CHAPTER - III

Design of the Study

3.1 Method of the Study
3.2 Population
3.3 Sample of the study
3.4 Data gathering instruments
3.5 Variables involved
3.6 Test Administration and Collection of data
3.7 Statistical Techniques
3.8 Computations
CHAPTER III

Design of the Study

The purpose of this chapter is to provide an overview of the research design followed in the study. Since research is a logical, objective and formal application of scientific method of acquiring new knowledge, it should involve a systematic and well defined approach. Research design is the plan and procedure of study that has to followed by the researcher for collection and analysis of data so that objectives of the research may be achieved as accurately, efficiently and economically as possible. In other words provides the structure and strategies that control the entire investigation and extract dependable answers to the questions raised by the objectives and hypotheses of research.

As a matter of fact one design can not solve all problems. The nature of the research problem determines which design is most appropriate and how. The design may be tailored to meet the needs of the investigation. The purpose of this chapter is to present an overview of the research design followed in the present study. For the sake of convenience in presentation and understanding the description of research design of the present study is divided into following eight parts:

3.1 Method of the Study
3.2 Population
3.3 Sample of the study
3.4 Data gathering instruments
3.5 Variables involved
3.6 Test Administration and Collection of data
3.7 Statistical Techniques
3.8 Computations

Each of these eight parts are presented in the following pages of this chapter one by one.
3.1 Method of the Study

As already has been discussed in the preceding chapters, researches in the field of mathematical creativity have employed different methods of research. It will be difficult to say which one of them is most appropriate, as each of them has its own merits and shortcomings. Moreover, it cannot be said that the research method used in one research is superior or inferior to those used in other researches. The theory of the topic under study, the objectives and hypotheses of the study, the resource available to investigator, the competencies of investigator etc determine the choice of research method. These considerations have led the present investigator to use NORMATIVE SURVEY METHOD of research for this study. According to Rosenberg, the survey is now accepted as a fundamental instrument of educational, sociological and psychological research. Sax, Kerlinger, Helmstedter, Sukhia and several other authors have described survey method of research in quite detail. In the present investigation all the steps and characteristics that are essential for the normative survey method of research have been followed.

3.2 Population

First of all, the population or universe of the study was decided. By population we mean the group to which our inference will apply. “It should be emphasized that when data are derived from a group without careful sampling procedures, the researcher should carefully state that his findings are applicable to the group studied, and may not apply to or describe other individuals or groups”, Best (1963). So decision about the population is vital for a researcher. The time and resources being two major constraints; the investigator could not carry out the researcher on the total population. Hence a feasible sample was drawn from the population. All the regular students studying in class 10th of CBSE and UP Board schools situated in Kanpur District constituted the population for the study. The study comprised only those students who were studying Mathematics as compulsory subject in class 10th.

Students studying elementary mathematics in class 10th of UP board has not been included in the population personality characteristics, attitudinal approach and
perception are likely to differ widely from those of students may be different in
findings of study. The Design of the accessible population of the present Study is
presented in Table 3.1.

Table 3.1

Population’s descriptions

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Stratum</th>
<th>Total No. of Institutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>UP Board</td>
<td>689</td>
</tr>
<tr>
<td>2</td>
<td>CBSE Board</td>
<td>102</td>
</tr>
</tbody>
</table>

3.3 Sample

The primary purpose of the research is to discover principles that have
universal application, but to study a whole population in order to arrive at
generalization would be impracticable, if not impossible. The process of sampling
makes it possible to draw valid inferences or generalization on the basis of careful
observation within a relatively small proportion of the population selected for the
study. Miller pointed out that the essential requirement of any sample is that it is as
representative as possible of the population or universe from which it has been taken.
The ample was to be selected so as to match the study and help in meeting with the
purpose of the study. Ary said that when the population consists of a number of sub-
groups or strata that may be differ in characteristics being studied, it is often desirable
to use a form of sampling called stratified sampling.

