CHAPTER-I

INTRODUCTION

Human beings are the unique creation of God. God has provided certain characteristics only to human beings, which makes them unique in this world. One of the most important ability that is provided to humans by God is that, they can preserve and transfer their experience and thoughts successfully, to the future generation. This process of transferring experiences from one generation to other generation or from one person to another person can be termed as ‘Education.’ Education is one of the most important factor which affects human personality in each and every aspect and during transferring of experiences from one person to another, in which, both gets benefited in one way or another. In the words of Rousseau, ‘Plants are developed by cultivation and men by Education.’ Education increases our fame, it makes us more cultured and pure, education nourishes us like a mother, it directs us to the right path like the father and it nurtures the feeling of self realization and evaluation of good or bad in us which refines us in all aspects of life. An important aspect of effective education is a true teacher, who accomplishes the task of education i.e. teacher is the source who transfers the huge store of knowledge accumulated in the form of experiences of various field to his pupils, who may be fully or partially unaware to it, but it certainly helps them in raising standard of their life in every dimensions. Previous experience or clear knowledge guides us to reach our destination. It is absolutely essential that a teacher firstly, has to be a true student and a sincere scholar of his own subject, before he starts teaching to his students.

A teacher can never truly teach, until and unless he is still learning himself. In each and every interaction with his students, he explores something new and innovating to preserve and to transfer it to others in form of teachings, so that they may also get benefited by it. This process of exploring or acquiring new methods and techniques to upgrade existing ideas in new aspect, manipulating and modifying it according to new situations offers much efficient and productive solutions to the familiar problem. This ability to recognise, re-create or reorganise pre-existing ideas to achieve more efficient, exact and fruitful solution to the familiar problem can be termed as ‘Creativity.’ Drevdohl (1956) described creativity as,
“...the capacity of persons to produce compositions, products or ideas of any sort which are essentially new or novel and previously unknown to product. It can be imaginative actively or thought synthesis...it may involve the forming of patterns and combinations of informations derived from past experiences...it must be purposeful or goal-directed, not ideal fantasy, it may take the form of an artistic, literacy or scientific production.”

This is the boon of creative energies of previous days which has brought the present world to a situation where annihilation of set norms to attain ultimate perfection is a grim possibility. The creative energies provide its beholders to understand, analyse and to modify the changing situations so that the increased potential for harm may be reduced to its minimum level. These problems may be very complex because of their changing nature with time, but the ability to create accordingly or, to render much efficient advanced solution than the pre-existing solution can provide a better way out to accommodate or to adjust with the changing situations of life. Although the bliss to create and to modify according to our own wish, is a capability which any individual in world might see but in real, it lies beyond the grasp of most of us after a certain limit. Yet the individual who needs this ability to solve any problem and deal effectively with the physiological or psychological changes they experience effectively today and tomorrow more critically than any one other in this world does, are the adolescence students in any classroom of any part of this world. Anything that can be done to help these young, innocent and less experienced people, who are generally unaware of their capabilities at this stage of life are meant to recognise and express their creative potentials, to take a step ahead in the direction of a better world. The creative potential of any individual helps them by providing them a power of assessment of their own capabilities and also helps them to recognise and impart needed change so that they may create situation for not only their own balanced growth, but for the betterment of the whole society. Describing the importance of creative person in society, Trowbridge (1966) commented:

“...creative person can contribute something to society which the intelligent person cannot. Similarly the intelligent person makes contribution which the creative one cannot. Also the achievements of
creatively superior individual do not equal the sum of the achievement of any number of less creative people. The rare creative individual is invaluable; they produce something that no other collection of person can. The same generalization holds true for intelligence.”

Describing the importance of creativity, Torrance(1969) consider deplorable waste of human talents can be prevented if the creatively gifted students or individual are made to use their power of creation constructively and intelligently. It also ensures their indirect development by preventing them not to proceed on the destructive path of delinquency, mental illness or at least the life of mediocrity and unrealized potentialities(Torrance, 1965). It becomes necessary that serious attempts should be taken to ensure the constructive development of creative potential in any individual. Tonybee (1962) considered human capability ‘to create’ as his greatest asset. Getzels and Jackson(1962) regard it as one of the most highly valued qualities of mankind. Haefele (1962) assumes creative activity at its highest level is the greatest of all human ecstasies and often brings moment of high personal drama, which can ensure all round development of individual.

Considering creativity as one’s most valuable resource, Patrick (1955) proposed that it can cope with life’s daily stress and shifting of its cuts at the very roots of satisfaction in time and ultimately creates overwhelming release from tensions and breakdowns. The creative thoughts are the primary asset of creativity which should be properly nurtured to provide proper condition to support creative enhancement in any individual. The conditions for creative production should be carefully planned, if we want more creative, more efficient, more purposeful act to be demonstrated (Hilgard, 1959; Torrance, 1962; Murphy, 1947; Goyal, 1973). Thompson and Debold(1971) have highlighted the prevailing educational structure which is hampering in the development of ‘one of the highly valued asset’ of human characteristics. Creativity, no matters in what field it is being used, it involves an active interaction of the individual with its surroundings, all the manifestations of nature, material and the people around it. Person creates anything in a response to a need stimulus provided by his surroundings, which generally confronts them as a problematic situation in some aspect. Problems and challenges always amidst
an individual and his state of equilibrium, which he has to overcome and here he needs to understand and explore the ‘Science’ behind every phenomenon or subject which is creating problem to them. In process to create solutions to any problem, it becomes very necessary to identify and explore the scientific aspect of creativity and also its various other related factors which effects this property of scientifically creating something new, particularly in the most stressful stage of life, where it is needed at its most. Science creates a sense of scientific observation, analysis, hypothesising, testing and retesting previous facts and findings in various new situations, on which a whole new realm of man’s consciousness of the world around him depends.

Creativity as an art develops a sense of order, harmony and beauty which not only affects man’s skills but enriches its sentimental life also. Understanding and following procedure of science enables man to think logically, act rationally and to invent or discover an idea or a work plan, which may always remain flawless by producing similar known results in futuristic similar problems faced by him or any other. That is, it can be concluded that artistic outcome is also an essential component of scientific approach, to solve the problem which differ only in the field in which it deals. Art is a capability of man to response in beauty, his capability to response to nature and to the life that he has earned for himself directly or indirectly through selection of various method of science, which can be straighter, more result oriented, more objective, in attaining similar results in similar condition if followed as a procedure of science, irrespective of a person, applying it. An investigator is generally keen to explore or to uncover the secrets of nature, to understand the cause and effect of things and the logic working behind any phenomenon so that he may learn how to control nature for the enrichment of human life. Thus, for considering phenomenal changes around oneself, artistic creativity is needed, whereas for setting a definite rule to describe or to create any definite result, scientific creativity is needed combining to both, a method of probing deep into nature and its truth becomes possible, with the method of application of creative imagination, scientifically.

Accordingly, keeping in mind the wide scope of working and logical investigation in the field of science and creativity, researcher decided to attempt for the research in not so explored area of ‘Scientific Creativity’, not only being limited to creativity in the realm of science, but also considering the scientific approach which is
of immense importance to any individuals’ life both to an adult person or in the stage of their adolescence, where an individual selects adopts and cultivates basic principles of life, which are then practiced by an individual throughout his whole life. This stage of adolescence includes development of various psychological capabilities in individual which in one way or another defines the overall personality of that individual.

1.1 MEANING AND BRIEF CLASSIFICATION OF SCIENTIFIC CREATIVITY

Scientific creativity can be defined, not only as a distinct and specific view, or a method to follow any distinct procedure for the attainment of any novel idea or act, but it is also a method to observe, understand and assimilate the objectives, phenomenon, working and creating capabilities of science, which works behind every scientific creation. It helps an individual in inventing more reliable, much scientifically proven solutions to any problem which may be taken into application by any person, anywhere, producing similar known products, if applied with proper know-how and situational setup of both, problem and its expected solution. Scientific creativity itself have a capability to manifest it according to the differing situations, not only for the conception of new ideas or contributing into enhancing scientific knowledge itself or in the formulation of new theories of science but also in devising of new principles to probe nature’s law and in the development of scientific ideas applied to particular domains of practical interest, helpful in the realization of new organizational features of scientific research and of scientific community. In the novel implementation of plans and blueprints for scientific activities, in trailblazing undertakings to transmit the scientific outlook into the general people’s mind and unlike by many other realms, scientific creativity not only helps us to create solution to a particular problem or field but also provides us a more objective and accurate solution to deal with the similar problem in future that too, with the minimum risk of failure. Process of scientific creativity itself demands for the scientific-creative approach as a set principles of science, where manipulation of objects or phenomenon is the preliminary key to invent or to reach in for any novel idea or object goes in hand in hand with its expression explore or to create any novel idea or product. Hu and Adey(2002) has defined the structure of Scientific Creativity as:
1. Scientific creativity is completely different from the creativity conducted in the fields of art, languages or descriptive sciences. Scientific Creativity is strictly concerned to the realm of sciences where all the general to particular principle of science are followed and a definite product is tend to develop or produce by the reaction of definite reactants. This principle of creation in science always ensure definite product creation or a solution to resolve the similar occurred problem not only at the time of their invention, but also in future each and every time when it will be used with the desired care and need.

