CHAPTER ONE

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The present study was designed to explore relationship of mathematical creativity as it relates to aptitude for, achievement in and attitude towards mathematics. A variety of forces are responsible for a great demand on educational research pertaining to creative talent. The recognition and demand for the creative individuals' contribution to society, the movement for educational equality, disenchantedment with intelligence tests and subsequent search for alternative measures of functioning have directed greater interest towards creativity. The goal of education in terms of increased capabilities, personal expression, greater inventiveness and blossoming of the gifted cannot be fully realised in the absence of adequate knowledge of creativity. We cannot afford to neglect any aspect of creative talent, its nature, assessment, nurture and utilisation. Comprehending creativity, therefore, is important in education programming especially in mathematics where many students encounter difficulties. In terms of its products, creativity in mathematics has been of vital importance in promoting the progress of human civilisation.
Despite numerous definitions and theories of creativity in the literature usually emphasising novel combinations or unusual associations of ideas, no agreement seems to have been reached regarding the degree of "Unusualness". Some authorities require that such combination or unusual associations have social or theoretical value; at least they must have some emotional impact on other people. Others do not emphasise this criterion but are content if the creative product is "new" to the individual doing the creating.

The research maxims in the sphere of creativity are:

- that the conventional intelligence tests are out-dated;
- that in place of the conventional intelligence test, we now have tests of creativity;
- that despite the existence of 'Creativity Tests' the factors which determine an individual's creativeness are personal not intellectual;
- that the originality in all spheres is associated with the same personal type, the diverger;
- that the convergence is a form of neurotic defence, while divergence is not. Divergence leads to all good things in life — personal as well as professional; convergence achieves the second at the expense of the first.
That the conventional education is antipathetic to the diverger. Hence it jeopardises the nation's supply of creative talent. Therefore, education should become more progressive.

In respect of Mathematical creativity or creative process in mathematics or the process of mathematical creation, human mind seems to take least from the outside world in which it acts or seems to act only of itself and on itself. Mathematical demonstrations consists of syllogisms, placed in certain order, and the order in which these elements are placed is much more important than the elements themselves. Invention is the discerning choice. The most fertile combinations come from disparate fields, and while many of these may be sterile, they rarely occur to the inventor. The power to differentiate, harmonious, fertile and beautiful combinations from others - sterile combinations differentiate creative and non-creative mathematicians or mathematics worker. Creative work in mathematics requires intuition, imagination, experimentation, judicious guessing, grouping, divination, insight, immense patience, continuous involvement in thinking, sudden illumination and sense of achievement. Creativity in mathematics requires willingness to give up or add some axioms. It requires relaxation or addition of some conditions of a theorem and seeing how far conclusions are modified. Mathematical creativity
expresses itself in generating new significant concepts, generalising a number of concepts or theorems, establishing link between obviously unconnected concepts and theorems and establishing relations among facts of mathematics and facts of nature and society. The following definitions have been offered with respect to mathematical creativity in particular:

— Creative thinking is thinking which results in addition to knowledge (Carlton, 1959).

— Creativity is the ability to produce original or unusual applicable methods of solution for problems in mathematics (Spraker, 1960).

— Creativity is the ability to combine ideas, things, techniques and approaches in a new way (Romey, 1970).

— Creative mathematics is the ability to analyse a given problem in many ways, observe patterns, see likeness and differences and on the basis of what has worked in similar situation to decide on a method of attack in unfamiliar situation (Laycock, 1970).

The first two definitions refer to product and the remaining to process and subjective experience. However, Jensen (1973) defines Mathematical creativity operationally
as the ability to give numerous and applicable responses when presented with mathematical situation in written, graphic or chart form. Hohn (1961) regards the study of patterns, relationships, forms, structures in system of numbers, geometric figures, functions and other objects of interest as the primary creative activity of mathematician and thus important in the identification of potential creative ability in mathematics. Before an individual can think of creative ways of solving a problem, he needs to have basic knowledge or capacity to carry out mathematical computation. Thus achievement in mathematics is pre-requisite to mathematical creativity. Mathematical skills and knowledge are necessary for mathematical creativity. Therefore, mathematical achievement plays a very important role in mathematical creativity.

Studies in this area have been scattered on intellectual and personality characteristics of creative individuals and the distinction between creativity and general intelligence. Mathematicians were subjected to investigation of their personality structure by Mackinnon (1962) and Barron (1965) to identify characteristics of creative men of mathematics. Creative mathematicians were found to be significantly different from the representative of their profession, being individualistic, preoccupied, artistic, complicated, courageous, emotional, imaginative
and self centred. These creative individuals were high both on theoretical and aesthetic values.

Kesse (1972) investigated creative thinking ability and students achievement in mathematics using discovery and expository method of teaching. His findings were that there was no interaction of teaching method with creative ability, and no significant differences were found between high and low creative students in achievement and attitude towards mathematics.

Salandanan (1976) investigated relationship between conceptual style and mathematical creativity and found that conceptual style, mathematical creativity and intelligence or verbal aptitude are at least partially independent.

