CHAPTER 1
CHAPTER - I

INTRODUCTION

1.1 CREATIVITY IN THE WAKE OF GLOBAL CHANGES AND CHALLENGES

One of the main difficulties to conduct research in creativity lies in our failure to formulate an accepted definition. Some of our definitions pre-dominantly support the importance of studying the domain of creativity from the viewpoint of its effect on the society whereas some other definitions recognize the importance of personal expressions of human activity. Hence extrinsic and intrinsic importance is coming to the fore.

There is no uniformity in views regarding creativity as phenomenon of creativity is too flexible. It is only in the recent years that systematic and scientific research has been shown in the subject.
In the past, Creativity was considered as a divine gift, as an imagination ability, intuition and cosmic fence. Terms like originality, insight, adventurous thinking, discovery, problem solving and inventive ability, have been used synonymously with creativity.

Creativity involves not only one but many abilities; three of these are fluency, flexibility and originality. According to Drevdahl (1956, 1958), “Creativity is the capacity of a person to produce compositions, products or ideas of any sort which are essentially new or noble, and previously unknown to the producer. It can be imaginative activity or thought synthesis, where the product is not a mere summation. It may involve the forming of new patterns and combinations of informations derived from past experience, and transplanting of old relationships to new situations and may involve the generation of new correlates. It must be purposeful and goal directed not merely idle-fantasy-although, it need not have immediate practical application or be a perfect and complete product. It may take the form of an artistic, literacy, mathematical or scientific production or may be of procedural and methodological nature”.
Cattell and Butcher (1968) pointed out that creativity is a vague term, but it describes a quality or a complex of qualities, whose importance can hardly be exaggerated and it appears to be the best term for the wide spectrum of behaviour involved. That spectrum includes mathematical and scientific discoveries, artistic production, musical composition, technological inventions, political and social innovations, literacy creation and even religious leadership.

Many authors and researchers have given definitions and explanations to make the concept of 'creativity' clear but there is no complete unanimity among those studying creativity as to what it really means (Freeman, Butcher and Christie, 1971, Barron, 1981). Hallman (1963) gives two reasons for the confusion in conceptual clarity and disagreement among the various researchers, as

i. The tendency to emphasize interest by a wider area of disciplines to investigate the creative process, and

ii. The complex nature of creative experience.

The first view of assigning different meanings to the process of creativity by different investigators
has been reported by Vinacke (1960), Ghiselin (1963), Zimmerman (1964), Yamamoto (1964), Romey (1975) and Howley (1979). Whereas the second view is extensively found in the numerous definitions which Rhodes (1961) attempts to condense into four roughly discriminating areas; person, process, product and press. In the same lines Torrance (1965) attempts to classify the dimensions as:

i. Newness as Criterion
ii. Creativity vs. conformity
iii. Creativity as a process
iv. Creativity through the approaches of mental abilities.
v. Levels of creativity and
vi. Approaches through the studies of creative persons.

To an Architect, “creativity is the ability to produce new forms and new approaches and new materials in the functional design.

According to mathematician, “creativity is the ability to solve mathematical problems which are useful in creating combinations and that provide knowledge of mathematical law/principle.
According to scientist, “creativity is the ability to explore ways of extending the frontiers of knowledge.

Torrance (1966) conceives creativity as ‘a process of being sensitive to problem, deficiencies, gaps in knowledge, missing elements and so on, identifying the difficulties, searching for solution, making hypotheses, testing and retesting these hypotheses and possibly modifying them and finally communicating the results’.

Thus creativity is a process, this process is a goal oriented which leads to the production of something new idea (many be verbal or non-verbal, concrete or abstract, may be artistic or in other area of life). In other way it is a specific way of handling informations.

