit of knowledge, means knowledge of nature in the widest
possible form. Different people have given different definitions of science. Generally the knowledge gained in systematic way is a Science. The Science is a collection of facts. Science includes logical knowledge involving casual relationships. In sciences chemistry, physics, geology, zoology, botany etc. subjects are included. In general sciences, integrated curriculum is correlated with modern life.

1.6.1) Definitions of Science

According to B. F. Skinner “Science is first of all a set of attitudes. It is a disposition to deal with facts rather than with stones. But collection of facts is no more a Science than a heap of stones is a house”.

Cedric Griggs (1960) defines, science in fact is more than a subject, it is a method of acquiring knowledge and of necessity the approach must be corrected.

W. Pauli (1960) defines science, “The aim of science teaching is not in the acquisition of information and a few skills but to attain the understanding of the relationship which connects the answer to the problem.”

In 1960, Frederic Fitzpatrick, defines science, in the report “Policies for Science Education” as “Science is a cumulative and endless series of empirical observations which result in the formation of concepts and theories with both concepts and theories being subject to modification in the light of further empirical observations.

Science is both a body of knowledge and the process of acquiring and refining the knowledge. According to the Columbia Encyclopaedia ‘Science’ (1963) - “Science is an accumulated and systematized learning in general usage restricted to natural phenomenon.

The progress of science is marked not only by an accumulation of facts, but by the emergence of scientific method and of the scientific attitude.”

According to W.C. Dampier, “Science is an ordered knowledge of natural phenomenon and the rational study of the relations between the concepts in which those phenomena are expressed.”.
1.6.2) **Nature and Characteristics of Science**

As said earlier, man is curious with his advent on earth about everything, to gain experience, to explore, to experience, to know about the phenomenon occurring in the universe. With passage of time gradually man learnt to study the scientific phenomena which were later known as the scientific method of thinking and of investigating problems.

Science, as a system of searching the truth, is based on conclusions emerged as a result of empirical explorations and observations and using reasoning in correlating, in accumulation of ideas which provides better and more accurate answers to the problems related to different fields of knowledge like sciences, social sciences etc.

The term Science is now thought of as a method or attitude rather than a field of subject matter. It is method of inquiry that permits man to examine the phenomena of interest to him.

The nature and characteristics of science can be visualised through certain points which are as follows –

i- Science is a process as well as the product of the process. In the process form, it suggests the ways and means of exploring the truth and in its product form; it presents a systematic and organised body of useful knowledge.

ii- The process form of science is more important than its product form as the way of exploring the truth and acquiring knowledge is always given more preference in science than the mere memorization or gaining knowledge of the accumulated facts.

iii- Science constantly remains in search for truth and what it gets in account of this search, can never be taken as absolutely and permanently true.

iv- The method or process adopted by science is known as scientific method and is characterised by qualities like: validity, reliability, impartiality and objectivity in its procedure and approach.
Science develops scientific attitude among its readers by providing solutions to day to day problems. The development of such attitude is known as scientific attitude.

Thus, science can be seen to discharge two types of responsibilities, namely -
1. investigating and exploration of the facts, and 2. Building of a systematic and organised body of facts as a result of such exploration.

The term Science, therefore is a systematic method of inquiry or attitude towards exploring rather than a field of subject matter. It is described as a method of inquiry that permits man to examine the phenomena of interest to him.

Science is based on certain beliefs and assumptions. All events in nature are at least to a degree, lawful or ordered, predictable and regular. This order, predictability and regularity of nature can be discovered in the activities of the scientific method. Truth can ultimately be derived only from observation. Scientist does not depend upon authority as a source of truth, but relies upon empirical observation.

Thus the phenomena that can actually be observed to exist, lies within the domain of scientific method. The scientist maintains a doubtful attitude towards data. He regards findings as tentative unless they are verified. Verification of the findings requires that other scientists must be able to repeat the observations and get the same results.

The scientist is objective, impartial and logical in making observations, collecting and interpreting data. His personal bias does not in any way influence the truth and facts even when they are not, in conformity with his own opinions. Scientist does not bother about the moral implications of his findings. He always deals with facts and does not consider what finding is good or what is bad for us.

The ultimate goal of science is to integrate and systematize findings into meaningful pattern or theory. The theory, however, is regarded as tentative and not the ultimate truth. It is subject to revision or modification as new evidence is found.

**1.6.3) AIMS OF TEACHING SCIENCE**

According to All India Seminar on Science Teaching, held at Taradevi, the aims
for teaching Science at the high and higher secondary stage is to acquaint learners with the scientific method and enable them to develop the scientific attitude. Kothari Commission clearly states that at the secondary level, science should be taught as a discipline of the mind and a preparation of higher education.

Science education should aim for the development of scientific attitude among the learners. It should aim in providing proper opportunities for the development of scientific temperament and attitude among the students. It should develop in them a spirit of curiosity for knowing about the things, developing scientific thinking and scientific creativity in the students in discovering, exploring the nature and creating unique ideas and products.

Students should penetrate deeply into the nature of the things and events surrounding them and they should do all this quite systematically by adopting scientific method of thinking and solving the problems. The achievement of aim of teaching science is possible only when virtues of scientific attitude, scientific creativity and scientific temperament are developed among students.

1.7) Concept of Creativity

There’s relatively very small portion of world’s population who could devise new methods, reorganize existing ideas and offer improved solutions to the familiar problems.

According to Guildford (1959), “Creativity is the ability to go beyond the immediate solution, ability to redefine the problem or some part of it, ability to cope with ideas that are unusual and ability to change or having new approach to the problems”.

Murray (1959) says “Creativity refers to the occurrence of a composition which is both new and valuable”.

Torrance (1962) defined creativity - “Creativity is an activity resulting in new products of a definite social value”. Creativity is defined as the tendency to generate or recognize ideas, alternatives, or possibilities that may be useful in solving problems, communicating with others, and entertaining ourselves and others”.
Papalia and Olds (1993) – “Creativity is the ability to see things in a new way, to see problems that no one else may even realize it exist, and then cope with new, unique and effective solution to these problems”.

Three reasons why people are motivated to be creative:

i. Need for novel, varied, and complex stimulation.

ii. Need to communicate ideas and values and

iii. Need to solve problems.

In order to be creative, there is a need, to be able to view things in new ways or from a different perspective among other things, the need to be able to generate new possibilities or new alternatives. Tests of creativity measure not only the number of alternatives that people can generate but the uniqueness of those alternatives. the ability to generate alternatives or to see things uniquely does not occur by change; it is linked to other, more fundamental qualities of thinking, such as flexibility, tolerance of ambiguity or unpredictability, and the enjoyment of things heretofore unknown.

According to Michaly Csikszenmihaly –“Creativity is commonly used for persons who express unusual thoughts, who are interesting and stimulating - in short, people who appear to be unusually bright and people who experience the world in novel and original ways.

These are personally creative individuals, whose perceptions are fresh, whose judgements are insightful, who may make important discoveries, about which only they know about. Individuals who have changed our culture in some important way like Leonardo, Edison, Picasso, Einstein etc.

“Creativity is any act, idea, or product that changes an existing domain or that transforms an existing domain into a new one. What counts is whether the novelty he or she produces is accepted for inclusion in the domain.”

CHARACTERISTICS OF THE CREATIVE PERSON:

i- Creative individuals have a great deal of energy, but they are also often quiet and at rest. Creative individuals tend to be smart, yet also naive at the same time.
ii- Creative individuals have a combination of playfulness and discipline, or responsibility and irresponsibility.

iii- Creative individuals alternate between imagination and fantasy at one end, and rooted sense of reality at the other.

iv- Creative people seem to harbour opposite tendencies on the continuum between extroversion and introversion.

v- Creative individuals are also remarkable humble and proud at the same time.

vi- Creative individuals to a certain extent escape rigid gender role stereotyping and have a tendency toward androgyny.

vii- Generally, creative people are thought to be rebellious and independent.

viii- Most creative persons are very passionate about their work, yet they can be extremely objective about it as well.

ix- The openness and sensitivity of creative individuals often exposes them to suffering pain yet also a great deal of enjoyment

Trow Bridge (1996) comments “The creative person can contribute something to society which the intelligent person cannot. Similarly the intelligent person makes the contribution which the creative one cannot. Also the achievement of creatively superior individual do not equal to the sum of the achievements of a number of less creative people. Creativity is a unique gift of nature to man.