The stratified sampling method is the ideal one when comparison between
different variables has to be made, for example, if comparison has to be made in UP
Board Students and CBSE Board students or rural and urban students, male and
female students, it would be very difficult to select the required numbers of units
through any other method of sampling. If any other method is used, the problem 0f
bias and prejudice creeps in. As the purpose of the a study is to compare the
Academic Climate, style of learning and thinking of CBSE and UP board students, therefore purposive stratified random sampling technique taking institution as the sampling unit has been used for selecting the sample for the present investigation. A statistical sample of 300 UP board and 300 CBSE board students was selected by using stratified random sampling techniques.

For this investigator prepared lists of Schools affiliated to CBSE and UP board. Each school in the population was given a code number. Ten sample schools were selected from each board. Viz. CBSE and UP board). One section from each school was selected randomly. In all of 678 students (348 from UP board and 322 students from CBSE) only 612 Scales were found to be complete and usable data were obtained from 600 students only. These 600 students constituted the major sample or the statistical sample for the present investigation. Details of statistical sample are given in the following table:

**TABLE 3.2**

*Design of Statistical Sample*

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Board</th>
<th>School’s Name</th>
<th>No. of Students</th>
<th>Usable Returns</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>UP Board</td>
<td>Mohan Vidya Mandir Govindnagar</td>
<td>34</td>
<td>31</td>
</tr>
<tr>
<td>2</td>
<td>UP Board</td>
<td>P.P.N. Inter college Parade</td>
<td>36</td>
<td>35</td>
</tr>
<tr>
<td>3</td>
<td>UP Board</td>
<td>Pt. Lalmani tripathi inter college rewna Kanpur</td>
<td>43</td>
<td>40</td>
</tr>
<tr>
<td>4</td>
<td>UP Board</td>
<td>APPD inter College Shambhua Kanpur</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>5</td>
<td>UP Board</td>
<td>VNSD Shiksha Niketan Chunniganz Kanpur</td>
<td>32</td>
<td>30</td>
</tr>
<tr>
<td>6</td>
<td>UP Board</td>
<td>Harjinder nagar Inter college kanpur</td>
<td>35</td>
<td>30</td>
</tr>
<tr>
<td>7</td>
<td>UP Board</td>
<td>Vivekanad Higher secondary School</td>
<td>28</td>
<td>25</td>
</tr>
</tbody>
</table>

79
<table>
<thead>
<tr>
<th>No.</th>
<th>Board</th>
<th>School Name</th>
<th>City</th>
<th>District</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>UP Board</td>
<td>Asteek muni Inter college koriyan Kanpur</td>
<td>Kanpur</td>
<td>37</td>
</tr>
<tr>
<td>9</td>
<td>UP Board</td>
<td>Aklavya Inter College Sajeti Kanpur</td>
<td>Kanpur</td>
<td>42</td>
</tr>
<tr>
<td>10</td>
<td>UP Board</td>
<td>Shri Gandhi Vidya Peeth Inter College Ghatampur Kanpur</td>
<td>Kanpur</td>
<td>31</td>
</tr>
<tr>
<td>11</td>
<td>CBSE Board</td>
<td>Oxford Model Senior secondary School Shyamnagar</td>
<td>Kanpur</td>
<td>40</td>
</tr>
<tr>
<td>12</td>
<td>CBSE Board</td>
<td>St. Xavier’s senior Secondary school</td>
<td>Kanpur</td>
<td>30</td>
</tr>
<tr>
<td>13</td>
<td>CBSE Board</td>
<td>Woodbine Gardenia School Rawatpur Kanpur</td>
<td>Kanpur</td>
<td>24</td>
</tr>
<tr>
<td>14</td>
<td>CBSE Board</td>
<td>Mercy memorial School Kidwai nagar Kanpur</td>
<td>Kanpur</td>
<td>35</td>
</tr>
<tr>
<td>15</td>
<td>CBSE Board</td>
<td>Kendriya Vidyalaya No-1 Chakeri Airforce station Kanpur</td>
<td>Kanpur</td>
<td>32</td>
</tr>
<tr>
<td>16</td>
<td>CBSE Board</td>
<td>Dayanand deenath Education centre Ramaipur Kanpur</td>
<td>Kanpur</td>
<td>27</td>
</tr>
<tr>
<td>17</td>
<td>CBSE Board</td>
<td>Ganges world school jajmau chauraha Kanpur</td>
<td>Kanpur</td>
<td>36</td>
</tr>
<tr>
<td>18</td>
<td>CBSE Board</td>
<td>Javahar Navodaya Vidyalaya Sarsoul Kanpur</td>
<td>Kanpur</td>
<td>32</td>
</tr>
<tr>
<td>19</td>
<td>CBSE Board</td>
<td>SJ Education Centre Hanspuram Naubasta</td>
<td>Kanpur</td>
<td>39</td>
</tr>
<tr>
<td>20</td>
<td>CBSE Board</td>
<td>PTDP Misra Memorial school saroj colony Kanpur</td>
<td>Kanpur</td>
<td>27</td>
</tr>
</tbody>
</table>
The total sample of 600 High School students consists of 300 UP board and 300 CBSE board students; 300 boys and 300 girls from both the board; 300 from rural and 300 from urban areas.

