CHAPTER - V

Findings Conclusions and implications

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CHAPTER 5

Findings, Conclusions and implications

The final step in scientific process of research is to summarize the findings, arriving at conclusions, formulating proper generalization for the population to which these are applicable. Conclusions are essential for study, which tell about its outcomes. They are derived from analysis and interpretation of data. The present study was undertaken with the specific purpose of determining the mathematical creativity and effect of some factors such as academic climate, style of learning and thinking on mathematical creativity of CBSE and UP Board students. The design of investigation was directly condition by these objectives. The normative survey method of research was used. The stratified random sampling technique was used to select the sample. For purpose of analysis and drawing up of results from raw data mean, standard deviation critical ratio ‘t’ test F test chi square coefficient of correlation were used. On the basis of analysis and interpretation of data in the previous chapter, the conclusions are drawn. This chapter starts with the answer of hypothesis that was formed in collection with this investigation.

The text of this is reported under following heads:-

5.1 Major findings
5.2 Conclusions at a glance
5.3 Educational Implication of the study
5.4 Suggestions for further researches

5.1 Major findings:

The results analyzed and interpreted in previous chapter need to be discussed for the verification of hypotheses formulated in first chapter. The discussions for achieving the conclusions are as under:-

- CBSE and UP Board students differ significantly on their mathematical creativity and its dimensions. CBSE students are higher in mathematical creativity as well as in its
dimensions viz. fluency, flexibility and originality than UP Board students. This shows that the type of board affects the mathematical creativity of students. CBSE board students posses high mathematical creativity than UP board students which tell us that CBSE board students are more aware in study of mathematics. CBSE schools provide a better environment and facilities for fostering of Mathematical creativity talent such as mathematical Laboratory, institutional and instructional facilities well trained and qualified teachers, continuous internal assessment system, innovative policy of education. results of few years and percentage of selections in competition IIT- JEE and AIEEE show the better performance of CBSE Board in comparison to UP board students. Achievement and giftedness in mathematics affects the mathematical creativity. Parasnis \(^1\) (1985) and and Tulı\(^2\) (1979) reported significant correlation between achievement in mathematics and mathematical creativity. Few years Board results, performance in competition show that CBSE board students' are superior to UP Board students on their achievement in mathematics. That is why CBSE board students posses high mathematical creativity than UP board students.

► CBSE Board schools and UP Board schools differs significantly on their level of academic climate as well as in its dimensions. CBSE board schools are better in physical material, interpersonal trust, school provisions and academic provisions than UP board schools. CBSE Board Schools are better in academic climate and its dimensions this may cause due to its broad area, CBSE is a central board spread over not only in India but also in other countries while UP Board is a state board spread in Uttar Pradesh only. On the other hand recognition policy, norms and standards, rules and regulations of CBSE board are not liberal like Uttar Pradesh state Board. This may cause that the academic climate of CBSE board schools is better for its all dimensions than UP board schools.

► There is a significant difference in the preference for concepts of learning and thinking styles among right hemisphere and left hemisphere dominant CBSE and UP Board Students. Style of learning and thinking are developed due to environmental condition and by way of nurturing children by their parents and teachers. The climate of CBSE
Students was found superior to UP Board students. That is why that the CBSE and UP Board students differ significantly on their style of learning and thinking.

► Students belonging to high academic climate group and low academic climate group differ on their level of Mathematical Creativity. It means academic climate affects the mathematical creativity of students. For the fostering and development of creative talent in mathematics conventional and modern facilities are necessary. Kumar (1996) on his study reported that facility affects the climate of school and students Mathematical Creativity. High level of academic climate will be helpful to develop creativity in mathematics. So by providing better facilities and good academic climate we can foster and develop creative talent in mathematics.

► There is significant difference in style of learning and thinking for information processing in right and left hemispherical preferences students belonging to high and low level of academic climate. Therefore the academic climate affects the style of learning and thinking as the right and left hemispherical function of the brain. Styles like abilities are not etched in stone at birth. They are in large part developed due to environmental condition and by way of nurturing children by their parents and teachers. In academic climate the physical material facilitates the students perceptual attitude towards the things, and incidents happening in daily life. This brings out flexibility in the direction of learning and thinking. Inter-personal trust, i.e. students attitude towards their teachers, principals, other teaching staff, teachers attitudes and views about the school, students, and teacher’s teaching learning strategies, school provision and academic provision also play an important role for nurturing and development of different styles among the students. That may be the reason that academic climate affect the style of learning and thinking style.