According to Michele Shea - “Creativity is ....seeing that doesn’t exist already. You need to find out how you can bring it into being, and in that way be a playmate with God’’. It is a potential which influences human active in almost all spheres – scientific, technical and artistic.

Creativity whether that of a poet, or a sculptor or that of a carpenter or farmer, mechanic or engineer or a scientist or philosopher involves an active interaction of the individual with his surroundings, all the manifestations of the nature and materials and the people around.
According to Webster’s Dictionary, the definition of creativity is artistic or intellectual inventiveness. Creativity is marked by the ability or power to create or bring into existence, to invest with a new form, to produce through imaginative skill, to make or bring into existence something new. When you create something, you are actually bringing it into being, making it from nothing. But how do you make something from nothing? How do you achieve creativity? What is the essence of creativity? Some have said- it must be divine inspiration.

Creativity is simply thinking the impossible, and then doing what no one else have done before, sometimes developing completely new worlds. If you’ve taken a new approach to a problem and it works, then you’re using your creativity. Generally, creativity comes in many forms, scientific creativity, resulting in inventions or medical cures, artistic or musical, resulting in beautiful paintings, sculptures or operas and songs, creative writing, resulting in novels, short stories and poems.

Creativity can even be as simple as arts and crafts, such as needle arts, yarn crafts, and woodcrafts - things you create with your own two hands. The important thing to remember is that creativity includes generating the idea or concept, as well as applying that idea and producing or manifesting the end product or result. Creativity or imagination is an integral part of being human and separate us from the animal world.

Carl R. Rogers said, “The very essence of the creative is its novelty, and hence we have no standard by which to judge it”.

*Maya Angelou said-You cannot use up creativity. The more you use the more you have*. And John

Haefele (CEO and entrepreneur) defined creativity as the ability to make new combinations of social worth.

Roger von Oech explains creative thinking, as it involves imagining familiar things in a new light, digging below the surface to find previously undetected patterns, and finding connections among unrelated phenomena. Example: *Creativity is like a cat chasing its tail.*
In the act of creating or in solving problems in creative ways we often go round and round in endless circles wanting to pounce on an idea. Sometimes the answer or solution is right before our eyes but we cannot see it. In order to find the solution, find the missing piece, solve the problem, we need to just look at something familiar in a new and different way.

**OTHER PERSPECTIVES OF CREATIVITY – CONVERGENCE AND DIVERGENCE:**

A great deal of effort has been put forth defining creative problem-solving. In one of the more common definitions of creativity has to do with dissecting creative thought into a process of dual exchanges through the melding of two types of thinking – a) convergence and b) divergence.

The divergent thinking usually includes the ability to elaborate, and think of diverse and original ideas with fluency and speed. Ideating and brainstorming are premiere examples of this type of thinking. Divergent thinking emphasises diversity of ideas. Originality springs from divergent thinking. Students using a divergent approach to the solution of problems begin to look at problems in a new light. Divergent thinking opens thought by providing a multiplicity of ideas.

In creative production both thought processes and diverse ideas in numerous quantities are necessary. The creative person narrows and refines the ideas. Specifically in creative problem solving, or in any complex problem solving activity for that matter, one needs to be able to weave in and out of divergent and convergent thought patterns in arriving at an appropriate conclusion specific for a given situation.

Convergent thinking is defined as the ability to use logical and evaluative thinking to critique and narrow ideas to ones best suited for given situations, or set criteria. We use this type of thinking when we make crucial and well-formed decisions after appraising an array of ideas, information, or alternatives. In convergent method thinking emphasis is given to activities that are directed toward a correct answer.

The process of creativity involves the recognition of a problem or the encounter; the classification and assessment of different components of the problem or delineation;
manipulation and linkage of ideas to solve the problem or revelation and refinement of the ideas or confirmation and summation. Both convergent and divergent thinking are involved in the process of creativity.

**TYPES OF CREATIVITY:**

Taylor (1959) described five types of creativity on the basis of strength of quality and types of products, a) Expressive b) Productive c) Inventive d) Innovative and e) Emergentive. And

De Haan and Havighurst (1969) have mentioned three fields of creative activity:

i- Affective creativity in which emotions, senses and feelings of the creator act as a media.

ii- Functional or problem solving creativity which is related to solutions of social and mechanical problems, and

iii- Abstract creativity that deals with the concepts, definitions, abstractions and generalizations.

Ghiselin (1963) has advocated two levels of creativity: 1. Creative action of higher order which alters the universe of meaning, or some new order of significance. 2. Creative action of lower order which gives further development to an established body of meaning through initiating some advance in its use.

Marksberry (1963) accepted, the degree the of creation as the criterion of classification, and believed that “there are continuous gradations of creativity extending from the spontaneous drawings of children to the high level types illustrated in the production of such creations as space satellite”.

Lehois (1963) added level of intensity to the degree of creation as criteria of classification of creativity. His two types of creativity include (i) Macrococomic (ii) Microcosmic. According to the former, the man is simply growing and developing as a human being whereas the latter type creativity is engaged in a particular set of creation; such as painting, sculpture, etc.
His classification based on level of intensity includes three types: 1. Spontaneous-expressive 2. Technical-inventive 3. Integrative-emergentive. The third category yields highly original product widely applicable and useful.

### 1.8) Concept of Scientific Creativity

Scientific creativity is in which one deals with the unusual and original excellence in the field of science or scientific productivity and the most important aspect of scientific creativity is insight, which helps the matrices of thought and create ideas in the fields.

In 1962, Torrance has conceptualised 'Scientific Creativity' as a "process of becoming sensitive to problems related to science, deficiencies, gaps, missing elements, disharmonies, identifying the difficulty searching for solutions, testing and retesting of these hypotheses in science and possibly modifying and retesting them and finally communicating the results".

As such, scientific creativity is a creative thinking through the media of science (Lacklen, 1964). It is a multidimensional attribute, differentially distributed among people and chiefly includes such factors as fluency, flexibility, originality and inquisitiveness.

The scientific creativity as conceptualised by Mackinnon (1963) involves the creation of scientists and engineers who act only as mediators between externally defined needs and goals. As such, product is neither related to the creator nor to his needs. It is an objective creativity meeting the social needs on some aspect of the environment in such a manner as to produce a novel and unique product. The functional or problem solving creativity as conceptualised by DeHaan and Havigthurst (1961) which involves situations concerning the solutions of mechanical and social problem with a touch of abstract creativity, comes within the preview of scientific creativity. Scientific creativity is objective in its conception.

Mac Kinnon (1963) has classified creativity into three types:

**Type 1 –**
Artistic creativity is the creativity in which the product of creation is an expression of their inner states of the creator; e.g. his needs, perception, emotions etc. The creator externalizes some of these inner states into any external things or public field. The art of poetry, painting, sculpture and such other products find expression in the creative products of such creators.

Type 2 –

Scientific creativity is the creativity in which the product is not related to the creator or his inner states; but it involves situations concerning the solutions of mechanical and social problems existing in the environment and in which the creator functions only as a mediator between externally defined needs and goals in his attempt to produce a novel or unique product or discover the best solution by manipulating primarily rooted in creator’s inner world whereas the latter has its roots in external world.

Type 3 –

Technical Creativity- although it has relatively lower social prestige, it is the creativity related with technological processes and inventions carried out in industrial laboratories.

Technical creativity is not only an expression of the creator characterising a very personal product, but also at the same time an impersonal meeting the demands of the external problem, cutting across both types of creativity, i.e Type-1 and Type-2.