**TABLE: - 3.3**

Sample Structure

<table>
<thead>
<tr>
<th>Board</th>
<th>CBSE Board</th>
<th>UP Board</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>75</td>
<td>75</td>
<td>300</td>
</tr>
<tr>
<td>Urban</td>
<td>75</td>
<td>75</td>
<td>300</td>
</tr>
<tr>
<td>Total</td>
<td>150</td>
<td>150</td>
<td>600</td>
</tr>
</tbody>
</table>

**TABLE: - 3.4**

Category wise Sample Structure

<table>
<thead>
<tr>
<th>Board</th>
<th>CBSE Board</th>
<th>UP Board</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
<td>Boys</td>
<td>Girls</td>
<td>Boys</td>
</tr>
<tr>
<td>General</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>OBC</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>SC/T</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Total</td>
<td>150</td>
<td>150</td>
<td>150</td>
</tr>
</tbody>
</table>

3.4 Data Gathering Instrument (Tools)

A research tool plays a major role in any worth while research as it is the sole factors in determining the sound data and in arriving at perfect conclusion about the problem or study in hand, which ultimately, help in providing suitable remedial measures to the problem concerned. The selection of tools for a particular study depends on various considerations, such as objective of the research, availability of suitable tests, personal competence of the investigator, techniques of scoring and interpretation and so on. Keeping all these factors in considerations, a review of instruments needed for the study was done. Considering the flaws and merits of the
selection of the tools in either way, the researcher is interested in using the standardized tool. Hence the investigator selected following tools for the present study.

1. Mathematical Creativity Test prepared and standardized by Prof. Bhoodev Singh Head and Dean BHU Varanasi.
2. Academic Climate Description questionnaire prepared and standardized by M.L. Shah and Amita Shah.
3. Style of Learning and Thinking prepared and standardized by D. Venkatraman.

3.4.1 Details of Mathematical Creativity Test

(a) Selection Rationale

The investigator wanted to measure the creative ability in Mathematics i.e. Mathematical Creativity of students studying in schools affiliated to CBSE and UP boards in Kanpur district, so he selected the Mathematical Creativity test prepared and standardized by Prof. Bhoodev Singh, as the test best suited for Indian conditions for students of age group of 13-16 years. The test also measures the three components of mathematical Creativity viz. Fluency, Flexibility and Originality. Thus the test considers almost aspects of Mathematical Creativity. Furthermore, the test is self administrative and requires approximately 40 minutes completing.

(b) Description of Mathematical Creativity Test:

Verbal Mathematical Creativity was developed by Singh (1985) to identify mathematical talent at High School Stage (13 to 16 years of age). In the test the situations are real and allow the students to think and utilize their Mathematical talent to the maximum possible extent. The test is composed of four activities: Patterns in Mathematics, new relationship test activities, rule test activities and redefining of problems. It yields scores on the three creative ability measures of fluency, flexibility and originality.

The correlation of items with the total activity scores (Urban sample=85) for the test range from 0.5548 to 0.8548. In case of rural sample (N=75), the correlations of items with the total activity scores range from 0.5676 to 0.7981. the item sum
correlation for urban sample range from 0.2562 to 0.6890. and for rural sample the item sum correlations range from 0.2241 to 0.6597.

The correlations of total activity scores with grand total for the urban sample range from 0.6371 to 0.8429 and for the rural sample, correlations range from 0.4912 to 0.7824.