To arrive at a meaningful picture of numerous definitions of creativity, all different views have been tentatively designed and presented in the same pattern as given by Gakhar (1975) within the roughly discriminating categories of product, process, person and press.
The study of creativity has assumed great importance in recent years and research in this area has profound impact on learning situations. Unlike in the not too distant past, there is increase awareness today that student scores in standard IQ tests are not diagnostic of creativity.

While the study of creativity is an important research problem, what is more relevant to us in India is to find the factors which promote the creative behaviour of the children in the home and in school. It has been shown that there is a definite increase in creative thinking and creative activity among children and young when constraints of the classroom and home and society are relaxed and creativity is encouraged (Torrance, 1965).

Although, it is true that language and fine arts are the most obvious subjects where creativity can be easily encouraged, it is most important to enlarge the scope to include social studies, science and mathematics subjects at school level.

An area of particular interest in the Indian context is the recognition of creativity among the rural and urban disadvantaged children who form the bulk of our population and
yet who are almost completely bypassed by the existing talent search programme.

Further, in the wake of global changes and challenges, there is need that research in the field of creativity must display the courage to grow in a realistic educational environment.

1.2 MEANING, NATURE AND IMPORTANCE OF MATHEMATICS

According to Bhargavas Standard Illustrated Dictionary (1965), “Mathematics is the science of space and numbers”.

According to Chamber’s Twentieth Century Dictionary (1970), “Mathematics is the science of magnitude and numbers and of all their relations”.

Good’s Dictionary of Education (1973) defines mathematics as, “Mathematics is the science of measurement, quantity and magnitude”.
In the words of P.A.M. Dirac (cited by Gakhar, 1990), “Mathematics is the tool specially suited for dealing with abstract concepts of any kind and there is no limit to its power in this field. In other words, as in mathematics we find at the abstract level with the help of process of reasoning, therefore, mathematics may be regarded as a science of abstract form”.

From the above opinions we conclude that – Mathematics is a science of quantity (amount, size and portion) and space (time interval, distance). It deals with the questions and problems involving size, portion, area, time, interval, distance etc. It is also a science of calculation involving the use of numbers. It deals with the relationship between magnitude. It deals with the numerical part of man’s life. In this way it is a systematic, organized and exact branch of science which deals with abstract concepts.

Mathematics has its own language and symbols, which cut short the lengthy statement and help the expression of ideas or things by giving them exact form. Due to this nature of Mathematics, Lindsay remarks “Mathematics is the
language of physical sciences and certainly no more marvelous language was ever created by the mind of man”.

Mathematics is the science of logical reasoning where results are developed through a process of reasoning. In this connection the words of Locke are worth mentioning here – “Mathematics is a way to settle in the mind a habit of reasoning”.

Mathematics is also the science of inductive and deductive reasoning. Inductive reasoning means when a particular property is true in a sufficient number of cases, then we conclude that it will be prove in all similar cases. Due to this nature of mathematics, mathematicians are of the view that – “Mathematics in the making (beginning) is inductive and not deductive science “. Likewise, mathematics is also deductive science and deductive reasoning is based on axioms, postulates, self-evident truth, unidentified terms and definitions. That is why A. N. Whitehead has said rightly that, “Mathematics in its widest sense is the development of all types of deductive reasoning”.

Mathematics is an exact science and involves high cognitive abilities and powers. In this connection Courant
etc. (1941) have expressed their views about the nature of mathematics in beautiful words as – “Mathematics as an expression of the human mind reflects the active will, the contemplative reason, and the desire for aesthetic perfection. Its basic elements are logic and intuition, analysis and construction, generality and individuality”.

Mathematics is of two types – Pure and Applied mathematics. Pure mathematics deals with the theories and principles without regard to their application to concrete things where as applied Mathematics is the practical side of pure mathematics. That is why each and every invention and discovery in the field of physical, biological or social science sciences owe much to applied mathematics.