► Mathematical Creativity is significantly correlated with academic climate, style of learning and thinking, i.e. If the level of academic climate is good then level of Mathematical Creativity will also increase. The academic climate of students affects the mathematical Creativity. Then by providing appropriate and proper facilities sited for
fostering and development we can increase the level of mathematical Creativity of students. The mathematical Creativity of students is also found to be correlated with the style of learning and thinking. The study habit pupils perception of teachers impression about their performance in mathematics are correlated with pupils mathematical creativity. If teacher use flexible way and students responses in any direction are invited then styles of learning and thinking are developed in students. Academic Climate, Style of learning and thinking are the essential part of learning process. Hence the Mathematical Creativity of student is affected by academic climate, style of learning and thinking. Biswal^4 (1988) also reported significant relationship between study habit, pupils perception of teachers impression about their performance in mathematics and Mathematical Creativity.

► Boys and girls do not differ on their Mathematical Creativity. For two dimension mathematical creativity viz. fluency and originality boys and girls do not differ. Boys and girls differ on level of Flexibility in Mathematics. Girls were found to be more flexible in mathematics than boys. Gender does not put its effect on the mathematical creativity of boys and girls this may cause due to the awareness of parents and society. In the present scenario we observe that gender discriminations are minimized and girls are doing in all the fields and all the departments together with boys. Parents, Guardians and society are aware and providing all the facilities to boys and girls in the same manner that may be reason that gender does not affect the mathematical Creativity. For the two dimension of MCT boys and girls do not differ but it was found that girls are more flexible in mathematics than boys it may cause due to their perception about the mathematical theories, principles, facts and fictions, mathematical objects and situations. But for the Total Mathematical Creativity there is no significant difference found between boys and girls. Vora^5 (1984), Singh^6 (1986). And Singh A.7(2000) fond the same results.

► Urban and rural students do not differ on their Mathematical Creativity as well as its dimensions viz. fluency, flexibility and originality in mathematics. i.e. locality of student does not affect the Mathematical Creativity. The information science, technology and facilities are available in rural areas as well as in urban so the students of rural areas are getting the approximate same facilities being provided to urban students. Singh^8 (1981)
also reported no significant difference between rural and urban children in Mathematical Creativity score.

► There is no significant difference in the Mathematical Creativity and its dimensions viz. fluency, flexibility and originality of General, OBC and SC/ST students. i.e. caste category does not affect the Mathematical Creativity of students. Students belonging to OBC and SC/ST are getting the proper facilities of Mathematics education. Today the guardians of OBC and SC/ST are aware for education of their children as well as the Guardians of general category. On the other hand Government is also providing the Scholarship, merit and different encouragement policies for the better development of students. While Singh$^9$ (1990) reported that high caste children were found higher on mathematical creativity than OBC, SC and ST children.

► There is a significant difference in the preference for concepts of learning and thinking styles among right hemisphere and left hemisphere dominant boys and girls.