The correlation between factor scores, i.e. scores for fluency, flexibility, originality and grand total scores were also found to be high. In to urban sample the factor sum correlations range from 0.635 to 0.795 and for the rural sample, correlations range from 0.492 to 0.776.

Test-Retest Reliability was found to be 0.8408 (Urban Sample N=61). For the factor scores the test-retest reliability was found to be 0.6537. Test-Retest Reliability of the total Mathematical Creativity scores was found to be 0.8130.

(c) **Scoring:** Verbal Mathematical Creativity test was scored according to the manual prepared by the author. The raw scores obtained for fluency, flexibility and originality were converted into T-Scores with mean=50 and S.D.=10. T-Scores of all dimensions of the test were added to get composite scores of Mathematical Creativity.

**Table 3.5**

**Scoring process of originality of the MCT**

<table>
<thead>
<tr>
<th>Scores</th>
<th>Percentage of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Above 10%</td>
</tr>
<tr>
<td>1</td>
<td>5% to 9.9%</td>
</tr>
<tr>
<td>2</td>
<td>4% to 4.9%</td>
</tr>
<tr>
<td>3</td>
<td>3% to 3.9%</td>
</tr>
<tr>
<td>4</td>
<td>2% to 2.9%</td>
</tr>
<tr>
<td>5</td>
<td>Less than 1.9%</td>
</tr>
</tbody>
</table>
3.4.2 Academic Climate Description Questionnaire

(a) Selection Rationale

The investigator wished to assess the academic climate of the students studying in schools affiliated to CBSE and UP boards in Kanpur district. For measuring the academic climate of students studying in different schools affiliated to different educational boards the investigator used a standardized test prepared by M.L. Shah and Amita Shah department of Education Garhwal university Shrinagar Garhwal. The test is standardized test and it is easy, interesting and takes less time to complete it. The test measures the academic climate of students studying in different types of schools situated in different and following rules and regulations determined by different educational boards.

(b) Description of Academic Climate description questionnaire:

Academic climate Description questionnaire (ACDQ) was developed by M.L. Shah and Amita shah (1988) to identify the academic Climate of Students studying in Different types of Secondary and Senior Secondary Schools. Keeping these views in consideration the academic climate of a school has been conceptualized as a climate wherein the teaching learning is spontaneous and natural, wherein hurdles in the process are removed by willing mutual effort of teacher and students; wherein students feel encouraged to engage himself in learning activity and makes an effort of improving and fashioning his behavior accordingly. Thus the component of academic climate can be visualized as a concept incorporating (a) the motivation on the part of the student (b) Encouragement and inspiration on the part of the teacher (c) interpersonal trust between the authority and students (d) an atmosphere wherein hurdles, problems and obstacles become the part of motivating matrix. So the physical and material aspect that imbibes in students a sense of dedication to learning can also be said to be contributory aspect in academic climate.

ACDQ measures the academic climate in four dimensions viz. Physical Material (P.M.), Interpersonal Trust (I.P.T.), School Provisions (S1), Academic Provisions (S2). The ACDQ questionnaire contains 84 items the placement of items in the ACDQ is given in the table below:
TABLE -3.6
Placement of items in ACDQ

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Dimension</th>
<th>Item No.</th>
<th>Total No. of items</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Physical material (P.M.)</td>
<td>1.2,3,6,7,9,13,14,15,16,17,18,19,20,21,22</td>
<td>16</td>
</tr>
<tr>
<td>2</td>
<td>Inter-personal Trust (I.P.T.)</td>
<td>23-36.</td>
<td>14</td>
</tr>
<tr>
<td>3</td>
<td>School Provisions (S1)</td>
<td>4.5,8,10,11,12,37,40-44,47-49,55,60,63-69,71-73,75,76,80-82</td>
<td>32</td>
</tr>
<tr>
<td>4</td>
<td>Academic provisions (S2)</td>
<td>38,39,45,46,50-54,56-59,61,62,70,74-79,83,84</td>
<td>22</td>
</tr>
</tbody>
</table>