2. Scientific creativity demands various psycho-physiological characteristics to create any solution or any needed article, in the problematic situation to any individual so that it may adjust into it. But the most important ingredient needed to make the principles of science work, is the intellectual power possessed by the scientist or a creator, so that he may be capable of not only in selecting proper and appropriate principle but also be capable in applying necessary alternation to pre-existing solution such that the scientific principle it follows remains intact and also it must be capable in maintaining equilibrium in a situation imposed to him as a problematic situation.

3. Scientific creativity also relies on pre-existing scientific rules and scientific procedures, which are capable of creating known result again and again upto a certain limits. Scientific creativity as its prime constituent includes individualistic capabilities to select appropriate known procedure to solve out the disequilibrium created or to create alternations to the known principle such that it may be used with more accuracy and appropriateness in the newly encountered problematic situation.

4. Creativity and analytical intelligence are considered two different factors which act as a single capability of any individual which is ultimately aimed to create something new scientifically and can be originated by the perfection of mental ability of individual to apply the known facts it in new situations so that the desired product or creation can be produced scientifically.
According to Mansfield and Buse (1981; as stated by Liang, 2002) the creative process in the scientific fields can be described into following five points:

1) Sensitive assumption and appropriate selection of the problem.
2) Increasing directed and meaningful efforts to solve the problem.
3) Selecting the appropriate experimentation, methodological procedure and needed cognitive skills to increase the chance of attaining better adjustable conditions.
4) Keeping an alternate to implement the needed change in respect to the hypothesis created in attaining the desired result.
5) Implementation of the tested experiment in similar or deviated experimenting conditions, again and again, to verify and to explore the range of elaboration and accuracy of the experiment in different problematic situations.

In short, the aspects of scientific creativity can be summarized as, a capability to being sensitive to any problems, ability to produce new ideas which are scientifically accepted, ability to wonder, understanding the world around, ability of problem solving, seeking solutions, designing experiments, imagination, identifying difficulties, making predictions or hypothesizing etc which at the last, ends in to the creation of any novel and purposeful creation. To maintain the dependency and reliability of any product or an idea it has to follow a scientific path, no matter from which field solution to a problem is sorted out. Keeping this point in mind and considering involvement of some science in every creation, scientific creativity can be referred as the central concern to all the work in the field of creation and it should be the topic which should be taken into interest in almost every major areas of research in psychology as it can ensures nurturing of individualistic capability to adjust in changing situations on individual’s condition, which no other psychological attribute does.

Although many psychologist in various field, ranging from the field of Psychoanalytic accounts of creativity (Freud, 1932), to Gestalt (Wertheimer, 1945), Social (Amabile, 1983) to Cognitive (Simon, 1977) and also in psychometric approaches (Roe, 1952) scientist has worked on the area of scientific creativity, but its involvement of proper procedure and its involvement in every field provides it a large
scope of research which still makes scientific creativity a field where researchers always have ample of possibilities to explore. In the field of educational psychology, as a result of complex understanding and procedure this concept of scientific creativity seems to be lagging far behind. Since it is believed that, science is the base of all subjects and it is involved in every invention or discovery in any of the field, it should not be taken as a prerequisite for scientific progress, as a frame of mind without which scientific creation would be stagnant or vice versa. Thus something, irrespective of working field, has to be trained or encouraged for enhancing creation of ideas or objects scientifically. Rather scientific creativity should be taken as a method to explore new ideas to deal up with changing situations more effectively and providing a solution which is far much more objective and reliable than any other solution of artistic creativity provides. All creativity including scientific creativity too by nature involves innovative constraints, which are far much more particular and strict to follow in scientific creativity than any other creativity. On the other hand to create something new in a changing situation, considering proper and specific procedure only do not results in scientific creative solution or task. It is very necessary to create a balance in order to get deviated from traditional procedure to create something new, but also keeping an eye on every action done, as it always create specific reaction and to use this reaction in a constructive approach, it is a prerequisite for a successful creation in the realm of science.

Most of the researchers categorises scientific creativity as same as any other form of creativity as a belief it is being composed of the same material processes that guide all the other forms of creativity. The only difference that sets scientific creativity different is that there has a vast but particular theoretical, technical and experimental knowledge that creative scientific ideas must either extend or more rarely supplant. Furthermore this process of scientific creation includes certain fundamental principles, norms and practices that should be taken in concern or should be followed in search of any new scientific discovery or in any scientific invention which should be abided by its proposer before it is accepted by other researchers or investigators as to in search of any other discovery. One of the most common ways of develop sense of scientific creation is considering or analyzing the life, thought process and responses of a creative scientist that how certain scientist made certain scientific creation, or by exploring what is the scientific approach which any particular scientist has adopted to
sort out any problematic situation for creating any novel idea or thought. The most important and vital aspect is to analyses or to determine the mental processes or the scientific perspectives towards the problematic condition which follows a particular work plan, which leads to a definite and particular discovery or creation, following the rules of science.

Many scientists, psychologists or even researchers proposes new and specified definitions to define scientific creativity but still many facts and characteristics are yet to be disclosed to find the exact and universally accepted definition of scientific creativity. At present, investigations reveal the existence of many definitions which is based on new characters and specifications which keeps on expanding day by day. If we examine the main definitions, we can define and classify the term scientific creativity into six major groups or classes. These groupings are not mutually exclusive since each definition of scientific creativity contains various elements which differentiate them in different classes. On base-theme of creativity, on which various definition are based, these definitions of Scientific Creativity can be classified in following six classes:

The first class of definition can be classified under the label of ‘Gastalt’ or ‘perception’ type definitions wherein the major emphasis is upon the recombination of scientific ideas or the restructuring of a ‘Gastalt.’ Certainly, Wertheimer’s (1945) defined that creativity is the, ‘process of destroying gestalt in favour of a better one’ belongs in this category. So also the definition of Keep(1957) that it is the ‘intersection of the two ideas for the first time’ and Duhrsse’n’s(1957) notion that it is the ‘translation of knowledge and ideas into a new form’ belongs in this category. Mooney(1955), Von Frange(1954) and others also utilize this approach. This class of definition in field of scientific creativity explains the assumption of overall approach of attaining problems in the field of science and then transforming or restructuring them, following the method of science, so that it may not only be more appropriate in solving scientific problems with more accuracy and efficiency, but in any field following the similar phenomenon. This procedure also provides more reliability to transfer the solution to the upcoming generations, so that they may use it more precisely and efficiently in the all the problems they face in their future life.

The second class of definitions for Scientific Creativity may be called
‘endproduct’ or ‘innovation’ type of definitions. A representative member of this class is Stein’s (1953) definition which states that ‘Creativity is the process which results in a novel work that is accepted as tenable or useful or satisfying by a group at some point in time.’ Even Webster Dictionary (1953) is oriented in this direction for ‘to create’ is defined as ‘to bring into being,’ ‘To produce as a work of thought or imagination.’ Harmon (1955) prefers to speak of it as ‘any process by which something new is produced—an idea or an object, including a new form or arrangement of old elements.’ It signifies Scientific Creativity as a powerful tool ‘to create’ or ‘to innovate’ something new, adopting scientific principles and procedure which ultimately leads to the creation of something new, scientifically. These definitions lays their emphasis on adopting or setting a novel, an appropriate and innovatively new scientific procedure on basis of which they may can overcome the problems in the field of life. This creation of a scientifically proven, end product which is new and purposive and can be accepted as a permanent and reliable mean to sort out any particular problem of life irrespective of time or place where it is used also helps into creation of equilibrium with changing situations of life.