Results indicate that gender plays a role in hemisphere preference for information processing. In right hemisphere preference, boys dominated while in left hemisphere preference, girls dominated. This has been observed by Jangaiah$^{10}$ (1998) on a study on learning and cognitive styles for the same age-group. In total, right hemisphere dominated in hemisphericity preference among children Results indicate that there are gender differences with respect to the styles of learning and thinking; the right brain learning and thinking style and left brain learning and thinking style; the right and left hemisphere learning style and right and left hemisphere thinking style; and the preference for each concept under learning and thinking styles for right and left hemisphere. The boys who are more right hemisphere oriented preferred learning styles of concepts in the order of Content Preference followed by Interest, Learning Preference, Class Preference and Verbal. The boys who are left hemisphere oriented preferred learning styles of concepts in the order of Verbal, Class Preference, Learning Preference, Content Preference and Interest. Under thinking styles, those boys with right hemisphere preference showed preference for concepts in the order of Problem Solving, Creativity, Convergent/Divergent, Logical/ Fractional and Imagination respectively. The boys who
were left hemisphere oriented in their preference of concepts of thinking styles showed the order of preference as, Convergent/ Divergent, Imagination, Creativity, Logical, Fractional and Problem Solving respectively. The preference of conceptualization bears close resemblance to the description given by Springer and Deutsch\(^{11}\) (1989). Among the girls who preferred right hemisphere for information processing in learning style, they preferred the concept Content Preference followed by Learning Preference, Interest, Class Preference and Verbal. Among the girls, who preferred the right hemisphere for information processing, in learning style of concepts the order of preference is Verbal, Learning Preference, Class Preference, Interest and Content Preference respectively. Pask\(^{12}\) (1986) too found that females (similar age group) of the right hemisphere dominance showed greater preference for learning styles of concepts that are more verbal followed by other concepts. In the concepts of thinking style the girls who preferred left hemisphere for information processing showed the order as Convergent and Divergent Thinking, Imagination, Creativity, Problem Solving and Logical/ Fractional respectively. Those who showed right hemisphere preference in thinking style among girls showed preference for Creative Thinking followed by Problem Solving, Convergent/Divergent Thinking, Logical/ Fractional and Imagination. The right and left hemispheres have their own peculiarities and significance. But for an individual to function better, an integrated function of both the hemispheres is necessary (Kane & Kaane, 1999)\(^{13}\).

- There is no significant difference in the preference for concepts of learning and thinking styles among right hemisphere and left hemisphere dominant urban and rural students.

Locality variable though puts a positive impact on urban and rural students but it could not reach to the level of significance this may cause due to availability of all the resources in urban and rural both the areas. Ramesh Singh (2007)\(^{14}\) also find out the same results.

- There is a significant difference in the preference for concepts of learning and thinking styles among right hemisphere and left hemisphere dominant General, OBC and SC/ST students.
Caste category variable does not affect the learning and thinking styles among right hemisphere and left hemisphere General, OBC, and SC/ST students. In other words we can say that caste category does not affect the learning and thinking styles. The guardians of different categories are aware for the qualitative education of their children. And they are trying to provide the better facilities of education for their children that may be the reason that General, OBC and SC/ST students do not differ on their style of learning and thinking.

5.2 Conclusions at a glance
1. CBSE and UP Board students differ significantly on their mathematical creativity and its dimensions. CBSE students are higher in mathematical creativity as well as in its dimensions viz. fluency, flexibility and originality than UP Board students.
2. CBSE Board schools and UP Board schools differs significantly on their level of academic climate as well as in its dimensions. CBSE board schools are better in physical material, interpersonal trust, school provisions and academic provisions than UP board schools.
3. There is a significant difference in the preference for concepts of learning styles among right hemisphere and left hemisphere dominant CBSE and UP Board Students.
4. There is a significant difference in the preference for concepts of thinking styles among right hemisphere and left hemisphere dominant CBSE and UP Board students.
5. Students belonging to high academic climate group and low academic climate group differ on their level of Mathematical Creativity.
6. There is significant difference in style of learning for information processing in right hemispherical preferences students belonging to high and low level of academic climate.
7. There is significant difference in style of learning for information processing in left hemispherical preferences students belonging to high and low level of academic climate.
8. There is significant difference in style of thinking for information processing in right hemispherical preferences students belonging to high and low level of academic climate.

9. There is significant difference in style of thinking for information processing in left hemispherical preferences students belonging to high and low level of academic climate.

10. There is significant correlation between Mathematical creativity academic Climate, Style of learning and thinking.

11. Boys and girls do not differ on their Mathematical Creativity. For two dimension mathematical creativity viz. fluency and originality boys and girls do not differ. Boys and girls differ on level of Flexibility in Mathematics. Girls were found to be more flexible in mathematics than boys.

12. Urban and rural students do not differ on their Mathematical Creativity as well as its dimensions viz. fluency, flexibility and originality in mathematics.

13. There is no significant difference in the Mathematical Creativity and its dimensions viz. fluency, flexibility and originality of General, OBC and SC/ST students.

14. There is a significant difference in the preference for concepts of learning styles among right hemisphere and left hemisphere dominant boys and girls.

15. There is a significant difference in the preference for concepts of learning styles among right hemisphere and left hemisphere dominant urban and rural students.