Reliability of the ACDQ: The reliability of ACDQ was estimated by split half method (Guilford, 1954) and the value was found to be 0.85. Secondly test-retest reliability was determined first after an interval of three months and other of six months and values were found to be 0.73 and 0.78. This indicates that the scale is highly reliable to measure the academic climate of an educational institution. The above reliability co-efficient are represented in the table below:

TABLE-3.7
Indices of Reliability of ACDQ

<table>
<thead>
<tr>
<th></th>
<th>Split half method</th>
<th>Test-Retest Method</th>
<th>Test-Retest Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>N=200</td>
<td></td>
<td>Time 3 months N=100</td>
<td>Time 6 months N=100</td>
</tr>
<tr>
<td>0.85</td>
<td>0.78</td>
<td>0.73</td>
<td></td>
</tr>
</tbody>
</table>

Validity of ACDQ: The items of ACDQ were selected with the help of careful content analysis of relevant literature the preliminary form was submitted to a group of 10 judges. Only highly diagnostic items were selected in the final form of the test.
Moreover item analysis was done for each item by bi-serial correlation method. So the face validity of the questionnaire is fairly very high.

The construct validity of the test was worked out by calculating the correlation of different dimensions of the academic climate scale with total scale score. The result of computation of the correlation co-efficient has been shown in the table below:

**TABLE-3.8**

**Correlation coefficients of total scores with scores of different dimensions of ACDQ**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Dimension</th>
<th>Correlation coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Physical material (P.M.)</td>
<td>0.85</td>
</tr>
<tr>
<td>2.</td>
<td>Inter-personal Trust (I.P.T.)</td>
<td>0.72</td>
</tr>
<tr>
<td>3.</td>
<td>School Provisions (S1)</td>
<td>0.67</td>
</tr>
<tr>
<td>4.</td>
<td>Academic provisions (S2)</td>
<td>0.78</td>
</tr>
</tbody>
</table>

**Administration of ACDQ:** The ACDQ can be conveniently administered in groups. It is desirable to establish rapport with teachers and students before administering the test. Before distributing the booklets among students they should be briefly introduced with the objective of the study and the imperative need of the objectivity in their responses to items. The students should be asked to read the instructions carefully and remove their doubts if any. After it students should be asked to write the answer in the appropriate columns. They should also be told that they have to mark the answer the each and every item of ACDQ. There is no time limit; however 40 minutes are sufficient for taking the test. Count the number of booklets before students leave the class.

**Scoring Procedure:** The scoring procedure of ACDQ is very simple. The responses are scored as follows:

(I) 2 for positive statement (response alternative (a))
(II) 1 for neutral statement (response alternative (b))
(III) 0 for negative statement (response alternative (c))
The students are required to tick only one response of the three given alternatives for each item. There are 84 items in ACDQ. Thus the maximum score is 168 and minimum score is zero.

3.4.3 Style of Learning and Thinking

The investigator wished to assess the learning and thinking styles of the students studying in schools affiliated to CBSE and UP boards in Kanpur district. For measuring the learning and thinking styles of students studying in different schools affiliated to different Educational boards the investigator used a standardized test prepared by Dr. D. Venkatraman. The test is standardized test and it is easy, interesting and takes less time to complete it. The test measures the five types of learning styles viz. Verbal, Content Preference, Class Preference, learning preference and Interest. The SOLAT test also measures five types of thinking styles viz. Logical/Fractional, Divergent/Convergent, Creative, Problem Solving and Imagination of students studying in different types of schools situated in different and following rules and regulations determined by different educational boards.

Description of the Style of Learning and Thinking (SOLAT) tool: Style of Learning and Thinking (SOLAT) was developed by Dr. D. Venkatraman (1994). The initial version of Style of Learning and Thinking (SOLAT) tool was intended for school children from 8th standard up to college students, and consisted of 100 items based on accumulated research findings concerning the specialized functions of left and right hemispheres. Each item provided the respondent with three choices- one representing the a specialized function of the left cerebral hemisphere, the second representing the parallel specialized function of the right hemisphere and the third is checking of both the items representing the integration of left and right hemispherical functions.