Broadly speaking, the term mathematics covers two areas of activities – Theoretical and Applied. The duties performed, the processes involved, equipment used, etc. in the two fields of work may differ at times. Even then, work is not always demarcated and a mathematician may be involved in both theoretical and applied mathematics.
Theoretical mathematicians are concerned with the logical developments of mathematical system. They deal with pure and abstract mathematical concepts without concern for the practical application of their work to everyday problems.

Applied mathematicians use mathematical theories and principles as tools to solve problems in any field such as physics, chemistry, biology, business, industry and so on. They analyse various aspects of the problem and describe the existing relationship in mathematical terms.

The knowledge of mathematics is indispensable for a wide variety of professions. Any person planning to study physical sciences i.e. physics, astronomy or engineering subjects should have studied one or two years of college mathematics over and above 4 to 5 years high or higher secondary school mathematics. And this is just the beginning for the mathematician, who needs 5 to 6 years of graduate and post – graduate work in a college or a university. The Ph.D. degree in mathematics is also a desirable qualification for persons choosing teaching or research as a career in mathematics.
A large variety of occupations are available these days to persons having a degree or post-graduate qualifications in mathematics. There are four broad areas in which the services of mathematicians are generally needed.

These are:

a) Teaching
   (i) in Schools,
   (ii) in Colleges and Universities;

b) Application of Mathematics, Mathematical Statistics and Operational Research;

c) Computer Programming;

d) Actual Mathematics.

Teaching offers large number of job openings for persons with mathematical qualifications. Mathematics teachers work in schools, colleges and universities.

Mathematicians engaged in applied work are being increasingly called upon to handle statistical work. Mathematical statisticians, through their expert knowledge, help in finding a solution to the problems of trade, industry, business,
etc. In recent years, government departments have come to greatly rely on statistical data especially for economic planning.

Mathematicians handling statistical work in government offices are engaged in varied phases of socio-economic activities. They may forecast population growth, estimate the country’s natural product and analyse trends in the growth of national economy. They may estimate crop yields, predict and evaluate the results of new technique introduced. They may be engaged in constructing indices of cost of living, prices or other economic indicators. Persons engaged in the private sector are called upon to conduct public opinion poll or judge the popularity of particular brand of community.

In recent years, the trend has been to conduct sample surveys on current topics of socio-economic subject. Mathematicians working on such projects have to collect, analyse and interpret statistical data. For that, they have to chalk out a survey questionnaire or reporting form. They determine the type of data to be gathered and size of the sample to be drawn. They prepare instructions for those who will code and tabulate returns. The data thus collected is analysed and given a summarized shape. Tables, charts and graphs are also got prepared to facilitate
interpretation of mass of information. Mathematicians have to draft reports and highlight the conclusions drawn. Earlier, the task of mathematicians was that of summarizing a mass of data to yield a few key figures that measured the economic and social phenomena of the country. But recent advances in the quantitative analysis, including simulation and model building, has made the task of applied mathematicians, particularly a higher level, all the more important and significant.

This is an age of machines, and these also have found their way into offices. There are machines to relieve workers of drudgery which was perhaps inevitable when everything had to be done by hand. The latest of those technological changes are the evolution of the electronic computer.

A computer is an advanced type of calculating machine which speeds up many operations associated with modern offices. We in India are rather a late starter in this field, but now the number of computer machines is rapidly increasing.
Mathematicians are also required in the field of electronic computers. Statistical data is processed in various types of computers. This facilitates accuracy, speed and convenience in analysis of mass of data. “Mechanical Brains” as these machines may be called, need competent persons with mathematical background to handle them.

Computer Programmers or Systems Analysts who handle mechanical tabulation of data have to study the problem carefully from the customer’s point as well as from the machine which will have to respond in order to produce desired results. They prepare a flow chart which shows the steps in sequence which the machine must take. When the programme is made, they test its working practicality. Facts and figures to be processed are kept converted into the form (cards or tapes) used by the computer machine. Operator runs the machine according to the instruction sheet and procedure to be followed.