A third class of definition in which scientific creativity can be characterized is as ‘Aesthetic’ or ‘Expressive’ method to create something scientifically relevant in a desired condition or place with an equal aesthetic and expressive sense in it. The major emphasis here is upon self-expression. The basic idea seems to be that one has a need to express himself in a manner which is at least unique to him. Any such expression is deemed to be creative and when any such expressions proves to be even a tentative solution to any scientific problem, this process of creating something new scientifically, is termed as Scientific Creativity. According to a major definition of Scientific Creativity of Lee (1957), ‘Scientific Creative process can be defined as an ability to think in uncharted waters without influence from convention set up by past practices.’ In this vein, Lange (1957) offers that, ‘The creative process is God, the creator, working through his creation, man.’ Northrop (1952) speaks of it in terms of stimulating our sensibility to dissatisfaction and Compton (1952) sees the essence of scientific creativity as being the decision to do something scientifically appropriate, when anyone is irritated. Thurstone (1954) thinks of it in terms of problem sensitization in science and Ghiselin (1955) defines scientific creativity as ‘the process of change, development or evolution, in the organisation of subjective life.’ These all
proves scientific creativity as a scientific approach or method to sense problem, evaluate it and seek for a possible solution to it and also a method to scientifically accumulate it to propose the aesthetic, expressive and scientific solution to any problem.

The fourth class of definition of Scientific Creativity can be characterised as ‘psychoanalytical’ or ‘dynamic.’ In this group, we find scientific creativity is defined in terms of certain interactional strength ratios of the id, ego and superego. In this respect, Bellak(1958) assumes that forms of creativity are permanent operant variables of personality and he subscribes to the notion that to be creative, in any terms, may be in the field of science also, the ego must regress in order for preconscious or unconscious material to emerge. Leading proponents of this type of definitions are Anderson (1959), Kris(1951), Kubir(1958). These thinkers assumed that ego acts as a factor to drawback the process of scientific creativity by suppressing the function of emerging new and innovative scientific solution to a problem at preconscious or unconscious states of mind. Attainment of scientific solution from preconscious or unconscious mind always plays a significant role in proposing scientific solution with a short period of incubation time, this process is lagged or suppressed at innovative as well as functional level if the ego level is high than the normal level.

A fifth class of definitions can be grouped under the classification of ‘Solution Thinking.’ Here the emphasis is upon the scientific thinking process itself, rather than upon the actual solution of the problem. Spearman (1931), for instance, defines the scientific creativity in terms of its correlates. That is, scientific creativity is present or occurs whenever the mind can see the scientific relationship between two items in such a way as it may generate a third novel item. Guilford(1959) on the other hand, defines scientific creativity in terms of a very large number of intellectual factors. The most important of these factors are the ‘discoveries factors’ and the ‘divergent-thinking factors.’ The discovery factors are defined as the ‘ability to develop scientific information out of what is given by stimulation.’ The divergent-thinking factors relates to one’s ability to go off in different directions when faced with a problem. This is similar to Dunker’s notion (1945) that in order to solve a problem one often must move tangentially from common type of solutions. Other proponents of this class of
definitions are Poincare(1913) and Wallas(1926). They considered scientific creativity as a process, not a product, which can be followed to obtain something, novel and innovative in any situation, by the help of pre-existing idea, solution or thing.

The sixth and the last class of definitions of scientific creativity can be labelled as ‘Varia’ simply because there is no easy way of characterizing them. There is, for instance, Rand’s(1952) definition that scientific creativity is the ‘addition to the existing stored knowledge of mankind.’ Lowerfeld(1957) speaks of it as the result of our subjective scientific relationship with man and its environment. Porsche(1955) sees it as the integration of scientific facts, impressions or feelings into all newscientific situation. Read (1955) feels that it is that quality of the mind which allows an individual to juggle scraps of scientific knowledge until they fall into new and more useful patterns and Shepard(1957) speaks of it as a destructive process much like Wertheimer when he spoke of scientific creativity in terms of destroying one Gestalt in favour of another.

Thus, it may be concluded that in one way or another scientific creativity is involved in each and every aspect of human life, there exist no single field which sets human free from adopting any particular scientific approach, deliberately or indeliberately, to reach in for some specific solution or conclusion. Creativity when adopts more specific, more precised and more particular methods to proceed in a particular direction following scientific approach, to attain desired outcome from the problematic situation, the process of attaining convergence by diverging nature to find solution or creation comes under the heading of ‘Scientific Creativity’. Generally differentiation is done on the basis of working field in which any creative procedure is conducted and to carry out creations any scientific approach to reach for any novel creation as a solution to any problem comes in the diverged heading of scientific creativity.

1.2 APPLICATION OF SCIENTIFIC CREATIVITY

Scientific Creativity is one of the most important factor which affects to each and every part of individual’s life directly or indirectly. Although research started in the pursuit of exploratory field of scientific creativity, it was realised that the concerted efforts can be made in this direction for many reasons which are very
important in field of scientific research for extending the frontiers of knowledge. Since research in creativity is mostly different in the absence of replicated studies, follow up investigation, conceptual and somatic agreement, adequacy of sample, precision of measuring tools, unanimity about problem of criteria and predictors and longitudinal studies, the construct of scientific reactivity is in a developing stage and needs to be refined through persistent efforts (Bennett et al., 1968). The importance of scientific creativity in the atomic age itself is contributory to accelerating the pace and demanding more concern to research activity.

Creativity in science has provided psychologists and philosophers enormous material needed to debate, discuss, investigate, and explore the cause and effects of any phenomenon taking place in nature. Recent works has also involved philosophers in producing and implementing computational models of creativity in science also, to clarify some of the issues involved rather than delimiting themselves to follow path, procedure or concerning field only to create something new. Three important areas in the philosophy of scientific creativity are in the advancement of science through the introduction and maintenance of inconsistencies, the transfer of ideas from a known domain to a new domain and the social aspects of scientific discovery. L. Magnani (1999), discussed the role of inconsistencies in the advancement of a scientific theory and the part that scientific creativity plays in generating and maintaining inconsistencies. Magnani discussed inconsistencies within the framework of explanation-driven or abdicative reasoning, where certain facts or laws are inferred in order to explain any phenomenon. Deviations aroused from the pre-established facts and findings, which existing principle and theories are incapable to explain, tends concerning scientist to propose explanatory and accepted principle which can only be achieved by following the specific path of scientific creativity.

In scientific creativity, it is necessary to maintain both theories until the possibility of rejecting one becomes necessary and feasible, but regarding following of scientific procedure it do not have any option of not following it in any circumstances. Following specific procedure of accepting the feasible theory and rejecting the less feasible one, not only helps us to obtain the most appropriate explanation to any phenomenon taking place but also both these phenomenon evolves to give rise a far much better and efficient idea, which not only proves to be a solution
of the problem for which it is been developed or synthesised, but also to many similar problems if applied in similar situations creatively. This stepwise procedure of observing, hypothesising, testing and retesting it in various conditions, reaching to some result and again testing it and formulating any theory to explain any phenomenon or to sort out some problem comes under the heading of scientific creativity, which is not only helpful in academic achievement of any individual but also in better adjustment of anybody’s life.

Scientifically, creative art enormously affects the progress and up-gradation of commercial life of any individual also. Many of our present means of travelling, communication and production which can be proved to be a much better mean of livelihood were traced back because of creative thinking by different people, at different stages in our civilization and this field consists of endless opportunity to explore at every stage of mankind. It is expected that nations consisting countrymen with more conscious of identifying, developing and encouraging creative potential and having creative and progressive realistic ideas in their people, find themselves to be in more advantageous positions as compared to those who do not possess the capability to think in this direction.

1.3 IMPORTANCE OF SCIENTIFIC CREATIVITY IN EDUCATION

Scientific Creativity is very important for research purposes or in educational fields in exploring the new concepts, solution to the problematic situations, understanding it, developing or applying the novel approach of their consideration, the cause or effect of the event occurring around them particularly if they are creating disequilibrium to attain educational objectives of any individual. Scientific creativity includes possession or development of individualistic capability of any person to approach to any situation regarding its meaning, nature, significance and measurement that can also be in educational skills or even at any part of educational field. Scientific creativity is the term used not only the educational field but in every field of life for obtaining a more complex understanding of the human mind and personality and their functioning to stimulus. It can act as a possible basis for individualised instruction, as a part of guiding mental capabilities of students to develop desired character or growth, as an indicator of mental health status, as a source of collection of details or treatment of social, psychological or physiological
problems faced by any person in any phase of life. Scientific Creativity also acts as a strong mean for not only constructing scientifically novel objects in educational field, but it also helps in implementing and assessing differential or summative effect of various kinds of educational treatments provided to students like different experimental programs, curricular arrangements of study materials, organisational arrangements, specific teaching procedures, special treatment to the needed childrens etc. which are essential to achieve educational objectives for which they are being implemented.