In the light of the research on creativity cited, specifically investigations which have involved identification and measurement of creative potential in mathematics, the reliability and validity of data collected from various studies are so sketchy that there is a need to carry out research with great rigour. The lack of conceptual clarity and disagreement among experts as to meaning, nature, and measurement of creativity lead to contradictory results in exploration of mathematical creativity. The studies by Mayhon (1966), Yeremian (1967), Dhaliwal and
Saini (1976), Tanpraphat (1976), and Milgram (1976) reveal that achievement is independent of creativity. But the investigations of Spraker (1960), Doh (1965), Evans (1965), Jensen (1973) and Balka (1974) established a positive relationship between achievement and creativity. Metcalf (1965), Irvine (1968), Massad (1969) and Marrian (1975) found that creativity and aptitude are independent of each other. However, Harper (1966), Jenson (1973) and Korb (1974) discovered a positive correlation between creativity and aptitude. A negative relationship was revealed between aptitude and creativity in an investigation by Tanpraphat (1976).

The studies of Evans (1965) and Cheong (1966) reveal that attitude towards mathematics and experimental attitude respectively are significantly and positively correlated with creativity. However, attitudes towards mathematics and mathematical creativity were found to be independent of each other by Buckye (1969). He discovered that attitude towards mathematics was not significantly related to creativity.

In view of importance of mathematical creativity and research findings it appears logically that its nature, nurture and utilization may be explored with great rigour, which will have far reaching implications for education.
programme in terms of pedagogy of teaching, curriculum construction and educational planning. An attempt has been made in the present study to investigate the relationship of mathematical creativity with aptitude for mathematics, achievement in mathematics and attitude towards mathematics.

The present study entitled 'Mathematical Creativity as Related to Aptitude for, Achievement in, and Attitude Towards Mathematics' was aimed at exploring the nature of creative ability in mathematics and determining its relationship with aptitude for, achievement in, and attitude towards mathematics for high/higher secondary school students.

The following research issues were raised for examination which emanated after a systematic sifting of relevant research studies:

— Whether mathematical creativity and aptitude for mathematics are two distinguishable modes of the same cognitive functioning.

— Whether mathematical creativity and attitude towards mathematics are independent of each other.

— Whether mathematical creativity and achievement in mathematics are independent of each other.
The hypotheses for examination of various issues as raised above were:

- mathematical creativity is significantly related to aptitude for mathematics.

- significant relationship exists between mathematical creativity and attitude towards mathematics.

- mathematical creativity contributes significantly towards achievement in mathematics.

- aptitude for mathematics and attitude towards mathematics conjointly contribute to mathematical creativity.

For the purpose of this study, various concepts were operationally defined as under:

- **Mathematical creativity** was operationally defined as the total score on fluency, flexibility, and originality as measured by C A M T.

- **Convergent thinking** was operationally defined as the ability to 'zero in' on a correct or most appropriate answer.

- **Divergent thinking** was operationally defined as the ability to generate information, where the emphasis is on variety of responses and quality of output.
Fluency of thinking was operationally defined as the ability to call up ideas, where the quantity and not quality of ideas is emphasised. The measure of fluency was the fluency score obtained by the subject on the CAMT.

Flexibility of thinking was operationally defined as the ability to produce a diversity of ideas or categories in a situation that is relatively unstructured. Its measure was the flexibility score on CAMT.

Originality was operationally defined as the ability to produce remotely associated or uncommon responses. Its measure was the originality score obtained by the subject on the CAMT.

Attitude for mathematics was operationally defined as the score on numerical ability test (NA), verbal reasoning test (VR) and abstract reasoning test (AR) of revision of differential aptitude tests for higher secondary school by J.M. Ojha.

Achievement in mathematics was the score obtained by the student in mathematics at Punjab School Board Examination.
Attitude towards mathematics was operationally defined as the score obtained on the instrument MAS developed in this study to measure attitude towards mathematics.

The final report comprises of six chapters: Introduction; Theoretical View of Creativity and Mathematical Abilities; Methods and Procedure; Construction of Research Tools; Analysis of Data and Discussion of Results, and Summary & Conclusions.

In the introductory chapter the background, need and significance of the study along with the issues raised and hypotheses formulated have been given.

The second chapter describes theoretical views of creativity, mathematical abilities and educational implications. This chapter is divided into four sections: The first section contains an overview of general creativity. The second section contains a discussion of the major areas of general creativity. In-depth view of nature of mathematics and mathematical abilities is given in the third section. The final section describes educational implications of creativity.

The third chapter deals with the Method & Procedure and is divided into four sections. It contains the method
and description of sample, the research tools, the Data collection procedure and statistical design & analyses procedure.

The fourth chapter describes the development, construction and validation of mathematics attitude scale (MAS) and the CAMT.

In the fifth chapter, analyses and discussions of results with respect to the hypotheses are provided.

In the sixth and the last chapter a summary of the thesis and its conclusions are included.