Persons with lower mathematical qualifications are also needed in the computer machines. They perform some routine jobs which are necessary before the machine is activated. Some of the junior machine room operatives are: Key Punch Operator, Verifier, Sorter Tabulator. However,
the type of junior staff deployed depends on the type of machine installed.

Mathematicians are in demand, though in small numbers, in yet another field of work. The modern “Actuary” is a person with a mathematical background.

Actuaries are primarily concerned with designing of insurance and pension plans and keeping these programmes on a sound financial footing. To that end, they apply their mathematical, statistical and financial knowledge; actuaries determine the insurance premium rates and contract provisions for each type of policy offered, etc.

Actuaries have to compile data relating to rates of mortality, sickness injury, retirement and property loss from accident, theft, fire or any other hazard. On the basis of information available to them, they analyse insurer’s claims against their corporation or company. By their understanding of theory of probability and calculus, they evolve new types of polices attractive to the customers which also bring business to their companies.
In order to be successful on the job, actuaries have to keep themselves well informed of general economic and social trends and legislative health, and other developments that may affect insurance practices. By virtue of their vast knowledge in the field of insurance, they also work on problems arising in investment, underwriting and may frame general policy of the company.

Actuaries are employed by the Life Insurance Corporation of India, general insurance companies, Employees State Insurance Corporation, banks, stock exchange and other financial institutions controlled by Government or private bodies, though insurance, now nationalized, continues to be the biggest employer.

Normally, actuaries are appointed as Administrative Officer, Section officer (Actuarial), Assistant Actuary etc. They rise to the posts of Branch Manager, Divisional Manager over a period of time.

Persons having mathematical qualification have some opportunities for self-employment. These are available
particularly in the field of education, both at school and college levels.

For coaching school students in the subject of mathematics, there is a demand for part-time tuitions. This work can be obtained either by accepting private tutorship or by opening tutorial institutes in the urban areas. Demand for such teachers is generally felt more a few months before the beginning of the examination season.

Similarly, there is some scope to engage oneself in the college level teaching. Opening of a tutorial institute with a view to catering to specific needs of the student community can become good business. Some students find mathematics a different subject. Therefore, they need individual coaching. This offers part-time work for mathematics teaching. Since mathematical is also prescribed as a subject in the various competitive examinations, there is good demand for tuition work.

In other fields, avenues of self-employment do not appear to be so bright except that some “actuaries” take to private practice by setting up consultancy service in the investment and share market. And persons engaged in research
work may contribute some articles and features on topics of current interest in newspapers, magazines, etc.

1.3 MATHEMATICAL CREATIVITY

As there is no universally accepted definition of creativity, similarly, there is no fully agreed definition of scientific creativity. Bennett et al. (1969) who researched the meaning of creativity remarked that creativity is multi-faceted and does not mean something to all people. The meaning of creativity is fundamentally unclear. Though various definitions of creativity has been presented (Ghiselin, 1952; Stein, 1953; Lowenfield, 1958; Rhodes, 1961; Maslow, 1962; Mackinnon, 1967; Koestler, 1964; Getzels, 1964; Guilford, 1964 and Gowen, 1984 etc.), but the most accepted definition of creativity is a given by Torrance (1967), in terms of process and the similar definition is equally useful in all areas like mathematics, science, language, social studies, psychology, music and physical education.

Sharma (1972) equated mathematical creativity with problem solving type fact-finding activity.
Mathematical creativity, therefore, is an attribute that permits the infusion of new elements into any and all of these aspects and objectives of mathematics. Thus, creativity can manifest itself in the conception of new ideas contributing to mathematical knowledge itself, in the formulation of new theories of mathematics, in devising of new experiments to probe nature’s laws, in the development of the mathematical ideas applied to the particular domains of practical interest, in the realization of new organizational features of mathematical research and of the mathematics community, in the novel implementation of plans and blue prints for mathematical activities in trail blazing undertakings to transmit the mathematical outlook into public mind and in many other realms. The common elements in all these channels are the establishment of something that was absent previously and which at the same time significantly furthers the objectives of mathematics.