Scientific creativity includes development of creative insight as its most important characteristic of an individual consisting it, which can help in the matrices of thought, create much effective and purposeful ideas and its unique implication which can lead to much fruitful results, even in the field of education also. Scientific creativity demands some basic psychological traits like fluency of ideas, flexibility in seeking solution to any problem, originality of thoughts or idea, divergent thinking to seek for some solution to problem, convergence to reach for some conclusion, finding relevant conclusion to a problem by dispersed information collected by various means or method etc. which helps any student or any individual to uncover the hidden secret of nature, to understand the cause of event or phenomenon and to develop endeavour to control or manipulate it according to the situation for the betterment of their life.

1.4 NEED AND JUSTIFICATION OF INVESTIGATION

Ever since, the educational research has started in the pursuit of exploratory field of scientific creativity, it is realised by all that concerned efforts should be made in this direction for several known and unknown reasons. Firstly, educational research is very much needed to explore the possibilities of what scientific creativity can provide to students in educational field which can help them in extending their frontier of knowledge not only in creating something new but also attaining any goal of life, where academic achievement is just a fraction of the whole. As described earlier, research in scientific creativity needs special efforts and mostly lacks in presence of replicated studies, follow up investigations, conceptual and somatic agreement, inadequacy of sample, precision of measuring tools, unanimity about problem of criteria and predictors and longitudinal studies, the construct of scientific creativity provides a larger and essential field to be explored which affects every
aspects of individual’s life more concerning to more stressed stage of human life. Concerning the importance of scientific creativity in the present atomic age which itself is contributory to accelerating the pace of research activity Taylor(1964) rightly remarks,

“Creative act at its highest level has probably been as important as any human quality in changing history and in reshaping the world.”

A constructive role of a creative person is more important in the initial phases of any problems. Conant (1959) supports this point of view and says that the ten second rate men are no substitute for one, first rate man in science. He explains and uncovers the needed ingredient to all great inventions and discoveries by donating them as the fruit of creative thinking which is implicated as a process by a creative person.Scientists quest to improve their knowledge to unravel the hidden mysteries of the universe and to create new ideas and objects that enabled them to change the inner dynamism of society from every aspect. Barron(1969) indicates that the role of scientific creativity in the whole process of socialization is critical. A scientifically creative person has sense to respect a spark of creativity in other person.Creativity, thus also helps in facilitating the process of socialization by effecting the internal dynamism of society and results to in desirous social change that too without disrupting social cohesiveness. Creativity in the field of education helps into develop individual’s capabilities, personal expression, inventiveness and gifted leadership in students or in teachers as per requirement, which cannot be fully realized or attained without the adequate and accurate knowledge of creativity. The creative thinking includes special students’ abilities which can contribute significantly to the acquisition of information, processing it as needed in situation, reaching on to some result and developing or manipulating educational process involved such that it enhances educational skills resulting in to achievement of aim of better learning.

In the context of learning, particularly at institutional level, creativity is considered in relation to some specific domain(domain of specific task, trait, content, knowledge etc.). Therefore, though most of the earlier researches on creativity recognized it as domain dependent, but creativity related to learning is free from domain specificity by nature. Its functioning in one domain is unique and psychologically differs from that of in other. Alexander and
Amabile (1990) emphasized the need for specific domain or discipline based knowledge and skills for fostering creative thinking in learning. Albert, Baer, Filho, Alencar etc. have also recognized the importance of domain specific context of research study on creativity and therefore support the view. Morten and Vanesa pointed out that each individual subject should emphasize creativity within an agenda reflecting characteristics of each, indicating also the domain specific nature of learning based creativity. Moreover the precise and inadequate tools and technique to assess creativity as a whole in all realms is still not explored by men. This is why domain-specific creativity is gradually receiving more and more attention of researchers, working in the field of creative research in the context of school education. Scientific Creativity is a domain specific creativity which is the focal theme of the present research work. There are number of problems related to educational and psychological field which can bring up to an end, if answers to some questions related to creativity, specifically in the field of science, which could be provided with the reliable and relevant method of research. Some of the important questions aroused in the mind of researcher while framing the design of the study in this context are as follows:

- Does science education have the scope to nurture creative thinking?
- Does scientific creativity emerge as a consequence of creative thinking particularly in the realm of science?
- Is scientific creativity an independent field of research or is just a branch of the research on creativity, in general?
- How and in what extent the phenomenon of creativity loses its original identity when it is introduced in solving the problems creatively, particularly in the field of science?
- How do different science educators explain the nature of the scientific creativity and its process?
- What are various dimensions associated with the culture of scientific creativity and how they are helpful in problem solving in new situations?
- Is there any unexplored area of scientific creativity?
- In educational field, how and to what extent some primary psychological variables which affects education achievement of
students, are interrelated?

- How some of the primary psychological variables, responsible for better academic achievement of students are affected by scientific creativity?

Present study is an attempt to search for the solution of these questions along with some other important questions concerning school education. The study particularly aims at, explaining emergence of the concept of scientific creativity in the contemporary social context, describing nature of the construct as viewed by different researchers in relation with different operational dimensions as identified by them and to identify the unexplored area of scientific creativity and its relational dimensions with some important variables and their effect on students’ cognitive abilities, keeping a close view of other related studies in the concerning field. Studies like Cline, Richards and Abs (1962), Drevedoth (1956), Gretzels and Jackson (1962), Guilford (1956), J.L. Holland (1961), Klanmeier and Wiersma (1964), Torrance et-al (1960), Vamamoto (1964) etc. has given the impression that cognitive traits associated with creativity traps a different spectrum of intellectual ability than the traditional tests of intelligence, personality, concept formation methods to attain or perceive new concepts, behavioural aspects related to scientific creativity etc. Thoroughly reviewed literature findings showed that the creative studies had covered the largest part of the researcher in the fields of correlates of creativity but some important aspects like attainment of new concepts, effect of study habits or acquiring new knowledge and its correlates with the scientific creativity of any individual, still seems to be unexplored. Some of the other relevant questions which came to researcher mind to undertake the specific research, related to solve the problem of correlates of scientific creativity are as follows:

1) Creativity covers mostly all the major research areas or studies but one of its important aspect, Scientific Creativity is still lagging behind in the field of humanities subjects although having an immense possibilities for research.

2) What are prime correlates related to scientific creativity and what affect do they induce, in creating direct or indirect psychological affect on adolescent students particularly?
3) Do these prime correlates get affected by the scientific creativity of students? If yes, then to what extent?

4) Most of the researches have been confined to the study of creativity among adult stage very few studies have been focused on the age defined study for creativity in adolescence, which should be taken in consideration for research purposes.

5) Do these correlates of scientific creativity result in to creating better and more feasible environmental conditions for students in a detailed perspective which affects each and every aspect of their personality?

6) Do these correlates of scientific creativity have a significance correlation, which can help in to predict extent of scientific creativity in students?

Researcher has tried to explore this area with some primary variable important for educational achievement of students at their adolescence stage using intercorrelational, comparative and predictive methodology for research. After the detailed reviewing the concerned literature, the present problem was selected in keeping the above considerations in mind and to study creativity particularly in the area of sciences, along with some basic correlates like Intelligence, Personality and Study Habits of adolescence (XI grade students) on the criteria of gender differentiation in students, as a novel area of research work. The importance and usefulness of the research is also enhanced by its detailed study of the detailed description of the primary variable, it also helps in to explore and to reveal the importance of these variables and their interrelational affect (if any) in achieving one of the prime objective of adolescence and its role in preparing them to achieve better adjustment and satisfaction in upcoming life.

1.5 STATEMENT OF THE PROBLEM

Every individual has to face various types of problems every now and then, and the role of education here becomes more important as education is considered as a mean to not only understand, analyse and to solve the problem but it also provides a firm and definite knowledge of action taken and its consequences which can be effectively used to find a better solution to any problem so that it may be tackled with less efforts and less wastage of time and energy in future also. But it is not necessary
that problem always arises in the same form as it was in its past, so it is very important for any individual to develop essential skills to create or to modify the pre-existing articles, ideas or solution which may solve the new form of problem in accordance with new circumstances. In the field of educational psychology, some skills like intelligence, personality traits, memory, reasoning, cognition etc. acts as the deciding factors to attain academic achievement as a short term objectives, which later on also helps them in understand and to manipulate their adjustment level in changing situations of life, for their betterment. So, researcher has decided to study some basic skills which help and effect the development of problem solving skills in adolescence which prepare them to cope up with changing situations of life along with their contemporary need to achieve high in academics. Researcher has decided to study the effect of intelligence, personality and study habits in relation to scientific creativity of adolescences i.e. XI grade students, internally categorised on various criteria of intelligence, personality and study habits factors, and thus the final statement of the problem selected comes to be as,

A STUDY OF SCIENTIFIC CREATIVITY AMONG XI GRADE STUDENTS IN RELATION TO INTELLIGENCE, PERSONALITY AND STUDY HABITS.