The contributions of the investors, sculptures, painters, designers, architects, and others to the society are classified under Type3. As such Type 3 creativity meets demands of the creator as well as of the society dealing with immediate social problems.

Hebb’s(1949) classification of creativity very well covers Type3 creativity in which he has conceptualised an integrated harmony between external world of reality and creator’s internalised needs.
Third Type - The technical creativity - has relatively a lower social prestige; though the technological inventions and advancement largely shape the national progress and prosperity.

The technical creativity is mostly an outcome of the institutionalization process and team work. Technical inventions are increasingly carried out in research institutes, design offices, industrial laboratories and dominated by team work in contrast to the individualised characteristics of the artistic or scientific creativity.

The frequency and familiarity of the creative products of the latter make the artists and scientists more popular among the public, thereby, raising the social prestige in comparison to creative technicians.

1.8.2) **Nature of Scientific Creativity**

The scientific creativity is a fact-finding creative thinking process involved in the pursuit of consuming scientific procedures and methodology. As such, scientific creativity takes its refuge from truth and ends in truth.

Scientific creativity can be accounted for on the principles of scientific thinking. Scientific products are evaluated by logical consistency. The scientific creativity products are objective and scientific. Scientific creativity produces more of divergent products ensuring more of objectivity; facilitating scientific evaluation of creative products in science. Scientific creativity functions on divergent thinking processing.

Scientific creativity is insightful and imagination-oriented. Insight and imagination enrich the products of scientific creativity. The scientist catches the insight and develops his imagination. Sensitivity to problem functions in scientific creativity.

Scientific creativity yields socially useful and serviceable products in the process of meeting the needs and demands of the external world. The products so generated by transformations of objects in reality in scientific creativity enhance their meaningfulness and credibility.

Scientific creativity depends on the reality-oriented data that need exploration, examination and investigation with a view to discover the truth existing in the external
world. The scientific creative person devotes his energies and thoughts to impersonal objects by being neutral to his perceptions and emotions. Thus, scientific creativity is scientific in orientation, objective in evaluation, impersonal in procedural operation and unbiased and non-emotional in treatment.

Trilling (1955) observed that ‘artists are more wrecked by conflicts and neurosis than creative scientists’, the scientist conceals all his personal attributes and emotional states in the process if scientific discovery.

Scientific creativity is an objective representation of the relationships existing in the external world between various objects and things, acquired through pursuit if truth in nature. As such, science creates a sense of wonder and deepens man’s consciousness of the world around.

Science seeks to uncover the secrets of nature, to understand the causes of things and phenomena so that we may learn how to control nature for enrichment of human life. For this, science has to probe deep into nature to search for truth and this is not possible without creative imagination (Salmat Ullah, 1972).

MacKinnon (1978), said that in Scientific Creativity, it is argued that the product is unrelated to the creator as a person, who in his creative work, acts mainly as a mediator between externally defined needs and goals. However, in the highest reaches of science, as well as of art, it seems clear that, there is connection, albeit, a mysterious one, between affectively and the creative process.’

Zbigniew Pictrasinski (1969) specifies three basic spheres of creativity: the artistic, the scientific and the technical. The type of creativity is determined by the type of creative product involved; since each sphere of creative process produces specific form of product.

He (1969) points out that artist creates new aesthetic values; scientist discovers unknown properties and laws in the realm of matter. The inventor develops new and fruitful solutions to technical problems, in the form of complicated machinery or technological procedures; for example, relying upon the findings of scientific research.
The utilitarian character of his products commits the inventor to strict requirements of a
technical and economic nature.

**SCIENTIFIC CREATIVITY IN INDIAN CONTEXT:**

In India, V.P Sharma and J.P Shukla (1985) conceptualised ‘scientific creativity’
as ‘process oriented concept’ measuring the extent of scientific temper and talent on
common contents of science and technology.

They states that ‘Scientific Creativity’ may be considered as specific creative
expression, unique production and divergent thinking in science and technology. It may
be a unique scientific process responsible for novel scientific excellence and
accomplishments in science and technology.

In Indian context, developing scientific creativity the traditional techniques and
conventionalisation tend to thwart the scientific creative process and make the individual
conformist to social norms.

Self-directed learning, imitativeness, intuitive responses, and emotional
excitation facilitate the individuals to become creative artists, scientists and inventors.
The technical invention is characterised by sequential refinement and improvement
whereas the scientific inventions are characterised by methodical operations.

The identification of hidden relationships and the advancing of hypothesis, the
detection of the causes of failures, improvement of methods, techniques and scientific
apparatus, are always codified in the scientific inventions. Spirit of enquiry, vivid
imagination, superior intelligence, independence of judgement, perseverance, tolerance
for failure and ambiguity, enthusiasm for the exploration of new problems, and
concentration of all efforts upon the test are some of the important traits that make the
individual efficient scientist and inventors.

The national system of education has designed to teach a number of subjects
which could easily be grouped into five heads: science, mathematics, language, social
study and arts and crafts. The political-oriented educational system could not reorient the
children for creative thinking in either of these subjects.
The most challenging serious shortcoming of our national pattern of education is that it ends to encourage dependence upon planned learning experience. The pupils are not given opportunities to think for themselves, to discover new and original solutions, to suggest novel ideas.

The unusual answers and ideas are rather discouraged, the brilliancy and originality in thought and expression which may function as remedial measure for our country’ national problems beset unless and until the school takes up the responsibility for the proper promotion and development of the creative talents.

The country’s huge national rich resources would go on wasting; and the society as a whole would be deprived of their valuable contributions towards its welfare and prosperity. In the light of the defects existing in the present system of education, it is, rather, imperative to discuss the ways and means of promoting the teaching of creative thinking in various scholastic subjects in the educational institutions.

However, it is well known that in the process of scientific creativity the scientists illumination occurs only in an individual when he have spent sufficient time with the problem and kept on worrying about it on and off during incubation period. The preparation takes a long time of getting experience, formulating hypothesis and verification.

The process of scientific creativity involves systematic and logical approaches to the verification of results. The scientific creativity springs from “Truth” and ends with “Truth”. It is functional type of problem solving type in terms of DeHaan and HavingHurst which necessarily involves situations and social problems with a touch of abstract thinking ability.

1.9) Concept of Temperament

In psychology, temperament refers to those aspects of an individual’s personality, such as introversion or extroversion that are often regarded as innate rather than as learned.

Allport (1961) defined temperament as the characteristic phenomena of an individual’s emotional nature including his susceptibility to emotional stimulation, his
contemporary strength and spread of response, the quality of his prevailing mood and all peculiarities of fluctuation and intensity in mind.

This phenomenon is being regarded as depending upon constitutional make up and therefore largely hereditary in origin. In 1986, Thomas and Chess define temperament as the behavioural style or how of the behaviour.

1.9.1) Temperament Characteristics

Research by Thomas and Chess used the following nine temperament traits in children, based on a classification scheme developed by Dr. Herbert Birch. The nine temperament traits are:-

i- Activity: Activity refers to the child's physical energy. Is the child constantly moving, or does the child have a relaxing approach? A high-energy child may have difficulty sitting still in class, whereas a child with low energy can tolerate a very structured environment. The former may use gross motor skills like running and jumping more frequently. Conversely, a child with a lower activity level may rely more on fine motor skills, such as drawing and putting puzzles together. This trait can also refer to mental activity, such as deep thinking or reading—activities which become more significant as the person matures.

ii- Regularity: Regularity, also known as rhythmicity, refers to the level of predictability in a child’s biological functions, such as waking, becoming tired, hunger, and bowel movements. Does the child have a routine in eating and sleeping habits, or are these events more random? For example, a child with a high regularity rating may want to eat at 2 p.m. every day; whereas a child, lower on the regularity scale may eat at sporadic times throughout the day.

iii- Initial reaction: Initial reaction is also known as approach or withdrawal. This refers to how the child responds (whether positively or negatively) to new people or environments. Does the child approach people or things in the environment without hesitation, or does the child shy away? A bold child
tends to approach things quickly, as if without thinking, whereas a cautious child typically prefers to watch for a while before engaging in new experiences.