Dimensions of SOLAT Tool: The number of items that the each dimensions measures in two styles, of learning and thinking are the following:

1. LEARNING STYLES

1. Verbal 1 to 5 items
2. Content preference 6 to 10 items
3. Class preference 11 to 15 items
4. Learning Preference 16 to 20 items
5. Interest 21 to 25 items

II THINKING STYLE

1. Logical/Fractional 26 to 30 items
2. Divergent/convergent 31 to 35 items
3. Creativity 36 to 40 items
4. Problem solving 41 to 45 items
5. Imagination 46 to 50 items

Reliability Of SOLAT tool: The reliability of the test was measured by test-retest method. One month after the first test, retest was conducted to 300 students of 150 boys and 150 girls.

The reliability coefficient of correlation for the right hemisphere was found to be 0.89 for the left hemisphere function the coefficient of correlation was found to be .65 the correlation for integrated score was 0.71. These coefficient suggest that SOLAT Possesses reliability of significant level.

Validity of SOLAT tool: Content, construct and concurrent validity of SOLAT was determined each type of validity details is given below:-

Content Validity: A compilation of findings was made from an extensive survey of literature on specialized cerebral function of hemisphere (Venkatraman 1989). The items were constructed by attempting to translate research findings on hemisphericity into a multiple choice format without representing particularly right hemisphere functions or left hemisphere functioning.

The original inventories consisted of 62 items, and out of them 12 items were deleted on the basis of pilot study (small group study) and opinion from the experts. The items were finally selected for inclusion based on the sustained experts opinion, from professors and doctors connected in the field of psychology and neurosurgery respectively.

Construct Validity: The initial construct validity study was conducted by the author. The SOLAT was tested with 50 students from a variety of disciplines. As part of the
course, each student takes several tests of creativity which to construct validity evidence. Creative problem solving and creative thinking call for both left and right hemisphere functions. Considerable evidence suggests that the essence of creative behavior calls for right-hemisphere functions and judgment, evaluation and elaboration require left-hemisphere functions.

**Concurrent Validity:** The SOLAT tool was constructed and validated with the help of standardized SOLAT tool constructed by Paul Torrance. To find the validity of the tool, both the SOLAT tools prepared by Torrance and investigator were administered to 300 students. The correlation between the two tests was .842 for the right hemisphere part; 0.621 for the left hemisphere part and 0.678 for integrated part.

**Administration of the SOLAT:** The style of learning and thinking style is constructed with simple sentences and can be easily administered in group. It can be administered from 8th standard to Post Graduation level. Good testing arrangement should be maintained. They should be ordered to keep quiet, as distractions are possible. The temperature of room should be comfortable. Make sure that decision making procedure is clear. For each items there are two statements, and there are four ways to respond:

1. Check the first statement if it describes you.
2. Check the second statement if it describes you.
3. Check both statements if both are applicable to you.
4. Check neither statement if both are not applicable to you.

**Scoring Procedure:** In the tool, against serial number 1 to 50, checking of first item indicates right hemisphere; second items indicates left hemisphere and checking both the items indicates integrated hemisphere or whole brained.

3.5 **Variables involved:** The present descriptive survey research study involved three kinds of variables, namely:

   (a) **Dependent Variable.**
   (b) **Independent Variable.**
   (c) **Controlled Variable.**

All of these three types of variables are involved in the study are discussed one by one in the forgoing lines of this section.
(a) **Dependent Variable:** According to *Tuckman* the dependent variable is that factor which is observed and measure to determine the effect of independent variable. In the present study the dependent variable is Mathematical creativity of Students studying in Different educational boards that is measured through Standardized Mathematical Creativity Test developed by Dr. Bhoodev Singh.

(b) **Independent Variables:** According to *Tuckman* the independent variable is that factor which is measured, manipulated or selected by the investigator to determine its relationship to an observed phenomenon. In the present research study the independent variable consists of academic climate, Style of learning, style of thinking.

(c) **Controlled Variable:**

According to *Tuckman*, all of the variables in a situation or in a person can not be studied at same time, some must be neutralized to guarantee that they will not have a different or moderating effect on the dependent variable. A number of factors may affect the relationship between dependent variables and independent variables in a complex manner. Therefore in present investigation age of students and their grades have been identified as controlled variable. The age has been controlled by selecting the students 14-15 years only and only 10th grade students in the preceding study.