16. There is a significant difference in the preference for concepts of learning styles among right hemisphere and left hemisphere dominant General, OBC and SC/ST students.
17. There is a significant difference in the preference for concepts of thinking styles among right hemisphere and left hemisphere dominant boys and girls.

18. There is a significant difference in the preference for concepts of thinking styles among right hemisphere and left hemisphere dominant urban and rural students.

19. There is a significant difference in the preference for concepts of thinking styles among right hemisphere and left hemisphere dominant General, OBC and SC/ST students.

5.3 Educational Implication of the study

Educational research must begin with a felt problem and must return to that problem with a proposed solution of fresh knowledge leading to the solution of that problem. Indian education system varies state wise, region wise and religion wise due to diversity in education system the educational outputs i.e. quality of Indian schools and demand of Indian talents in global perspective is criticized. Published news about the quality of Indian educated persons and ranking of Indian university in global perspective is not satisfactory. Due to different educational systems the standard of education is deteriorating day by day. The main problem of our nation is to provide talented persons in the entire field for the construction of progressive India. Any research effort goes waste if it does not contribute to the existing knowledge or help the discipline in which it has been made. The attempt has been made to drive implications based on findings of this particular studying for practicing school teachers. The topic of the study is of enormous importance in the field of education and are stated under following heads:

1. For teacher- Trainee and Teacher Educator

The findings of this study may be discussed with the trainee and efforts can be made to develop insight in them for nurturing and fostering the mathematical creative talents among students in the classrooms. By organizing workshops, orientation and refresher programmes the teachers can be dealt with the concepts, situations and skills of students handling to the unexpected and irrelevant responses in mathematics classroom.
Which type of academic climate is more suitable for nurturing and fostering creative talent in mathematics and to decide the appropriate teaching methodology, teaching models, strategies and techniques related discussions can be made to the teachers working in the field of mathematics.

2. For Training Institutions
The findings of the study may be more beneficial for training institutions, especially for mathematics and science teacher educators. In training mathematical laboratory, mathematical clubs and different teaching models of mathematics using skills may be developed in training institutions for the development of creative talent in mathematics.

3. For supervisor and administrator
The findings of the study may be discussed among supervisors and administrators that which type of academic climate and facilities are required for school and classrooms to nurture, foster and develop creative talent in mathematics among students.

4. For Policy planning
The findings of study will have implication for policy planning also by making several recommendations and programmes to reduce the gap between different Educational boards such as academic climate, syllabus, and facilities diversity can be minimized.

It is in the best interest of the field of mathematics education that we identify and nurture creative talent in the mathematics classroom. "Between the work of a student who tries to solve a difficult problem in mathematics and a work of invention (creation)...there is only a difference of degree" Polya\textsuperscript{15} (1954). Creativity as a feature of mathematical thinking is not a patent of the mathematician! Krutetskii\textsuperscript{16} (1976); and although most studies on creativity have focused on eminent individuals (Arnheim, 1962; Gardner, 1993, 1997; Gruber, 1981), I suggest that contemporary models from creativity research can be adapted for studying samples of creativity such as are produced by high school students. Such studies would reveal more about creativity in the classroom to the mathematics education research community. Educators could consider how often mathematical creativity is manifested in the school classroom and how teachers might
identify creative work. One plausible way to approach these concerns is to reconstruct and evaluate student work as a unique evolving system of creativity Gruber & Wallace, 17 (2000) or to incorporate some of the facets suggested by Gruber & Wallace (2000). This necessitates the need to find suitable problems at the appropriate levels to stimulate student creativity. A common trait among mathematicians is the reliance on particular cases, isomorphic reformulations, or analogous problems that simulate the original problem situations in their search for a solution (Polya, 1954; Skemp, 1986). Creating original mathematics requires a very high level of motivation, persistence, and reflection, all of which are considered indicators of creativity (Amabile, 1983; Policastro & Gardner, 2000; Gardner, 1993). The literature suggests that most creative individuals tend to be attracted to complexity, of which most school mathematics curricula has very little to offer. Classroom practices and math curricula rarely use problems with the sort of underlying mathematical structure that would necessitate students' having a prolonged period of engagement and the independence to formulate solutions. It is my conjecture that in order for mathematical creativity to manifest itself in the classroom, students should be given the opportunity to tackle non-routine problems with complexity and structure - problems which require not only motivation and persistence but also considerable reflection. This implies that educators should recognize the value of allowing students to reflect on previously solved problems to draw comparisons between various isomorphic problems. In addition, encouraging students to look for similarities in a class of problems fosters "mathematical" behavior (Polya, 1954), leading some students to discover sophisticated mathematical structures and principles in a manner to the creative processes of professional mathematicians.