iv- **Adaptability**: Adaptability refers to how long it takes the child to adjust to change over time (as opposed to an initial reaction). Does the child adjust to the changes in their environment easily, or is the child resistant? A child who adjusts easily may be quick to settle into a new routine, whereas a resistant child may take a long time to adjust to the situation.

v- **Intensity**: Intensity refers to the energy level of a positive or negative response. Does the child react intensely to a situation, or does the child respond in a calm and quiet manner? A more intense child may jump up and down screaming with excitement, whereas a mild-mannered child may smile or show no emotion.

vi- **Mood**: Mood refers to the child’s general tendency towards a happy or unhappy demeanour. All children have a variety of emotions and reactions, such as cheerful and stormy, happy and unhappy. Yet each child biologically tends to have a generally positive or negative outlook. A baby who frequently smiles and coos could be considered a cheerful baby, whereas a baby who frequently cries or fusses might be considered a stormy baby.

vii- **Distractibility**: Distractibility refers to the child’s tendency to be sidetracked by other things going on around them. Does the child get easily distracted by what is happening in the environment, or can the child concentrate despite the interruptions? An easily distracted child is engaged by external events and has difficulty returning to the task at hand, whereas a rarely distracted child stays focused and completes the task at hand.

viii- **Persistence and attention span**: Persistence and attention span refer to the child’s length of time on a task and ability to stay with the task through
frustrations—whether the child stays with an activity for a long period of time or loses interest quickly.

ix- Sensitivity: Sensitivity refers to how easily a child is disturbed by changes in the environment. This is also called sensory threshold or threshold of responsiveness. Is the child bothered by external stimuli like noises, textures, or lights, or does the child seem to ignore them? A sensitive child may lose focus when a door slams, whereas a child less sensitive to external noises will be able to maintain focus.

Generally, temperament can be regarded as something that partially influences the way the person behaves, react to other people and to the situations in particular.

1.9.2) FOUR CLASSICAL TEMPERAMENTS

In the second century A.D, the physician Galen described four temperaments—sanguine, choleric, melancholic and phlegmatic which are based upon the four humours or bodily fluids. These became known as the four classical temperaments. The four classical temperaments are as follows:

A- Sanguine: are extroverted, very social people. Sanguine can also mean very sensitive, compassionate and thoughtful. Not very dependable. These people are considered to be least depressive due to their pro-activity and energy. However, this influences the fact that these kind of people sometimes get tired trying to do everything at the same time and fit every. Sanguine are prone to seasonal depression and mood swings because they are highly influenced by outside such stimuli as weather, other people’s moods, even food etc.

B- Choleric – this person is a doer. They have a lot of ambition, energy and passion. Choleric types rarely get depressed even they naturally like drama. Then they get depressed it is because of some significant loss or someone really hurt them. Then they will let whole world around to know that they are depressed but as soon as they will see something interesting to do they will get over it.
C- Melancholic – are a thoughtful ponderer, kind, considerate, perfectionists. Melancholic types tend to get depressed more easily than any of the others. Phlegmatic may always seemed depressed-even they are not, but melancholic are actually the ones to suffer from almost constant self-induced depression caused by their over-evaluation and reflection on life. These are the kind of people who have troubles letting things go and often see a problem where it does not actually exist.

D– Phlegmatic – are self-confident and kind. They prefer stability to uncertainty and change. They can be dependable. They are simply the people who like moderate and low-key lifestyle. These people are naturally calm and not too much expressive. Their needs are fulfilled in this simple and quiet life, in fact most phlegmatic are completely happy.

1.10) Concept of Scientific Temperament

According to Kunnath (1977) – Scientific temperament means ‘a spirit of true critical enquiry’ that demands the freedom to enquire, to question the prevailing ideas and to alter, modify or discard in favour of new ones.

Scientific temperament is reflected in the behaviour such as exploratory, inquisitive, searching attitude and questioning mind. It involves passion for facts, clarity of vision and expression, interrelations of things, a spirit of science etc.

Scientific temper of the child describes an attitude which involves the application of logic and the avoidance of bias and preconceived notions. Discussion, argument and analysis are vital parts of scientific temper. The scientific temper blends modesty and humility with self-reliance and initiative.

According to the Constitution of India – ‘To develop scientific temper’ is one of the fundamental duties of the Indian citizens. Scientific temper implies freedom of speech, academic freedom and freedom of the press (a sense of critical attitude that discourages blind submission), rationality, and tentativeness of truth, objectivity and humanism. Scientific temper depends on a change in beliefs, traditions, customs and
organized scepticism – a temporary suspension of judgments and detached scrutiny of beliefs in terms of empirical facts and logical criteria.

The Fourth survey of Research in Education (1988) emphasized the need of research in the study of scientific temper. Science education at the individual level is cultivation of scientific temper which includes a spirit of enquiry, a disposition of 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 the might be and finally recognizing the limits of reasoning power itself and the ability to use the scientific method of problem solving in handling the problems of life and society.

The development of scientific temper often remains confined to the cultivation of a mere attitude of questioning. But there are important ingredients of scientific temper and all of them need to be developed as adequately as possible.

A few of them are impartial observation, untiring experimentations, unprejudiced considerations of ever point of view relevant to the enquiry and courage to go to the end of enquiry, until ascertainable truth emerges through a process of verification and utmost possible synthesis of argument and counter arguments.

But in order to enhance the pace of development, to progress, to develop scientific temper, to solve economical and cultural problems through the right use of scientific and technological knowledge, the positive encouragement should be given to the contemporary teachers for embodying in themselves this ideal.

Scientific temper is necessary for all and not only for professionals who practice and deal with their applications. It is a dynamic device to minimize authoritarianism and to wither the estate of science criticism, even self criticism for self reliance through innovation.

The Scientific Temperament/Scientific temper is the state or condition or the bent of mind – working on any problem, process, situation, incident arising and faced by the students in school, in their daily life and society.
A student having inculcated the scientific temper showed impartial observation, experimentation, unprejudiced objectivity, creativity, aesthetic sensibility, spirit of enquiry, courage to question and to go to the end etc.

In developing scientific temperament in child- understanding of child’s temperament can help reframe how parents interpret children’s behaviour and the way parents think about the reasons for behaviours. For the parents having access to this knowledge now helps them to guide their child in ways that respect the child’s individual differences.

By understanding children’s temperaments and our own helps adults to work with them rather than try to change them. It is an opportunity to anticipate and understand a child’s reaction. It is also important to know that temperament does not excuse a child’s unacceptable behaviour, but it does provide direction to how parents can respond to it. By making small and reasonable accommodations to routines can reduce tension. For example-a child who is slow paced in the mornings may need an extra half hour to get ready. Knowing who or what may affect the child’s behaviour can help to alleviate potential problems.

Although children obtain their temperament behaviours innately, a large part that helps determine a child’s ability to develop and act in certain ways is determined by the parents. When a parent takes the time to identify and more importantly respond to the temperaments they are faced with in a positive way it will help them guide their child in trying to figure out the world.

Recognizing the child’s temperament and helping them to understand how it impacts his/her life as well as others is important. It is just as important for parents to recognize their own temperaments. Recognising each individual’s temperament will help to prevent and manage problems that may arise from the differences among family members.

Temperament also continues in adulthood, later studies by Chess and Thomas had shown that these characteristics continue to influence behaviour and adjustment throughout the life-span.
1.10.1) CONCEPT OF SCIENTIFIC ATTITUDE AND SCIENTIFIC TEMPERAMENT

The chief aim of education is to develop scientific attitude among citizens and enable them to think objectively on the basis of verified data and conclusion. Scientific attitude refers to an individual’s outlook towards life. It means willingness to adopt scientific approaches and procedures for resolving issues, assessing ideas or information.

Robert Ebel (1997) defines attitude as a mental condition, a stabilized mental setup which expresses itself in a tendency to react to any member of a class of stimuli in the same general way.