On the basis of Torrance’s definition of creativity, mathematical creativity may be defined as, “a process of becoming sensitive to problems to related to mathematics, deficiencies, gaps, missing elements, disharmonies and so on in mathematical knowledge; identifying the difficulty; searching for solution; making guesses or formulating hypotheses about
deficiencies; testing and retesting of these hypotheses and possibly modifying or retesting them and finally communicating the results”.

1.4 ROLE OF ENVIRONMENTAL FACTORS SOCIO-ECONOMIC STATUS IN THE DEVELOPMENT OF CREATIVITY

According to Rasool (1977) cited by Mathur (1977), all of us are born with creative potential and if given proper environment, technique and facilities, this potential can be recognized, nurtured and measured. Thus creativity is not a monopoly of a few, if opportunities are provided everyone has the potential to be creative in his own way.

Sometimes lack of stimulation comes from ignorance of its importance on the part of parents and other people in the child’s environment. Social attitude towards creativity sometimes militate against the development of creativity. For example, unfavourable attitude towards creativity and lack of social rewards for creativity.
Unfavourable home condition, for example discouragement of exploration, little free time for the child to do the things as they please, discouragement of fantasy, conservative parents over protected or authoritarian parents may be different factors arising out of home environment which prevent the child to make good adjustment in the different areas of creativity.

Similarly, in school environment there are many factors which discourage the development of creativity e.g. large classes, strong emphasis on memorization, highly organized schedule of class activities which restrict the movement of child towards creative activities.

There is also relationship between socio-economic status of the parents and development of creativity. For example, in very rich families, provision of highly structured play equipment also deprived the child of play activities outside the home. Similarly some restrictions put on the girls may deprive them in taking part outside the home activities.
1.5 RATIONALE OF THE STUDY

From the above discussion it is revealed that it is essential to develop creativity in students. Intellectual level of the students, home and school environment, socio-economic status of the parents, facilities/chance given to students to create some new idea or thing, all leads to the means to acquire knowledge and to create new information for the child which ultimately help the child in the development of mathematical creativity. According to Torrance (1969) everybody possesses to some extent the ability involved in being creative. These abilities can be increased or decreased in the way children are treated.

Creativity is a pathway to mathematical creativity. Encouraging children in orientation towards problem solving is of utmost importance to educators as it will help students to develop their abilities to solve many kinds of new problems, creative tasks in and out of the school.

Further, there is variation in creativity of the individual. Environment has great influence on the development of creativity. Similarly sex-differences, socio-economic status of the parents, family size, urban-rural differences, intelligence,
home and school environment – all have lot of influence on the development of creativity, including mathematical creativity.

In the light of above observations, it was considered appropriate to study the relationship of some intellective and non-intellective variables with the mathematical creativity of students who are studying at elementary stage of education.

Further, the investigator being a teacher was interested in the development of mathematical creativity of his students. For this it was necessary to understand the relationship between independent variables taken in the present study and dependent variables of mathematics creativity, in detail so that those independent and dependent variables which go together could be identified which could increase the creative thinking ability of the students, in the field of mathematics.
1.6 STATEMENT OF THE PROBLEM

“Intellective and Non-intellective Factors Associated with Mathematical Creativity at the Elementary School Stage”.

1.7 OBJECTIVES OF THE STUDY

1. To find the relationship of intellective variables (i.e. intelligence, creativity and mathematical achievement) with the mathematical creativity of the children.

2. To find the relationship of non-intellective variables (i.e. socio-economic status, home environment and institutional environment) with the mathematical creativity of the children.