Many weak points observed in pupils' problem solving skills and higher level thinking might be implications of excessive left hemisphere activity. The constant emphasis on rules and algorithms which are usually sequential may prevent the development of creativity, problem solving skills and spatial ability. Rich and varied learning programs which offer pupils possibilities for investigations, nonverbal expression, laboratory work and multi-sense learning, can give pupils possibilities to reach new levels in mathematics (Branthwaite 1986). Creative thinking might be defined
as a combination of logical thinking and divergent thinking which is based on intuition but has a conscious aim. When one is applying creative thinking in a practical problem solving situation, divergent thinking produces many ideas. Some of these seem to be useful for finding solutions. Of these, a summary will be made by a process of logical thinking. In a creative process, both hemispheres will be needed alternatively. The balance between logic and creativity is very important. If one places too much emphasis on logical deduction, creativity will be reduced. What one wins in logic will be lost in creativity and vice versa. In order to develop, creativity demands freedom from superfluous selection pressure and control. The meaning of knowledge for the problem solving process is well known and generally approved. But too little or too much knowledge may decrease the information processing.

Ability and effectiveness of the human brain, and therefore both might form an obstacle to creativity. An individual who has had a one-sided education with too much emphasis on knowledge might be unable to use his creativity, as the respective parts of his brain have not been trained enough while the preventive part has been over stimulated. Therefore, a school education which emphasizes knowledge and logic will neglect creativity education (Bergström 1985). In successful problem solving both hemispheres will be needed: First, the right hemisphere has a leading role as this is where holistic data processing takes place. The left hemisphere is better in logical tasks, therefore it dominates the work in the second stage of problem solving. When the solution has been reached, the solver will again consider the situation in a holistic manner (the right hemisphere) in order to check the reasonableness of the constructed solution. Our modern society especially stimulates and rewards actions of the left hemisphere. In school, the emphasis is placed on pupils’ verbal skills (both oral and written) and on their ability to follow different rules. The activation of the right hemisphere seems to be a necessary prerequisite for successful problem solving. On the other hand, solving problems fosters pupils’ creativity and thus activates their right hemisphere. The level of the problems used should correspond to the pupils’ skill, since they should experience success in order to be motivated to continue with problem solving. Actions which stimulate the right hemisphere are, e.g., tasks which demand inventing (Wheatley & al. 1978).
5.4 Suggestions for further researches

Due to the immense importance placed on mathematical creative talent among students and unending efforts to foster, nurture and develop creative talent, the present study has thrown some light and insight in teachers to develop creative talent in mathematics.

Summing up it is apparent that there are various studies on mathematical creativity and factors related to development of creative talent in the field of mathematics yet largely unspecified. The research reported here has raised for more queries than it has unanswered. The possibilities for further researches are indicated below:

1. The present study is confined to secondary level students studying in grade 10th only whereas earlier and later phase of school children could not be possibly studied, which can be considered as important areas of investigation.
2. In the present study only CBSE and UP board schools are selected whereas the same work can be done on different Educational boards CBSE, UP, ICSE and state board.
3. In the present study only schools of Kanpur city have been taken whereas the same work can be done on different districts, divisions, states and country level.
4. The present study is limited to a random sample of 300 students from CBSE and 300 students of UP Board in Kanpur city, where as more big sample and other sampling technique can be used for further studies.
5. The present study is limited to its research design. Several other designs with more sophisticated characteristics may be used in further studies.
6. Last but not least recommendation is that besides the selected tools used in the present study, one can select other suitable valid and reliable measures for further researches.

These are simply suggestions for further exploration and certainly final not the final project, because these can be outcomes of the investigations like the present one. Although there are immense possible ways to carry out research with theoretical and practical implications, it is beyond the scope of this work to suggest the design of such studies. But the investigator wishes to state the importance of this area which will contribute towards the field of education and psychological research.
References