According to NSSE, “Scientific attitudes can be defined as open-mindedness, a desire for accurate knowledge, confidence in procedures for seeking knowledge and the expectation that the solution of the problem will come through the use of verified knowledge”.

According to another view, scientific attitudes include freedom from bias, prejudice and superstitions, open mindedness, critical mindedness, intellectual honesty when new evidence is available.

Thus, the scientific attitude of an individual enables him to develop an understanding and intellectual integrity to shift truth from falsehood, facts from propaganda and to reject the dangerous appeal of fanaticism and prejudice. In short, greater the extent of scientific attitude in an individual, the more objective and critical he is in his decision making on the basis of verification of data.

1.10.2) DIMENSIONS OF SCIENTIFIC TEMPERAMENT

An individual having inculcated scientific temper bears certain dispositions or dimensions which are as follows:

1. **Spirit of Enquiry** - to discover new knowledge

2. **Creativity** means - dynamic nature.
3. **Objectivity** - reliance on facts, based on observation only and not on faith.

4. **Courage to question** - includes questioning attitude

5. **Aesthetic Sensibility** means - appreciation of truth, goodness and beauty etc.

6. **Experimentation** - includes untiring nature, testing, self discipline etc.

### 1.1.1) Concept of Institutional Climate

The Institutional climate/school climate is the total climate of the institution i.e. school. It generally refers to the psychological climate of the school as perceived by the students in school. The institutional/school climate is equated with, the ecology of the school, a safe and healthy school setting, caring school and with the culture of the school. In recent years, institutional or school climate is equated with ‘personalisation. More specifically, this involves making impersonal secondary schools more personalised for students by transforming the learning environment through reduced class size, theme based curricula, and newly developed advisory programs.

Efforts to improve schools must address and change educators’ beliefs, values and attitudes. However, these elements of the ‘culture of the school’ cannot be addressed in isolation. Robust educational change requires educators to simultaneously attend to the power of existing technical considerations such as school schedules, school size, course sequences, curriculum and instruction as well as the political reasons between the school and the broader community. Unsafe, deteriorated and overcrowded schools reduces student’s ability to pay attention and achieve academically.

By modifying the structure of teacher student interaction, to include small group discussions, individualised instruction encourages students to participate more actively in classroom lessons and thereby improves their learning.

According to Sagar and Kaplan(1972), by its very nature the family is the socio-biological unit that exerts the greatest influence on the development and perpetuation of the individual’s behaviour. Next to family, the school is the most important experience in the process of child development. When the child enters the school arena, he or she is presented with new opportunities in terms of socialization and cognitive development.
These opportunities are provided in different measures in different schools and may have a direct impact on the cognitive and effective behaviours of students.

The nature of this impact can be understood if research energies are directed to find out the environmental variables that are most effective in promoting optimum development of each child’s potentialities.

The institutional climate comprises of certain dimensions which are as follows-

a) **Creative Stimulation** –
   It refers to the provision of opportunities provided by the teachers to stimulate creative thinking of the students.

b) **Cognitive encouragement** –
   Is teacher’s encouragement to the child’s action or behaviour to stimulate his cognitive development.

c) **Acceptance** –
   It means that the child is given a certain degree of freedom to take responsibility and opportunity to express his feelings in the school. The teachers encourage them to utilize their potentialities full.

d) **Permissiveness** –
   It refers to the opportunities given to a child to express his views freely and act without interference from teachers.

e) **Rejection** –
   The teachers put restrictions on child’s behaviour. They do not allow the child to deviate, act freely and become an independent individual.

f) **Control** –
   Teachers put restriction in order to discipline the child’s behaviour and create autocratic atmosphere.

**CREATIVITY AND INSTITUTIONAL/ SCHOOL CLIMATE**

Creativity is awareness within the school of the problems it faces, a capacity to
devise and adopts solutions whether initiated from outside or generated internally and a willingness to evaluate their effectiveness.

Thus, creativity is not limited to meanings such as inventive or original or divergent whereby any change or innovation is seen as inherently good in itself. Nor should it be seen as the receptivity of a school to planned innovations from a central authority.

Rather, it refers to the capacity of the school itself to deal with innovation. School can and should perform an active and positive educative role in society. The schools are to develop the ability to analyse and provide realistic responses to the often conflicting demands placed upon them by students, parents, policy makers and the public.

It requires the commitment of individuals who recognise the potential and responsibilities that schools have to function as creative problem solving institutions, capable of responding to the changing individual’s needs of their students.

There are several factors of school which affects creativity –

- administrative relationships between the school and outside institutions
- organisation and relationships within the school
- professional support to the school from outside
- interventions for strengthening the schools, creativity(professional growth of teachers and administrators and institution development)
- incentive systems and employment conditions of teachers
- influence of the school’s environment
- allocation of financial resources
- academic freedom to teachers and students to experiment with new ideas.

**Teacher’s role in developing creativity in school context:**

i- Provide an intellectual atmosphere in the class: Teachers should provide an atmosphere that allows and stimulates creativity. The elements of convergent
and divergent should be continuously stressed and applied to the solution of the problems throughout the entire curriculum. Open-ended experiments and activities are extremely helping in developing creativity.

ii- Provide atmosphere of free expression: An atmosphere for free expression of ideas by the students is very essential in the development of creative thinking in the children. The authoritarian approach of the teacher in the classroom destroys the spark of creativity. Creativity flourishes in an atmosphere where thinking processes are automatic, swift and spontaneous. Children create best in an atmosphere that is relaxed, where individual situation prevails. Never laugh at student’s ideas or conclusions even if they are wrong. Always give positive reinforcement to their thinking. Always encourage new ideas and show your happiness and appreciation when a child comes up with a new idea. Permit children to carry out and complete their experiments and assignments in their own way. Do not hurry pupils on their projects. Give them enough time to think how best to do a science project or solve problem. Hence, periodic brain storming and imagining sessions in the class in which the students think, hypothesize and discuss even an unreal problem.

iii- Provide proper physical environment: In order to encourage creativity in the science programmes adequate physical facilities should be provided. The science classroom should room should have a scientific atmosphere. There should be enough space and materials to work with. The material and equipment need not be highly sophisticated. A large number of experiments and investigations can be done by using single improvised apparatus. The children should be encouraged to design and improve the basic equipment themselves. For this purpose various equipments and materials should be provided like nuts, bolts, nails etc should be provided in the science workshop. There should be a live corner where the students can display an aquarium or terrarium and can do experiments with small animals and plants. There should also be a section reserved for reading and research in science. Of course, all these facilities may be difficult to provide in all Indian schools. But efforts should be made to provide adequate physical facilities to the students
for exploring, manipulating, discovering, inventing, problem-solving and verifying ideas.

**Making educational process a creative process:**

James M. Smith has suggested the following basic principles which should govern the future educational programmes in order to make the educational process a creative process.

i. Development of creative power is a major objective of the school.

ii. Children are taught to use problem-solving processes.

iii. Teachers capitalize on the creative drives of children whenever possible.

iv. Teaching is directed to the development of divergent thinking processes as well as convergent.

v. Open-ended learning situations are employed

vi. Children are made more sensitive to environmental stimuli.

vii. Differences between creative thinking and critical thinking are recognised and teaching is directed to develop both.

viii. Tolerance is developed for new ideas. Children are not subjected to blind or meaningless conformity and rigidity.

ix. Democratic procedures are practised in the classroom

x. The steps in the creative process are recognised and polished products are not expected at the onset of the creative experience.

xi. All areas of the curriculum are regarded as instruments to develop creativity

xii. Provision is made for learning many facts and skills in new ongoing situations.

xiii. Self-initiated learning is encouraged and evaluated.

xiv. Skills of constructive criticism are developed.
Ev: Evaluation skills are taught and practised
xvi. Teaching is ‘success’ rather than ‘failure oriented’.