### 3.6 Collection and Organization of Data:

The investigator has attempted to use the best available methodology in the survey method of data collection. The collection of data for present study was done in Dec 2008 to Feb 2009. Taking the prior permission from principal of schools investigator arrived according to the time schedule of appointments. With the permission of principals of schools investigator administered three psychological tests as under:

1. First of all investigators introduced him and told the objective of his work to establish the rapport among students so that students can give their natural response. Then Mathematical Creativity Test (MCT) was distributed to each student. Instruction regarding how to respond to right responses was given.
Students were asked to complete entries on the top of the MCT. The respondents were asked to read the instructions in the cover page carefully. Then students were asked to complete the task no 1, 2, 3, and 4 respectively in the allotted time duration. For each problem of task examples were also given and investigator himself explained about the example before starting the task.

2. Secondly Academic Climate Description questionnaire (ACDQ) was distributed to each student after 15 minutes completion of MCT. The students were asked to fill up all the entries given in the covering page of ACDQ. The students were briefly introduced with the objective of study and conveniently rapport was established among the investigator and students. The students were asked to read the instructions carefully and remove their doubts if any after instructions students were asked to give their responses in appropriate column. They were told that they have to mark the answer of each and every item of ACDQ. There is no time-limit; however 40 minutes are sufficient for giving the responses of ACDQ. The numbers of booklets were counted before students leave the class.

3. After 10 minutes gap third data gathering instrument Style of Learning and Thinking SOLAT test was given to each and every students who have already given their responses in MCT and ACDQ.

3.7 Statistical Techniques used:

1. Mean: The most popular and widely used measure for representing the entire data by one value is called average and what the statisticians call the arithmetic mean. Garret12 The formula used for computing mean is –

$$M = A.M. + \sum \frac{f_d}{n} i$$

Where as:

- $M$ is mean
- $A.M.$ is assumed mean
- $f$ is frequency in particular class interval
- $d$ is deviation from assumed mean
- $n$ is sum of frequencies
- $i$ is size of class interval
2. **Standard Deviation**: The standard is most commonly used indicator of the degree of variability. The standard deviation is a kind of average of all deviations from the mean. It may be defined as the square root of the mean of the squared deviation taken from the arithmetical mean of the distribution. Garrrett\textsuperscript{13} The formula used for computing standard deviation is

$$S.D. = \sqrt{\frac{i}{N} \sum f d^2 - (\sum fd)^2}$$

Where in
- S.D. is standard deviation
- i is size of class interval
- f is frequency in particular class interval
- d is deviation from assumed mean
- N is sum of frequencies

3. **Test of Comparison**: The present study is also concerned with the comparison of two and three groups of students. In other words group of students are compared on various variables involved in the study. The 't' test and analysis of variance is an effective way to determine whether the means of two or more than two variables are too different to attribute to sampling error.

4. **'t' Test**: 't' test is a statistical test that allows the investigator to compare two means to determine the probability that the difference between two means is a real difference rather than a chance difference. It involves the computation of the ratio between observed variance (observed difference between two means) and error variance (the sampling error factor). Guptel\textsuperscript{14} The value of 't' is computed by the formula

$$t = \frac{M_1 - M_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

Where in
- $M_1$ is mean of first group
- $M_2$ is mean of second group
$S_1$ is standard deviation of first group
$S_2$ is standard deviation of second group
$n_1$ number of cases in first group
$n_2$ number of cases in second group

The significance of 't' ratio is found in the table of 't' values, which indicates the critical values of 't' ratio necessary to reject the null hypothesis at selected level of significance.

**Degree of freedom:** the degree of freedom 't' test is

$$df = n_1 + n_2 - 2$$

**Decision Rule:**
1. If calculated 't' value is less than table 't' value, we accept null hypothesis i.e. there is no significant difference between two series.
2. If calculated 't' value is greater than table 't' value, we reject null hypothesis i.e. there is significant difference between two series.