1.6 OBJECTIVES OF RESEARCH

Following are the objectives* of the present study:

1) To study the relationship between Scientific Creativity and Intelligence among XI grade students.

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Note:* The objectives were studied with reference to Male and female students separately.
1. Scientific Creativity was tested on 4 factors namely, Fluency, Flexibility, Originality and Inquisitiveness separately as adopted in the Test of Scientific Creativity (TSC) by Misra, K.S. (1986).
2. Intelligence was tested on below average, average and above average I.Q. of students as measured by Verbal Intelligence test (VIT) developed by Ojha, R.K. and Raychaudhary, K.
3. Personality was tested on 16 factors namely A,B,C,E,F,G,H,I,L,M,N,O,Q₁,Q₂, Q₃ and Q₄ separately on the norm of below average, average and above average personality factor of students estimated by the 16 PF test adopted by Kapoor, S.D.
4. Study Habit was tested for below average, average and above average study habits of the students
estimated by *Study Habit Inventory* (SHI-MS) by Mukhopadhyaya,M and Sanaswal,D.N.

2) To study the relationship between Scientific Creativity and Personality among XI grade students.

3) To study the relationship between Scientific Creativity and Study Habits among XI grade students.

4) To compare the Scientific Creativity of students of XI grade having above average, average and below average Intelligence.

5) To compare the Scientific Creativity of students of XI grade having above average, average and below average Personality factor.

6) To compare the Scientific Creativity of students of XI grade having above average, average and below average Study Habits.

7) To find out the extent to which Intelligence, Personality and Study Habits contributes to the prediction of Scientific Creativity of students of XI grade.

**1.7 HYPOTHESES OF RESEARCH**

Keeping the above objectives in view following hypotheses** have been framed and tested:-

1) There is no significant relationship between Scientific Creativity and Intelligence among XI grade students.

2) There is no significant relationship between Scientific Creativity and Personality among XI grade students.

3) There is no significant relationship between Scientific Creativity and Study Habits among XI grade students.

4) There is no significant difference in Scientific Creativity of XI grade students having above average, average and below average Intelligence.

5) There is no significant difference in Scientific Creativity of XI grade students having above average, average and below average Personality factor.

6) There is no significant difference in Scientific Creativity of XI grade students having above average, average and below average study habits factor.

7) Intelligence, Personality and Study Habits do not contributes significantly to the prediction of Scientific Creativity of XI grade Students.
**Hypotheses will be tested in reference to Male and Female students separately.**

### 1.8 OPERATIONAL DEFINITIONS OF VARIABLES

Any term, phenomenon, expression or event may have a different meaning on basis of how it has been defined or explained. In researches, it is important to define the variables included in research operationally, for convenience and to clear the exact sense for which variable is been included in research. In this investigation, few important terms which need to be defined and explained operationally are as follows:

#### 1.8.1 Scientific Creativity

Scientific Creativity is the process of becoming sensitive to problem, related to science; deficiencies, gaps, missing elements, disharmonies and so on in scientific knowledge, identifying the difficulty; searching for solutions, making guesses or formulating hypothesis about deficiencies, testing and retesting of these hypothesis and possibly modifying and retesting them, and finally communicating the results. Operationally speaking, scientific creativity is a multi-dimensional attribute differentially distributed among people and include chiefly the factors of fluency, flexibility, originality and inquisitiveness. (*Misra, 1981*)

**Fluency:** It is represented by number of relevant and unrepeated ideas which any one produces; relevancy is judged on the basis of appropriateness of the response when considered in relation to once the test problem. An unrepeated idea is one which has been expressed only under a given problem.

**Flexibility:** Flexibility is represented by person’s ability to produce ideas which differ in approach and thought tendency. It is related to with variety or responses.

**Originality:** Originality is represented by uncommonness of the given responses. Responses given by less than 5% of the group are treated as original.

**Inquisitiveness:** It refers the ability to ask many different questions about unfamiliar phenomenon and objects.

#### 1.8.2 Intelligence

Intelligence refers to the whole class of cognitive
behaviours which reflect an individual’s capacity to solve problems with insight, to adapt himself to new situations, to think abstractly and to profit from his experiences (Robinson and Robinson, 1965).

Intelligence can be defined as the ability to learn, to understand and to think in a logical way about things, this capability is reflected in behaviour. Intelligence are the abilities demanded in the solution of problem which requires the comprehension and use of symbol, i.e. words number, diagrams equations and formulae (Garrett, 1947).

1.8.3 Personality- Personality is the sum total of all the biological innatedispositions, impulses, tendencies, appetites and instincts of the individual and the dispositions and tendencies acquired by experience (Morton Prince, 1929).

According to Cattle (1950), ‘Personality is that which permits a prediction of what a person will do in a given situation.’ Cattle (1973) have identified sixteen major source traits or factors by factor analysis. All these factors were bipolar in nature and can be summarised as follows:

**TABLE 1.01**

Table Showing 16 Personality Factors and Its Description

<table>
<thead>
<tr>
<th>FACTOR</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor A</td>
<td>Schizothymia vs. Cyclothymia</td>
</tr>
<tr>
<td>Factor B</td>
<td>Less Intelligent vs. More Intelligent</td>
</tr>
<tr>
<td>Factor C</td>
<td>Affected by feelings vs. Emotionally stable</td>
</tr>
<tr>
<td>Factor E</td>
<td>Humble vs. Assertive</td>
</tr>
<tr>
<td>Factor F</td>
<td>Sober vs. Happy-go-lucky</td>
</tr>
<tr>
<td>Factor G</td>
<td>Expedient vs. Conscientious</td>
</tr>
<tr>
<td>Factor H</td>
<td>Shy vs. Venturesome</td>
</tr>
<tr>
<td>Factor I</td>
<td>Tough minded vs. Tender minded</td>
</tr>
<tr>
<td>Factor L</td>
<td>Trusting vs. Suspicious</td>
</tr>
<tr>
<td>Factor M</td>
<td>Practical vs. Imaginative</td>
</tr>
<tr>
<td>Factor N</td>
<td>Forthright vs. Shrewd</td>
</tr>
<tr>
<td>Factor O</td>
<td>Placid vs. Apprehensive</td>
</tr>
<tr>
<td>Factor Q</td>
<td>Conservative vs. Experimenting</td>
</tr>
</tbody>
</table>
1.8.4 **Study Habits** - Habits as defined by *Introduction to Psychology* means, 'a learned or fixed way of behaving to satisfy a given motive'. It indicates the predictable response which a person gives in a particular situation to achieve any desirable goal. When this definition is used to define the habits in which we study, it is termed as 'study habits'.

Study habits are study routines which include, but not restrict the frequency of studying sessions, review of material, self-testing, rehearsal of learned material, and studying in a conducive environment. Students’ attitudes toward the act of studying are referred to as ‘study attitudes’ *(Crede and Kuncel, 2008)*. Study habits are ‘the adopted way and manner from which a student plans his private readings, after classroom learning so as to attain mastery of the subject.’ *(Azikiwe, 1998)*.

### 1.9 RATIONALE OF THE STUDY

The most crucial phase of any individual’s life is his adolescence stage, where young not so mature children, are expected to perform well in each and every aspect of life. Not only others, they themselves too expect to prove their excellence in each and every field of life, which creates stress to themselves, moreover they have to undergo lots more sudden and noticeable changes physiologically, emotionally, psychologically and socially, which enhances their stress level sometimes to that level, which proves harmful to themselves too. All these changes and expectations develop adolescent stage of individual as the most stressful and unbearable stage of any individual’s life.

Several drastic changes, at every aspect of life along with unbearable intrinsic and external stress to achieve high in academics, demands certain psychological qualities which can help positively to these young section of society, who have just started to learn adjusting in the unknown situations of life, or to try in for creating the adjustable situations so that the stress they feel can act as a performance-enhancing variable for them. To deal up with changing situations of life, it generally demands to
create something desirable which can help in stress-reduction as well as achieving desirable objective upto the maximum extent to which it can be achieved by an individual. In this process of creating something more appropriate and purposeful, number of psychological factors works as a unit. Psychological characteristics, like ability to create something unique, novel, desirable and purposeful is resulted on the presence of psychological traits like creativity, intelligence, emotional intelligence, personality, aptitude, attitude, reasoning ability, numerical ability etc which helps an individual to realize, understand and act accordingly with the changing situations of life more effectively. As far as adolescence students are concern, some characteristics like creativity, intelligence, personality, scientific attitude etc. acts as prime requisite to score high in their academics. Another important factor which effects significantly in achieving high in adolescent students is the specific manner or technique which they adopt during studying i.e. their study habits.