1.12) Concept of Anxiety

The desire to achieve high puts a lot of pressure on students, which causes tension and anxiety. Anxiety in a way, is the most intimate experience to man. It enters in man’s life with the first breadth and ends with the last. It is the main cause of all mental disorders. Word anxiety comes from Latin word Anxietns- it means experience of various blends of uncertainty, agitation and threat. The credit to introduce the word in psychology goes to Freud (1894).

The anxiety is often defined as the feeling of foreboding that something negative is going to occur. It is a common emotion. Freud in 1936 defined – “Anxiety is a special state of un-pleasure with act of discharge along particular paths”.

Siebergea in 1960 defined “Anxiety is as a state of arousal caused by threat to the well being. It is a subjectively and apprehended threat to psychological self”.

Today, Anxiety is a common phenomenon of everyday life. It plays a crucial role in human life because all of us are the victim of anxiety in different ways. (Goodstein and Lanyon, 1975)

1.12.1) THEORIES OF ANXIETY:

The three major schools of psychology, The Freudian, The Behaviourist and the Humanistic each school gives different explanation for anxiety.

a) Freud Theory of Anxiety-Freud explained anxiety in symbolic terms. Such anxiety has merely the visible signs of fears or conflicts that are deeply rooted in the unconscious. Different types of anxiety in Freudian theory are-neurotic, reality and moral anxiety. And defence mechanisms are the unconscious, automatic, adjustment efforts that are used in an attempt to combat emotional conflict and deal with such unpleasant emotions such as anxiety. Most psychologists consider defence mechanisms to be normal and natural ways of dealing with anxiety, as long as they are used selectively and occasionally.
b) The Behaviouristic Approach to Anxiety-While the Freudian look to unconscious hidden conflicts in their efforts to explain anxiety, the behaviouristic takes quite a different approach. These learning theories see anxiety as an acquired fear, a learned fear reaction that is highly resistant to extinction and that may be evoked by diverse stimuli, similar to those that originally were traumatic. (Mischel, 1976) In other words, a learned or conditioned anxiety about one subject may be generalised to other sources. The learning theory explanation looks directly to conditioning as the cause of anxiety. When an event has unpleasant consequences in the past, just the thought of its recurring may be enough to cause anxiety. Doing poorly in exams may start a cycle of anxiety, resulting in poorer performance and so on. The fear of exams is called test anxiety and it is a very common problem. It is important to note that you do not have to directly experience negative consequences in order to feel anxious, you can also learn anxiety by watching or by listening to others. Both Behaviourists and Freudian theories explain anxiety in different ways, a third explanation is offered by the third major school of psychology i.e humanism.

c) The Humanistic Explanation of Anxiety-To the humanistic psychologists, anxiety is a basic condition of human existence. In understanding, why we all experience anxiety at one time or another, various theories look at a few universal conditions. One of these conditions is the free will. Humanistic psychologists emphasize the responsibility of each individual to make choices about his/her life. This responsibility is a great one however, and an awareness of our own freedom and responsibility for our own lives may be source of anxiety.(Corey,1977).And the anxiety that arises from having to make choices about the unknown is known as existential anxiety.(Chaplin,1975) To humanists, existential anxiety is not necessarily negative. On the contrary, it may lead to growth as the individual is propelled toward some type of change. It can be said that the humanist, the behaviourist and the Freudian, all recognize that anxiety can be an unpleasant experience, and it can cause people to function less efficiently than they might otherwise.

1.12.2) TYPES OF ANXIETY:
Spielberger (1962) states, anxiety can be of two types,

a) Trait anxiety

b) State anxiety

Trait Anxiety –

A trait anxiety is a stable characteristic or trait of a person. Trait anxiety is a personality trait for someone. The person having this type of trait perceives low dangerous situation as a high dangerous situation. This type of anxiety is permanent.

State anxiety-

State anxiety is temporary one. In normal life, this type of anxiety is of normal level but due to stimulation of a dangerous stimulus the level of this type of anxiety increases or exceeds. A state anxiety is one which is aroused by some temporary condition of the environment such as examination, accident, punishment etc. Academic anxiety is a kind of state anxiety which relates to the impending danger from the environment of the academic institutions including teachers certain subjects like Mathematics, English etc.

Nye (1975)-

states that the different types of anxiety in Freud’s theory are- neurotic anxiety, reality anxiety and moral anxiety.

Neurotic Anxiety –

this anxiety involves unconscious impulses that an individual repress or disguise. He may fear that his desires will get out of control causing him to do something for which he will be punished or he may fear that someone else will do something to him.

Reality Anxiety –

unlike neurotic anxiety, reality anxiety is focussed on a real, immediate threat. It is close to the conceptualization of fear.
Moral Anxiety –

The third type of anxiety, moral anxiety is similar to the sense of guilt. Moral anxiety is that anxiety which arises from violation of one’s conscience and is experienced as guilt.

Moral anxiety results from violation of the super egos structures. Actually people do not have to perform an action to feel guilty about it, sometimes just thinking about doing something wrong is enough to cause guilt.

In neurotic, reality and moral anxiety Freud recognised the feeling of anxiety as unpleasant because of this he believed that everyone tries to defend themselves against their own unconscious impulses entering their conscious awareness.

However, Dutt (1974) states that anxiety constitutes particular unpleasant psychological and physiological reactions of an organism to extrinsic and intrinsic threat, which amounts to disintegration of the organism. He has classified anxiety into ten components which are:

- Insecurity
- Loneliness
- Depression
- Self-consciousness
- Inferiority Complex
- Guilt proneness
- Organic tensions
- Paranoid suspiciousness
- Emotional instability
- Hypo-cordial tendencies and Romantic

1.12.3) Anxiety and Performance:
During a test, in an athletic competition an interview, or some other situation in which the individual want to do his best, anxiety may cause a poor performance instead.

It is true that anxiety can be responsible for failures, but it is also true that a little of anxiety often seems to help. Without some arousal and some challenge, people don’t put forth their best efforts in many situations. For example - If a person didn’t care whether he came in first or last in race, he would not have tried really hard as he could.

Anxiety is a common form of arousal and there are few tasks that we can perform well in a state of total relaxation. If a little anxiety seems to help, too much anxiety causes problems.

According to Yerkes-Dodson Law each task has its own optimal level of arousal. For simple tasks, relatively high anxiety may be helpful. For example, if you want to improve the performance of an athlete in a sprint, more anxiety may be required.

The optimal anxiety level of a complicated task in contrast is relatively low. The more detailed and complex the thinking required by the task, the greater the chance that anxiety will interfere with performance. Complex tasks – such as multiple choice exam or a calculus test – often require you to choose the required information from a large number of cues. If you are too highly aroused, you may find that you miss some relevant information, and don’t do your best (Easterbrok, 1959).

Anxiety can also interfere with learning and studying, especially if the material is new and complex. A little anxiety may be necessary to keep you studying those long hours – but if there is too much anxiety, you may find yourself reading the same passage over and over, unable to truly understand the material.

Anxiety can also disrupt interpersonal relationships. If you are afraid to join a conversation, meet someone at a party, or speak out in class, your life is made a bit more difficult and less enjoyable. Bodily symptoms, such as blushing, shaking hands, or a tremulous voice can all add to the anxiety by making it more obvious to other people around you.

Because these kinds of behaviours can stand in the way of your own satisfaction and performance it is useful to be able to control the tension and anxiety you feel.
1.13) Concept of Academic Achievement

Academic achievement is related to the acquisition of principles and generalizations and the capacity to perform efficiently certain manipulations of objects, symbols and ideas.

The achievement in the school or college means any desirable learning that is observed in the student. Since the word ‘desirable’ implies a value judgement, it is obvious that a particular learning may be referred to as achievement or otherwise depending on whether it is considered desirable or not.

Understanding in this way, any behaviour that is learned may come within the scope of achievement.

Although ‘achievement’ is used in the broader way, for acquisition of information, also including attitudes, values, etc. Schools and colleges should be concerned with the development of knowledge, understanding acquisition of skills in students

Academic achievement refers to the degree of level of success and proficiency attained in some specific areas concerning scholastic and academic work. It is a measure of what has been learnt in the academic area.