1. **F-test:** When researcher needs to compare the characteristics of more than two groups the F-ratio or F-Test or ANOVA analysis of variance is used to find out the conclusions from the given raw data. Analysis of variance the F-Ratio is computed that determines whether the group mean differs from one another to a greater extent than the scores differ from their own means. If we compare more than two groups then 't' test takes more time and too complex, that is why when we have to compare more than two groups then F-test is used. For calculation of F-test we compute the following:

$$SS_{t} = \sum x^2$$
$$SS_{p} = \sum \frac{x_i^2}{n_i} - \left( \frac{\sum x}{n} \right)^2$$
$$SS_{e} = \left( \sum x \right)^2 - \sum \frac{x_i^2}{n_i}$$
Degrees of Freedom: In ANOVA three sum of squares are calculated so degrees of freedom are calculated concerned to each sum of squares. SS\text{t} is calculated with number of total subjects called as N so
\[ df_t = N-1 \]
Mean sum of squares are calculated with the help of number of means called as k so degree of freedom for \( SS_b = K - 1 \)
Sum of squares within the group are calculated with the help of N and K so degree of freedom for \( SS_w = N - K \)
After calculating SS and df two ratios are calculated for the sample these ratios are called as Mean sum of squares or MS. Mean sum of squares are calculated for between and within the groups for the given sample.
\[ MS_b = \frac{SS_b}{df_b} \]
\[ MS_w = \frac{SS_w}{df_w} \]
When we calculate mean sum of squares for between and within the group we reach to calculate the F- ratio. According to Meddis, the value of F-Ratio may be computed by the following formula
\[ F - \text{Ratio} = \frac{MS_b}{MS_w} \]
Decision Rule:
1. If calculated F value is less than table value, we accept null hypothesis i.e. there is no significant difference between the calculated numbers of groups.
2. If calculated F value is greater than table value, we reject null hypothesis i.e. there is significant difference between the calculated number of groups.

Normal Probability Curve: In normal probability curve, the mean, meadian and mode i.e. measures of central tendency fall exactly on the midpoint of distribution and are numerically equal. The basic assumption of normal distribution is that the variables of behavioural science, bioscience of a large sample or representative are commonly in normal distribution with these assumption the whole sample is divided in to subgroups by using the formula:
\[ X = M \pm \sigma.Z \]
Where in
\[ X \] is raw score
M is mean

Z is standard score

σ is standard deviation

6. Chi-square test: the chi square test represents the useful method of comparing experimentally obtained results with those to be expected theoretically on some hypothesis. The formula for computation chi-square (χ²) is stated as follows:

\[ \chi^2 = \sum \frac{(f_o - f_e)^2}{f_e} \]

in which

\( \chi^2 \) is chi-square

\( f_o \) is frequency of occurrence of observed experimentally determined facts.

\( f_e \) is expected or theoretical frequency

7. Coefficient of Correlation: Correlation is the relationship between two or more paired variables, between two or more sets of data. The degree of relationship may be measured and represented by coefficient of correlation. According to Guilford16 a coefficient of correlation is a single number that tells us to what extent two things are related, to what extent variations in one go with the variation in the other. In the present study, the coefficient of correlation is used for describing the relationship between dependent and independent variables. According to Garret17 it may be used when:

(a) Distribution of two variables has a linear relationship.

(b) The distributions in two variables are normal or at least not badly skewed.

The above mentioned restrictions have strictly followed in the present investigation. Scatter-diagram has been prepared for judging the linearity of bi-variate distributions. As in the present investigation N is large, the assumption of equal scatter in columns (or rows) i.e. homoscedasticity may be reasonable accepted just by observing scatter grams. Thus after being satisfied with all the conditions mentioned above the
researcher has used the technique of coefficient of correlation for different combinations of variables with full confidence.

8. **Standard Scores:** In the present study T-scores are used as the standard scores. To make the Mathematical Creativity scores comparable and normalized raw scores for fluency, flexibility and originality were changed into the T scores then Composite scores of MCT were calculated.

9. **Level of Significance:** The confidence level with which an investigator rejects or accepts a null hypothesis depends upon the level of significance used in present study are 0.01

**3.8 Computations:**

The Mean, S.D., $\chi^2$ value of large sample can be easily calculated by the assistance of computer. The computer has made these techniques accessible and practical. Calculations have been made with the help of computer. After making all necessary computations, the results were summarized and interpreted.
References

10. B.W. Tuckman; Ibid.
11. B.W. Tuckman; Ibid.