This study aims to reveal the relation in between some of the most important psychological aspect of any adolescent student, which not only helps them to score high in their academics only but also enables them to develop the ability to cope up with every unfavourable situations of life much efficiently than anyone else can do. This study attempts to explore the relation (if exist) and its extent of prediction in between the variables like scientific creativity, intelligence, personality and study habits in the adolescence students of science stream and also how it vary in students of various academic achievement. A brief clarification for selecting these variables in the study is as follows:

1.9.1 **Scientific Creativity** - Scientific creativity in simple terms is considered as a scientific method or approach restricted to the field science for creation of something new or modifying the existing articles in such a way that it may solve out the problem faced by an individual in new situations. Generally in any form of creativity similar stages are followed in a definite sequence of preparation, incubation, illumination and revision of creation but various psychologists from all times holds conflicts and disagreements in regards the meaning, nature and procedure of different forms of creativity, where scientific creativity covers a wide aspect of differentiation done on the basis of area of application where the process of creativity is been carried
Many psychologists like Hallman(1963), Vinacke(1952), Ghiselin(1963), Yamamoto(1964) and Zimmerman(1964) proposed various fundamental concepts to describe and to differentiate in between the concepts of creativity and scientific creativity following different perspectives. Rhodes(1961) and Torrance(1965) attempted to classify and describe them on various dimensions of criterion newness, conformity assurance in creative procedure, procedural novelness adopted to conduct creative process and specific processes to obtain novel product following creativity. Creativity differentiations are majorly done on the basis of mental approach, which indulge specific creative process in different methods or techniques. Various levels of psychological factors included and approaches adopted to perceive the phenomenon acts combinely for a creative person to understand and to consider the desirable change in the problematic situationalong with the specificity of the process involved in creativity. Coler(1963) while commenting on creativity in science, stated that scientific creativity and creativity are basically different areas of human endeavour, which is variegated by the approach and means which any creative person adopts to create something new and novel which is more significant than the existing article.

Other psychologists like Mackinnon(1963), Seitz(1969) and Watson(1968) has proposed various differential methods and reasons to clear the difference in between the methodology involved in between the two, way to consider changing situations which gives a revealing insight of scientific creations as a result of adopting tools and techniques of scientific field which are more objective and reliable than the other methods to be creative. Four potential methods are generally considered to understand creativity upto a large extent (Simonton, 2008). First method assumes that creativity can be classified on the basis of mental process and problem-solving technique. In this approach creativity is measured with the help of divergent thinking tests which signifies the extent to which a person can think, to achieve for the solution to a problem. Secondly creativity can be classified as a specific personality trait which can be estimated, as well as classified with the help of various personality inventories used to classify personality on different basis. Third, creativity can be assumed as a specific character of a product which can be assessed by assessing the product created...
as a result of creative process. Lastly, creativity can also be defined as a function of environment, which proposes that discoveries and inventions are inevitable products of socio-cultural system, which takes place in society in one form or other as frequently as society undergoes changes in any aspect (Simonton, 2004).

Exclusive human endeavour like patience, collaboration, setting logical analogies, comparative and competitive spirit, moment of lucid insight, scientific approach to resolve problematic conditionsetc are very much important when it comes to create something new, logical and novel, but the most needed and important ingredient to perform a scientific creation is the scientific perspective. Scientific insight expects a certain scientific method to be followed to carry out any scientific creation which ensures the reliability on to which similar or exact results may be achieved again and again if that procedure is repeated in a similar problematic situation. Flexibility to create something novel and purposeful provides a defined and limited deviating from the prescribed scientific method to an extent to which scientific methodology can also be preserved in discovering or inventing new inventions in the realm of science.

The nurturing and development of this unique perspective of scientific approach or method to perceive and react scientifically with maximum assurance of desired results is very much important not only to students but also to any individual who tends to establish equilibrium with the dynamics of nature. Scientific creativity or scientific insight of knowledge to perceive problematic situation scientifically passes by the minimum tenure of stage of incubation which ultimately leads to illumination stage to solve the problematic situation. This approach of scientific creativity not only helps individual to find solution to the problematic situations but also acts as a powerful mean to extend the previous knowledge and provides a capability to deal with changing situation by inspecting it in diverging methods to seek solution to a problem and adopting convergence method to develop a scientific approach to solve not only that problem then but also similar problems making a bit of needed change as condition demands. Thus development of this scientific endeavour of creation is essential as it not only affects the scientific progressof student or individual in academics but also equips them to deal with the changing situation of their life more effectively.
By the means of Scientific creativity, concerning persons quest to improve their understanding and to unravel the hidden mysteries of universe to create new ideas and product which also enables them to change the inner dynamism of society and also empower them to cope up with changing situations of life and also with the stress and strain which adolescence experience at the most stressful and less experienced point of life. Thus, scientific creativity is taken as a prime variable along with some other important psychological variables which affects it directly or indirectly, in such a way that it overall not only decides, but can also predict the capability, personal expressions, inventiveness, life achievements of any individual, but also enables them to deal up to changing situations of life more effectively in such a way so that any desired objective can be achieved, in which desired academic achievement of students is also included.

1.9.2 Intelligence- Relational studies in between Scientific Creativity and Intelligence always end up with a support or oppose to the endless debate, based on the different psychological facts and findings, either setting differentiation or analogy in between the two. Any concept emerges to establish as a universally accepted concept to relate the two concepts of intelligence and scientific creativity, opposes each other in one way or another. Many psychologists assumes intelligence and creativity are the part of same process i.e. conjoint hypothesis and some believes both needs distinct mental processes to carry out i.e. disjoint hypothesis. On basis of theoretical and practical observations, it can be assumed that the analysis of relationship between intelligence and scientific creativity on both the subsets of one another are distinctly correlated and significantly possess more positive effect on each other than having their individualistic identity. But the matter of debate also arises to clarify the essentiality of minimum need i.e. weather it is necessary to possess certain amount of intelligence to create something new scientifically or this identity of individual mere needs normal level of intelligence, and vice-versa. Intelligence is a contextual element and so is scientific creativity. Intelligence not only affects scientific creativity in one form or another, but also gets affected by it.

Triarchic theory of intelligence proposes that to perform any task scientifically, any individual has to follow certain norms which signifies, the conclusion of the assigned task, following scientific approach. The need of creative
production starts with the stress caused due to inability of an individual to get adopted to the disturbed prevailing conditions, up to such extent that, it demands to any deliberate change or modification either in individual itself or in environment, so that it may assure adaptation of that individual to that in that new situation. More the stress created by the change occurred enhances the need of adaptation, resulting in to create changes needed for survival which ultimately results in to either sooner adaptation in new situation or extinction due to un-adjustment created. It also demands to have or to develop a specific creative insight needed to rearrange the resources provided in problematic situation such that it may create a better condition to live in, or using it in attaining equilibrium with minimum efforts to adjust in changed situation. It may also include development or possessing the ability to create a favourable situation for better and easy existence or to select the much appropriate situation for adjustment.

Another aspect of scientific creativity is that it is derives from the manner, style or level with which one directs one’s intelligence (Gakkar and Karna, 1976). Some level of intelligence can be considered as a necessary requisite condition to create something new and purposeful, but it cannot be a sufficient condition in full or in part because, in the process of creating something new scientifically, it is necessary to adopt scientific methodology such that it can create something new and purposeful along with following same hard-bound scientific pathway, only the appropriate selection of method and conducting or implying needed changes in such a way that it fulfils the underlined principle of science as well as to come out with something new than previous outcomes.

Intelligence is considered as an inherited quality, which is affected by various genetic as well as environmental conditions provided to any individual which unifies and stabilises on various psychological as well as physiological characteristics, which is unequally distributed among individual providing them, their personal intellect, in such a way that it helps the individual to maintain equilibrium with the changing situations of life. Intelligence can be explained as a unique and distinct capability of any individual to observe, perceive, understand and response to the change occurring in its surrounding which may result into disequilibrium. Intelligence not only provides knowledge and better understanding of a changing situation but also provides a better approach to find a better way out from problematic situations to establish equilibrium or
also in handling of novel situations to attain better adjusting situation. This capability to attain equilibrium by various methods primarily to attain scholastic achievements during the academic life of students and also equips a person to act more intelligently in all terms, in all other problematic situations of life.