It is related to the acquisition of principles and generalizations and the capacity to perform efficiently certain manipulations of objects, symbols and ideas.

Academic achievement or academic attainment refers to performance in school or college in a standardized series of educational tests. It is “accomplishment success” in bringing about a desired end which is successfully attained, the degree or level of success in specified area or general. In 1953, MC Cleleand et. al defined achievement as performing up to internal standards of excellence or simply as striving for success.

Thus, the researcher with the motive to explore more about the scientific creativity and scientific temperament undertakes to study the scientific creativity and scientific temperament in relation to the institutional climate/school climate, anxiety and academic achievement of science and non-science 11th class students.
1.14) Definition of the terms used in the study

1.14.1) Scientific Creativity

Murray (1959):

Murray says “Creativity refers to the occurrence of a composition which is both new and valuable”.

Torrance (1962):

Torrance defines creativity as “Creativity is an activity resulting in new products of a definite social value”.

Guilford (1957):

Scientific creativity may be considered as specific creative expression, unique production in science and technology. It may be unique scientific process responsible for some creative contribution in the field of science, technology or otherwise.

Sharma and Shukla (1985):

conceptualised ‘scientific creativity’ as process oriented’ concept measuring the extent of development of scientific temper and talent on common contents of science and technology. They assumed that scientific creativity may be considered as specific creative expression, unique production and divergent thinking in science and technology. It may be a unique scientific process responsible for novel scientific excellence and accomplishments in science and technology.

Hu and Adey (2002):

define scientific creativity as a kind of intellectual trait or ability producing or potentially producing a certain product that is original and has social or personal value, designed with a certain purpose in mind, using given information.

Erez 2004:

According to Erez, scientific creativity includes, developing a range of creative abilities, including being imaginative and playing with ideas and analogies; picking up and follow clues when working in the laboratory; and avoiding “conformational bias”.
All these are abilities that should be used in accordance with critical thinking and the search for evidence-based conclusion.

**Heller 2007:**

The definition of scientific creativity can be conceptualised as individual and social capacities for solving complex scientific and technical problems in an innovative and productive way.

Scientific Creativity deals with the unusual and original excellence in the field of science or scientific productivity. Scientific Creativity can also be thought of as scientific method or scientific process primarily involved in unusual and original scientific contribution. The unusual scientific thinking abilities characterized by systematic approach for all contents whether from science or humanities or otherwise could be considered as the basic attribute of scientific creativity.

### 1.14.2) Scientific Temperament

In Scientific Temperament, the various aspects of personality as joviality, moodiness, tenseness and activity level are rather referred as expressions of a person’s temperament. The term has an emotional connotation. It is the predisposition of a person’s temperament.

**Stelan (1983):**

Stellen defined temperament as the relatively stable feature of organism, primarily biologically determined as revealed in the formal traits of reactions of behaviour. Generally it stands for all the emotions in man and his special susceptibilities to the stimuli that rouse them along with his innate tendencies to various kinds of action.

**Thomas and Chess (1986):**

Thomas and Chess define temperament as the behavioural style or how of behaviour. The question ‘how’ mainly refers formal characteristics of behaviour such as reactivity, activity or self regulation on similar lines.

**Kunnath (1977):**
Scientific Temperament means ‘a spirit of true critical enquiry’ that demands the freedom to enquire to question the prevailing ideas and to alter, modify or discard in favour of new ones.

Scientific temper is reflected in the behaviour such as exploratory, inquisitive, searching attitude and questioning mind. It involves passion for facts, clarity of vision and expressions, interrelations of things, a spirit of science.

1.14.3) Institutional Climate

The Institutional climate is the total climate of the institution i.e. school. It generally refers to the psychological climate of the school as perceived by the students in school.

The concept of institutional climate/school climate has been defined in a many ways. It has been equated with the ‘ecology of the school,’ a safe and healthy school setting, classroom participation structures, a caring school environment and the culture of the school.

1.14.4) Anxiety

Anxiety is often defined as the feeling of foreboding that something negative is going to occur. It is a common emotion.

Freud (1936):

Freud in 1936 defined anxiety as follows – “Anxiety is a special state of unpleasure with act of discharge along particular paths.

Siebergea (1960):

Siebergea in 1960 defined “Anxiety as a state of arousal caused by threat to the well being. It is a subjectively and apprehended threat to psychological self.”

1.14.5) Academic Achievement

Academic Achievement refers to the degree of level of success and proficiency attained in some specific areas concerning scholastic and academic work. It is a measure of what has been learnt in the academic area.
Psychologists define achievement as performing up to internal standards of excellence or simply as, striving for success. (MC Clelleand et.al 1953)

It is related to the acquisition of principles and generalizations and the capacity to perform efficiently certain manipulations of objects, symbols and ideas. Academic achievement or academic attainment refers to performance in school or college in a standardized series of educational tests. It is accomplishment success in bringing about a desired end – that which is successfully attained, the degree or level of success in specified area of general.

1.15) NEED, IMPORTANCE AND JUSTIFICATION OF THE STUDY

The educational system, in which the development of total being is stressed, each individual thinking, feeling and perceiving must be equally developed in order that his creative abilities can unfold.

This study, its implications will help all persons related to education one way or the other, educational administrators, planners, teachers even parents, students also so as to plan, identify, improve and develop scientific outlook in schools and inculcating the habit of dealing situations of any type scientifically as desired by the modern society so that pace of development and progress is enhanced and scientific knowledge is put to right cause of humanity.

Today people are facing many perplexing situations in daily life. Society demands public issues to be settled without favour in a rational manner. In present context it is felt that there is need to develop scientific creativity and temperament among the future citizens, so that they act rationally and contribute in their own unique way.

Scientific temper is a value frame i.e. outlook of world and man’s own world. It is both value and method of attaining human rights. Legislative prescription, executive control and the aims cannot bring about peace and change in outlook.

Rationality, honesty, open-mindedness, tolerance of other issue, respect for evidence, critical awareness have an important place in the rational thinking. Healthy criticism, questioning and unbiased attitude, curiosity, quest for knowledge, objectivity, creativity, truthfulness, courage to question, systematic reasoning, acceptance after proof
and verification, search for perfection and team spirit are some of the basic values needed to be developed among students in context of modern India. Scientific temper is a core element of national curriculum framework for primary and secondary education.

As said earlier, scientific temperament is the tendency or disposition not to take things superficially or at their face value based on merely subjective experiences but one should examine them objectively in a rational manner based on facts and then made valid inferences from facts. This scientific bent of mind—a spirit of enquiry, a disposition to reason logically and dispassionately, a habit of judging beliefs and opinions on available evidences, readiness to reject unfounded theories and principles, the courage to admit facts, however unsettling or disagreeable they might be and finally recognizes the limits of reasoning power itself in certain areas like ethics etc. should be developed among students.

The scientific temper is more than science. It is art of thinking and feeling scientifically to gain not only knowledge but to realize truth and appreciate goodness and beauty also. It is a product of many factors like personality of students, school environment, home environment, anxiety etc.

Research is required in scientific creativity and in scientific temperament specifically in Indian context, it was realized that concerted efforts are required for extending frontiers of knowledge in the field of scientific creativity and in scientific temperament. Researches in these fields are required and persistent efforts are needed to know it fully. And it is also known that institutional climate or school climate, anxiety level in children and academic achievement are very important too so the researcher undertake this study with a motive to know more about these variables.

There’s lack of related studies, adequacy of samples, precision of measuring tools, there is also a need to enrich the subject matter of scientific creativity and scientific temperament particularly in Indian context.

In this context Taylor (1964) rightly remarks regarding the significance that “creative act at its highest level has probably been as important as any human quality in changing history and in reshaping the world.” As it is known fact that scientific creative art enormously affects the scientific progress and commercial life of the nations. Many of
our recent means of travel, communication and production can be traced back to creative thinking at different stages of our civilization. It is expected that nations which become conscious of identifying, developing and encouraging creative potential in their people may find themselves in very advantageous positions as compared to those others who do not care to think in this direction.