3. To study the differences in the mathematical creativity of children due to high and low socio-economic status, sex-differences, urban-rural differences, school wise differences and differences due to home and institutional environment.
1.8 DELIMITATION OF THE STUDY

1. Study was delimited to students of VIIth Class studying in Government/Private High/Senior Secondary schools and public schools situated in the Himachal Pradesh State.

2. It was delimited to 540 children including urban-rural, boys and girls.

1.9 DEFINITIONS OF THE KEY TERMS

Creativity

Creativity is the process sensing difficulties, problems, gaps in information, identifying the difficulties, searching for solution, making guesses, testing these guesses and finally communicating the results. Its measurements are the scores in terms of fluency, flexibility and originality measured by Creativity Activities Check List (Torrance, 1962).
Mathematical Creativity

On the basis of Torrance (1962) definition of creativity, mathematical creativity may be defined as a process of sensing problem in the field of mathematics, searching for solution, making guesses and finally communicating results. Its measurement is the score on Moghe (1989) Test for Testing Mathematical Creativity.

Mathematical Achievement

It is the knowledge attained or skill developed in the field of mathematics. Its measure is the score on Achievement Test in Mathematics (Prakash, 2000).

Home Environment

Environment means all that is found around the individual and that influence the personality, creativity and achievement of the individual. Its main aspects are – physical environment (food, building etc.), social environment (e.g. family, relatives, playmates, friends, neighbours), home
environment (home, TV, relationship with parents, brother, sister, size of the family).

1.10 NEED AND IMPORTANCE OF THE STUDY

Upto 1970 only five studies were completed in the area of creativity. But despite difficulties there has been consistent growth of research about this complex and multifaceted phenomenon of creativity as the situation is gradually improving in India because of 1993 as many as 214 research studies have been completed. Therefore, this field needs further exploration.

Mathematics is one of the oldest sciences. In fact its knowledge is essential for understanding of various other subjects. Its knowledge is indispensable for a wide variety of professions e.g. school teacher, college teacher, university teacher, computer programming, actuarial mathematics, statistical analysis, operational research, trade, industry, business etc. In the present age, knowledge of mathematics has become essential in almost every field. Every government of the world has come to greatly rely on statistical data especially for economic planning and budgeting. Each government relies heavily on the creative
and talented mathematicians as many vital decisions are taken on the basis of statistical data. From this study it will be helpful to get the awareness of mathematical creativity which in turn will help to examine the imaginative and productive application of this knowledge for improving the quality of life of our children.

Although some work has been done in the field of general creativity, but the area of subject creativity especially mathematical creativity has not been explored well. Researcher has come across with four studies as yet. Therefore, there is a great scope of research in this area.

Previous researches have concentrated on the correlational technique of analysis by finding the relationship of general creativity with cognitive factors or personality traits. This study will take into consideration in home environment and school environment. Findings could tell us clearly about the association of environment with mathematical creativity. Also multi-analysis will give total and true picture regarding the inter-play of intellective and non-intellective variables with mathematical creativity of children.
Further most of the work done in the field of general creativity or mathematical creativity is the secondary stage and elementary stage is neglected till now. Present study is conducted on the children of elementary stage as it is the foundation stage in the educational ladder of the individual.

It is also imperative that knowledge of the relationship between the independent variables with the dependent variable of mathematical creativity is very much useful in guiding students into their educational and vocational careers as also providing proper environment at home and school for improving these abilities.

1.11 PLANNING OF CHAPTERS

Introduction along with the objectives of the study has been given in Chapter I, while the Chapter II deals with the conceptual understanding and theoretical viewpoints about predictors. In Chapter III, Review of Related Literature and Hypotheses have been presented while Chapter IV is denoted for the Methodology employed in the present study. Chapter V deals with the Nature of score distribution while Chapter VI deals with Analysis of Data, Results and Discussion while in Chapter VII
Summary, Conclusions and Suggestions for Further Research have been presented. Bibliography and Appendices have been given at the end of the Research Report.