Investigations made by Binet-Simen and Terman (1916) are considered as the stepping stone in relating and establishing intelligence as a predictor of scholastic achievement of students. Their findings were very much supported by the similar result studies conducted later on, using different tests, criteria or methodology to correlate intelligence as a prime predictor of scholastic achievement. The correlational studies come out with co-efficient of a correlation which generally lies in between the range of 0.40 and 0.50. Since then, and the way far ahead, it has always been a matter of research to investigate whether intelligence can be considered as a predictor of scholastic achievement or not? Practically, the question of exploring the relationship between intelligence and academic achievement is found significant in researches and also acts as a prime variable ensuring better academic achievement of students, as more or less all investigations conclude with the findings which confirms a strong relation in between the two. From many similar researches it is concluded that the intelligence has an important contribution and significant impact on other psychological variables also, which are equally responsible for better academic achievement of students. The effect of factors like curriculum adopted, program of study, the teacher, the characteristics of the school, and certain other factors also act as a deciding role in scholastic performance of students (Naglieri and Bornstein, 2003).

In recent years, several researchers have shown much more interest in exploring relationship between intelligence and academic achievement taking concern various factors. Researchers conclude to a common conclusion with an empirical evidence of having a strong positive correlation between general cognitive ability and academic achievement in almost all sorts of circumstances. A study suggested that there is noticeable variance from 51% to 75% in academic achievement that is unaccounted for by measures of general cognitive ability alone (Rohde and Thompson, 2007). The academic achievement of students in high school strongly correlates with the coefficient of 0.50 to 0.70 with intelligence scores (Jensen, 1998).
In other studies, researchers framed the hypothesis that the relationship between general intelligence and academic achievement was in large part associated with mental speed of the student. At the beginning, the divided variance between general intelligence and academic achievement was found to be nearby 30% and after controlling the mental speed component, the shared variance between general intelligence and academic achievement was decrease approximately up to 6% (Luo et al., 2003). This result indicated significant relationship in between component of intelligence with the mental speed which has a clear significant effect on the academic achievement of students.

From time to time, many researches are conducted to examine the role of various psychological and social factors along with intelligence and academic achievement of students. Studies done by Aluja and Blanch (2004), Bruinsma (2004), Capra et al. (2006), Dickhouser and Reinhard (2006), DuPaulet al. (2004), Englund et al. (2004), Evans and Rosenbaum (2008), Gooden et al. (2006), Greene et al. (2004), Guglielmi (2008), Howes et al. (2008) Martin, Montgomery, and Saphain (2006), Martins and Alexandre (2008), Papaioannou, Ampatzoglou, Kalogiannis and Sagovits (2008), Schwartz, Gorman, Duong and Nakomoto (2008) etc establishes various psychological as well as social correlates with the aspect of intelligence and concluded that intelligence not only helps in achieving better academic grades but also acts as a deciding factor to adjust socially in various setups of life of students as well as common man.

The most investigated research area comes out with the exploration of relationship between intelligence and academic achievement where many researchers have been conducted in the area considering various variables affecting them directly or indirectly. Scientist like Ediseth (2002), Gagne and St. Pere (2002), Kossowska (1999), Parker et al. (2004), Smith, Smith, and Dobbs (1991) Stipek and Gralinski (1996), Chatterjy (1983) etc have conducted comparative researches on the variables like personality, intelligence and achievement motivation of successful (high scoring) scholars and less successful (low scoring) scholars and concluded that high scoring successful students are somewhere more positively correlated and possesses better intellect than that of their low scoring, less successful counterparts. Similarly many researchers investigated the relationship between intelligence, gender and
academic achievement. Duckworth and Seligman(2006), Ehrmann and Massey(2008), Fraine, Damme and Onghena(2007), Laidra et al.(2007) studied general intelligence and personality traits with the help of five-factor model and tried to explore whether intelligence can act as a predictor of academic achievement on a large sample of Estonian school students from elementary to secondary school or not. The study comprises the sample size of total of 3618 students (1746 boys and 1872 girls) from all over Estonia attending grade 2, 3, 4, 6, 8, 10 and 12. Intelligence was measured by the Raven’s Standard Progressive Matrices and was found to be the best predictor of students’ grade point average (GPA) in all grades.

Deary, Strand, Smith, and Fernandes(2007) found a strong and positive relationship between intelligence and academic achievement. This study examined the relationship between psychometric intelligence at the age of 11 and education achievement in 25 academic subjects at the age of 16. The correlation between latent intelligence traits and latent traits of educational achievement was found to be 0.81 which was quite high to determine the academic achievement of students with the help of their intelligence. General intelligence is founded significantly affecting the success rate of all 25 academic subjects of students invariantly. Understanding the nature of the relationship between general cognitive ability and academic achievement has widespread implications for both practice and in theory of students (Rohde and Thompson, 2007). Sarla Paul (2000) tried to investigate the probable causes of low achievement at higher secondary level and came with the conclusion that intelligence is a leading cause of low achievement. In another study, Watkins, Lei and Canivez (2007), stated there has been considerable debate regarding the causal precedence of intelligence and academic achievement.

Many scientists and researchers considered intelligence and academic achievement as identical constructs, whereas many others believe that the relationship between intelligence and achievement are reciprocal or very low and cannot be taken as determining factor of any of the two. Authors like Barron, Guilford or Wallach and Kogan suggested that the correlation in between these two factors is low enough to justify them as two distinct concepts. Laidra, Pullmann, and Allik (2007), reported that student achievement relies most strongly on their cognitive abilities through all grade levels. Through a bi-variate approach it was found that intelligence showed a
significant relationship with achievement, for both boys and girls (Mishra, 1997). A study exploring identical factors associated with poor academic achievement of students during the early school years was also concluded to found that intelligence is significantly correlated with academic achievement for both boys and girls. In the study, to identify factors associated with poor academic achievement during the early years, it was found that various factors of personality like cognitive ability, gender, prematurity and social environment also contribute significantly to the poor academic achievement of students. (Ong et-al., 2010).

After the review of studies conducted in the field of exploring the role of intelligence with various other important variables researcher concluded that most of the studies in and outside country tried to perform assessments by dichotomising the variable just into two parts or sometimes considering intelligence as a whole. A detailed classification of intellect among students coming from various parts and background should be explored on some wide scale of intellect. Thus, for a defined population, researcher conducted study to explore whether intelligence may or may not act as a predictor on the detailed aspects of above average, average and below average intelligence which students possess in their adolescence and develops in their later lives.

1.9.3 Personality - Many psychological researches concludes with a conclusion that the most important facet of creativity is found correlated more or less with intelligence only. The particular or classified aspect in which intelligence is utilized, defines intellectual styles as well as the intellectual level of any individual. It is also accepted that any of facets, creativity or intelligence, cannot be found independently in nature. The other equally important facet of creativity which affects intelligence as well as creativity to a large extent is ‘Personality’ which includes all physiological and psychological factors of any individual. In particular, certain personality attributes can act as a deciding entity to conduct the creative performance of any person than any others aspect can do.

According to Allport (1937), “Personality is the dynamic organisation within the individual of those psychophysical systems that determines his unique adjustment to his environment.” Allport in his findings tries to clarify the concept of personality on the basis of traits. He defined personality traits as the foundation stone of
personality development which acts combinely as a ‘generalised and focalised neuropsychic system’ that guides adaptive and excessive behaviour rather than considering personality as a one and only determinant, which controls all psychophysical activities conducted by any individual. Whereas, the Dictionary of Education defines personality trait as, ‘a characteristic and a permanent mode of behaviour, the outcome of heredity and environmental factors.’ Thus, personality should not be considered as the independent character but the unique collection of various psychophysical systems and characteristics within any individual which includes many specific character like tolerance of ambiguity (Veron, 1970; Gruber, 1986), willingness to surmount obstacles, willingness to grow (Gruber, 1986), Intrinsic motivation (Amabile, 1983), moderate risk-taking, desire to recognition etc. into it. It is very necessary that the individual involved in the processes of scientific creation, must possess some basic characteristic in their personality which can act as a deciding measure to consider any person to be creative or not in various aspects.