From above it is clear that it may not be possible for nations to depend on sheer quantity of man power, as the complex society of tomorrow would need high quality personnel especially creative persons to deal with initial problems.

Conant (1959) supports the point of view and says that the 10 second rate men are no substitute for one first rate man in science. His comment is justified for all great inventions and discoveries are the fruit of creative thinking made by creative persons.

Scientist quest to improve his knowledge to unravel the hidden mysteries of the universe and to create new ideas has enabled him to change the inner dynamism of society. It is fallacious to argue that nations change according to human plans. It is the scientific creativity which accounts for such changes by of man’s degree of enlightenment in a certain field as well as his vast production of material goods through creative performance. It also serves to strengthen one’s motive to reserve the results of man’s constructive energies. Barron (1969) indicates that the role of creativity in the whole process of socialization is critical. A creative person has sense of respect to spark of creativity in other person. Creativity thus accounts for the process of socialization, internal dynamism of society and social changes without disrupting social cohesiveness.

Creativity especially scientific creativity has it immense implications in the field of education too. The goal of education is to develop capacities, personal expression, inventiveness and gifted leadership. This cannot be fully realized without the adequate and accurate knowledge of scientific creativity. The scientific creativity contributes significantly in the acquisition of knowledge, scientific values, skills etc.

In the study by Gatzel and Jackson (1962) reveal that even in the present times, there is a tendency to prefer high IQ students and nearly 70% creative students are missed by selecting to 20% students on the basis of IQ. The cultivation of creative potentiality so far has, however been neglected by education. (Flescher, 1963).
Torrence (1962) too has recognized the importance of guiding the growth of creative thinking abilities among children for the reasons of ensuring their mental health, full functioning personalities, educational achievements, vocational success, and social importance and for providing different guidance roles.

Thus in view of the importance of creativity in all areas of life including educational there is a need to explore the field more scientifically and with great vigour. An intensive research is needed in basic as well as in applied.

In India attempts have been made but not up to the required standards. A thorough investigation is needed to make the best use of creative talent among students, to develop scientific temperament which is of paramount importance for any developing country. In present study the investigator has attempted to explore the relationship of scientific creativity and scientific temperament of school students in relation to variables i.e. institutional climate, anxiety and academic achievement.

1.16) Statement of the problem

The problem stated is as follows

“SCIENTIFIC CREATIVITY AND SCIENTIFIC TEMPERAMENT OF SCHOOL STUDENTS IN RELATION TO THEIR INSTITUTIONAL CLIMATE, ANXIETY AND ACADEMIC ACHIEVEMENT.”

1.17) Objectives of the Study

In this study, the scientific creativity and scientific temperament are studied in Science and Non-Science students in relation to their institutional climate, anxiety and academic achievement. To accomplish the study, the following objectives have been formulated in respect to the scientific creativity and the four tasks of scientific creativity, scientific temperament and the six areas of scientific temperament, institutional climate, anxiety and academic achievement of science and non-science students which are as follows:

1. To compare the scientific creativity of science and non-science students.
1.1. To compare the consequences test scores of scientific creativity of science and non-science students.

1.2. To compare the unusual uses test scores of scientific creativity of science and non-science students.

1.3. To compare the new relationship test scores of scientific creativity of science and non-science students.

1.4. To compare the just think why test scores of scientific creativity of science and non-science students.

2. To compare the scientific temperament of science and non-science students.

2.1. To compare the aesthetic sensibility area scores of scientific temperament of science and non-science students.

2.2. To compare the creativity area scores of scientific temperament of science and non-science students.

2.3. To compare the objectivity area scores of scientific temperament of science and non-science students.

2.4. To compare the experimentation area scores of scientific temperament of science and non-science students.

2.5. To compare the spirit of enquiry area scores of scientific temperament of science and non-science students.

2.6. To compare the courage to question area scores of scientific temperament of science and non-science students.

3. To study the correlation between scientific creativity with institutional climate, anxiety and academic achievement of science students.

4. To study the correlation between scientific temperament with institutional climate, anxiety and academic achievement of science students.

5. To study the correlation between scientific creativity with institutional climate, anxiety academic achievement of non-science students.
6. To study the correlation between scientific temperament with institutional climate, anxiety and academic achievement of non-science students.

7. To compare the significance of difference of correlations between scientific creativity and institutional climate of science and non-science students.

8. To compare the significance of difference of correlations between scientific creativity and anxiety of science and non-science students.

9. To compare the significance of difference of correlations between scientific creativity and academic achievement of science and non-science students.

10. To compare the significance of difference of correlations between scientific temperament and institutional climate of science and non-science students.

11. To compare the significance of difference of correlations between scientific temperament and anxiety of science and non-science students.

12. To compare the significance of difference of correlations between scientific temperament and academic achievement of science and non-science students.

13. To compare the significance of difference of correlations between scientific creativity and scientific temperament of science students and non-science students.

18) Hypotheses Of The Study

To conduct the present study following null hypotheses are formulated-

1. There exists no significant difference in mean scores on scientific creativity of science and non-science students.

   1.1. There exists no significant difference in mean scores on the consequences test of scientific creativity of science and non-science students.

   1.2. There exists no significant difference in mean scores on the unusual uses test of scientific creativity of science and non-science students.

   1.3. There exists no significant difference in mean scores on the new relationship test of scientific creativity of science and non-science students.

   1.4. There exists no significant differences in mean scores on the just think why test
of scientific creativity of science and non-science students.

2. There exists no significant difference in mean scores on scientific temperament of science and non-science students.

2.1. There exists no significant difference in mean scores on the aesthetic sensibility area of scientific temperament of science and non-science students.

2.2. There exists no significant difference in mean scores on the creativity area of scientific temperament of science and non-science students.

2.3. There exists no significant difference in mean scores on the objectivity area of scientific temperament of science and non-science students.

2.4. There exists no significant difference in mean scores on the experimentation area of scientific temperament of science and non-science students.

2.5. There exists no significant difference in mean scores on the spirit of enquiry area of scientific temperament of science and non-science students.

2.6. There exists no significant difference in the mean scores on the courage to question area of scientific temperament of science and non-science students.

3. There exists no significant difference in correlation scores of scientific creativity with institutional climate, anxiety and academic achievement of science students.

4. There exists no significant difference in correlation scores of scientific temperament with institutional climate, anxiety and academic achievement of science students.

5. There exists no significant difference in correlation scores of scientific creativity with institutional climate, anxiety and academic achievement of non-science students.

6. There exists no significant difference in correlation scores of scientific temperament with institutional climate, anxiety and academic achievement of non-science students.

7. There exists no significant difference in the correlations between scientific creativity and institutional climate (r1) of science and (r2) of non-science students.

8. There exists no significant difference in the correlations between scientific creativity and anxiety (r1) of science and (r2) of non-science students.
9. There exists no significant difference in the correlations between scientific creativity and academic achievement (r1) of science and (r2) of non-science students.

10. There exists no significant difference in the correlations between scientific temperament and institutional climate (r1) of science and (r2) of non-science students.

11. There exists no significant difference in the correlations between scientific temperament and anxiety (r1) of science and (r2) of non-science students.

12. There exists no significance difference in the correlations between scientific temperament and academic achievement (r1) of science and (r2) of non-science students.

13. There exists no significant difference in the correlations between scientific creativity and scientific temperament (r1) of science and (r2) of non-science students.

**2. Delimitations of the Study**

Following are the delimitations of the study:

1. The study will be confined to 11th class students, Science and Non-science only.

2. The sample of the study will comprise of 1000 students, out of 500 will be from science stream and 500 will be from non-science stream.

3. The study will be conducted in CBSE affiliated schools of Rohtak city only.

4. The study will be limited to the study of scientific creativity and scientific temperament of 11th class science and non-science students in relation to their institutional climate, anxiety and academic achievement only.