Many scientists like Roe (1951), Mackinnon (1960, 1962), Eiduson (1962), Cattell and Drevdhal (1955), Helson and Crutchfield (1970), Clifford (1958), Cole (1940), Barron (1969), Gatzels and Jackson (1958), Torrance (1960), Moore (1961), Onnstein (1961) etc. has differentially explored the various personality traits present in any creative person. Many scientists along with some well known psychologists comes out with the theory of ‘functional autonomy’ which welcomes the change from the concept that a person or distinguishing personality is only the product of his past. Adopting the scientific approach, Eysenck established correlation in between various personality aspects and creativity and proposed a similar model to the Big Five theory. He stated a three-factor structural model of personality that included neuroticism, extraversion, and psychoticism and tried to establish correlation between these factors with the defined factors of creativity. Neuroticism and extraversion were as same as the Big-Five. Psychoticism was a bipolar dimension with altruistic, controlled, and socialized on one side of the continuum and aggressive, impulsive and hostile on the other. Eysenck argued that there is a high correlation between psychotic personality and creativity.

Mackinnon (1960) and his associates at the University of California selected individuals from different background to study the differentiating pattern found in
their personality traits of different individuals which results to in differentiating creative levels of these individuals. They founded that the creative persons generally are not emotionally unstable, sloppy or loose joined persons. Generally the words like deliberate, reserved, industrious, through etc. are found to be more appropriate in describing the personality traits of creative persons included in their study. They also clarified that both introverts and extroverts can be found to have the creative characteristics, but the most important personality trait of creative person as described by Mackinnon, is their openness to experience which is found to be more distinct in person related with artistic creativity rather than scientific creativity. Thus, it can be concluded that enormous possibilities lies in creative act, which at its highest level has probably been an important not only in sorting out of problems which any individual faces, but can also incapable and enriches human quality to reshape the world to a more purposeful place to live in. Thus, it can be considered that personality is a distinct and unique character of any individual which is unique from the movement any individual attains its existence, but most of the personality traits acquire their distinct characteristics at the adolescence stage of any individual i.e. this characteristic of any individual starts attaining its unique identification at the adolescence stage of childrens at 12 years or above, this characteristic of any individual enables adolescence to utilize this power to create something new, in both constructive as well as in destructive purposes, therefore it becomes necessary to explore the relation and extent to which this characteristic of adolescence helps them to achieve desired academic achievement which is the most important need of their adolescence, which shapes their academic as well as social achievement in their future life.

According to Piaget(1952) the age of 12 years and above of a children is considered as the stage of formal operation, in which a child starts thinking operations and terms in abstract form, follow logical propositions and starts reasoning with the help of hypothesis formation. At this stage of adolescence problems concerning with hypothetical formation to the upcoming or ideological problems also affects adolescent personality. Keeping the view on the stress and strain experienced at this critical stage of development of all the psychophysical development within any individual which decides its competency to deal up with upcoming challenges of life, this age of personality development was selected to explore the relational effect, development pattern and extent to which they decide to shape in the personality of
individual considering some other cognitive and non-cognitive factors found as the prime characters of adolescence of age level 15 years and above.

1.9.4 Study Habits - The concept of study habits was firstly introduced by an American psychologist, Wreant(1930). Study habit plays an important role in any individual’s life and can act as the deciding factor to predict, what can be the academic achievement of any student. Hall-Quest described study habits as *the series of acts performed by an individual in order to stimulate and adequately direct the learning process*. Study Habits can also be defined as the habits or specific manner in which process of studying is performed which also affects the outcome of the studying process significantly. Generally study habits includes methods adopted for reading or writing but the ideal study habits include much more than reading or writing only. It not only include the proper and purposeful activity of analyzing and thinking the learned concepts, but also the method of forming concept in a way that it may be taken into practice flawlessly again and again with full efficiency, whenever needed. Studying in general can be considered as a work which assimilates idea and the most probable assumption of the outcome which can be expected as a result of any particular behaviour or deed. Thus, study can provide a previous knowledge of expected good or bad outcome which can help an individual to prepare for adjustment to the upcoming stressful situations of life. Moreover, attaining knowledge in certain field and developing suitable study habits incapable individuals to perform process of study in such a way that maximum learning or to cope up with stressful situations can be achieved with minimum efforts.

Psychologists and educators believes that study habits includes development of certain mechanical skills within a certain period of time which becomes distinct and definite in the process of studying of any individual (Verma, 1996; Nagappa, 2000). It is also directed that writing summary or important points after a close and particular study helps in understanding of text and revise briefly results to in great writing results by interactive analysis and fluency development to that concept which combinely enhances our study habits (Simmons, 2002). Similarly, improper development of reading and writing skills can be a direct result of inadequate or superficial reading which may develop improper studying habits which do not fulfils the achievement of desired goal in academics or also in attainment of desired
knowledge which can be developed as a result of developing appropriate study habits. Good study habits also develops the skills of critical reflection which includes development of skills such as selecting the purposive articles, analyzing it in regards to desired objective, critiquing, and synthesizing or developing it according to the changed situations which ultimately results to in better study habits and later on better academic outcomes (Fielden, 2004).

It is also believed by some educationists that better study habits enables students to study or to work by their own as they develop the learning tendencies that enables students to study individually by studying the study material, synthesis it according to academic goal which is desired to achieve and also to manipulate it according to the need of situation, while some assume study habits as a particular way or manner which any individual or student adopts to carryout essential study to achieve desired academic achievement. The way or manner which a student plans his or her personal reading outside lecture hours in order to master a particular subject or topic are described as the study habits of that students which eventually helps the student to achieve mastery in their areas of specialization (Nneji, 2002; Azikiwe, 1998).

Exploring relation in between study habits and academic achievement has emerged out to be one of the most explored area in both psychological as well as in educational field. Many researches has been conducted to explore the relation in between the two as it also effects the personality of any individual besides helping him in achieving well in their academics too. Researchers like Jain (1967), found that bright achievers possesses better study habits and higher achievement motivation than low achievers. Although overachievers too had to possess better study habits (Diener, 1960; H.G. Gough, 1953; De Sena Paul, 1964; Sorenson, 1964 and Smith Leland, 1965). Singh (1984) found that high achieving adolescents had significantly better study habits than middle and low achievers. Patel (1986) found that better the study habits of an individual much higher will be its achievement. Lidhoo and Khan (1990) found that under-achievement among bright subjects is the result of development of poor study habits and low need-achievement which were found to be associated variably. Ansari (1980) found that the academic performance of the students can be determined by the study habits and study attitudes which acts as the
significant variables to determine academic achievement of students. National Assessment of Educational Progress (NAEP) in 1994 conducted research to find out the relationship between study habits and academic achievement. The findings of this research revealed a positive correlation between study habits and academic achievement of elementary and secondary school students.

Onwuegbuzie (2001) conducted a series of studies to find out the relationship between study habits and academic success, and reported a positive relationship between them. Study habits are actually improving because of the advent and wide use of the Internet, hypertext, and multimedia resources (Liu, 2005). Karim and Hassan (2006) noted that the exponential growth of digital information changes the way students perceive study material. Many studies in India as well as in abroad have been conducted to study the effect of study habits of individual and its impact on other personality factors along with other factors of individuals. Studies conducted in which study habits are considered as a variable generally attempt to explore interrelation in between the two considering the effect of other psychological variables like intelligence, personality, logical skills, interest, aptitude etc as a constant or dependent variable. Whereas, creative potential can never be attained individualistically, researcher has decided to explore the intercorrelation of an important variable of study habits (if any) with other important psychological variables taken in the study and also the extent to which it can help in the prediction of the most affecting variable of scientific creativity at its various dimensions possessed by scientific creative adolescents students of XI grade.

1.10 DELIMITATIONS OF THE STUDY

Various concepts taken in the research form a tight, yet vague and complex inter definitional network from where there may be no escape to any person who so ever it may be, an ordinary man, a scientist, doctor or student of any level. Thus, the aim of the research taken in consideration is to help in clarifying some of these basic relationships in between various psychological variables necessary for any adolescent student at all aspect of life and also in examining different aspects to which they affect each another. These aspects correspond to certain sorts of constraint breaking and constraint abiding norms that reflect the social and on textual character of theory-choice selected for the study. As it is impossible to cover all the factors and
possibilities related to that study, some factors are assumed to be delimited at an extent which does not produce significant differences in the preliminary research objectives framed. Keeping various aspect of study in view the study was delimited on following points:

1) The study is limited only to the psychological factors which are previously described in the research.
2) The study is delimited to XI grade students of Uttar Pradesh (U.P.) board only.
3) The study is delimited to XI grade students of science stream (PCB group) only.
4) The study is delimited to hindi medium students of XI grade.