CHAPTER-VII

SUMMARY

7.1.0 INTRODUCTION

The study has been discussed in detail in the previous chapters. The present chapter is the description of the study in summates under the headings like Rationale of the study, statement of the problem, operational definitions, objectives, hypothesis, sample design, tools, and procedure of data collection, statistical techniques, findings, implications and suggestions for further research. The details are given one by one under their respective headings.

7.2.0 RATIONALE OF THE STUDY

Concept mapping has been widely recommended in teaching of different subjects in different countries like Germany, India, Japan, Kenya, Korea, Malaysia, Nigeria, Turkish, United Arab Emirates and UK. As compared to these countries very less work have been done in India. There are number of studies, which support the idea that use of concept mapping can extend and enrich students’ learning in different subject like in Basic Science, Geography, Special Education, Biology, Chemistry, Physics, English, in Higher Education and only some studies are seen in mathematics. Most of the work is done in science subjects and very less work is done in Mathematics. These studies in different subjects highlights the effect of concept mapping on achievement, cognitive skills, attitude of students, and its effectiveness across gender, (Caldwell and Rubaee, 2006 and Kaur, 2012). Illa (2006) studied the effect of concept mapping on students’ creativity. No study has been found in which effect of concept mapping in mathematics is seen on mathematical creativity of students. Commonly students have anxiety in different subjects. To overcome the anxiety different instructional strategies were used and only the effect of concept mapping on students’ anxiety and achievement in biology (Olugbemiro et al, 1990) is seen, but no study has been accounted showing the effect of concept mapping in relation to math anxiety.

With this, it can be concluded that teaching through concept mapping is a new teaching strategy in mathematics and is to be adopted by mathematics teachers
Summary

in India especially in government institutions. Very small amount of work had been carried out in India covering population of Chandigarh in study habits and styles of learning and thinking, environmental awareness and science (Kumar, 2009; Sharma, 2010; and Rani, 2011), covering population of Amritsar (Punjab) [Kaur (2012)], and covering population of Ludhiana (Punjab) (Chawala and Singh, 2015). However, there is no study in which effect of concept mapping in mathematics on achievement and mathematical creativity in relation to anxiety in mathematics has been seen. Therefore, the conduct of the present study to know the effect of concept mapping in mathematics is justified. It will reveal the effect of concept mapping in mathematics on achievement and creativity of the students. Thus by filling the gaps in research evidences of concept mapping in mathematics

7.3.0. STATEMENT OF THE PROBLEM

The problem under investigation was entitled as:

EFFECT OF CONCEPT MAPPING STRATEGY IN MATHEMATICS ON ACHIEVEMENT AND MATHEMATICAL CREATIVITY IN RELATION TO ANXIETY IN MATHEMATICS

7.4.0 OPERATIONAL DEFINITIONS

1) Concept mapping

Concept mapping refers to representing the concepts of mathematics topics enclosed in circles and boxes and the relationship indicated by connecting lines linking two concepts and phrases in the lines specify the relationship between the concepts.

2) Achievement

Achievement refers to success or proficiency attained in mathematics subject which will be assessed with achievement test in mathematics.

3) Mathematical creativity

Mathematical creativity refers to items pertain to overcome fixation, problem posing and problem solving/ testing solutions, as divergent production of semantics units, symbolic units, semantics classes, symbolic classes, symbolic relations, figural systems, symbolic systems, figural transformations, figural implications and symbolic implications.
4) **Mathematics anxiety**

Mathematics anxiety refers to learned phenomena on account that an individual has negative cognito-affective reactions (worry-fear/tension/physiological reactions etc.) towards mathematics.

7.5.0 **OBJECTIVES**

1. To study the effect of instructional strategy on mathematics achievement of IX grade students.
2. To study the effect of gender on mathematics achievement of IX grade students.
3. To study the interaction effect of instructional strategy (concept mapping / conventional method) and gender on mathematics achievement of IX grade students.
4. To study the effect of mathematics anxiety on mathematics achievement of IX grade students.
5. To study the interaction effect of instructional strategy (concept mapping/conventional method) and mathematics anxiety on mathematics achievement of IX grade students.
6. To study the effect of instructional strategy on mathematical creativity of IX grade students.
7. To study the effect of gender on mathematical creativity of IX grade students.
8. To study the interaction effect of instructional strategy (concept mapping / conventional method) and gender on mathematical creativity of IX grade students.
9. To study the effect of mathematics anxiety on mathematical creativity of IX grade students.
10. To study the interaction effect of instructional strategy (concept mapping/conventional method) and mathematics anxiety on mathematical creativity of IX grade students.
7.6.0 HYPOTHESIS

H 1(a). There is no significant difference in the adjusted means scores of Mathematics Achievement of Experimental and Control Groups by considering Pre- Mathematics Achievement as covariate

H 1(b). There is no significant difference in the adjusted means scores of Mathematics Achievement of male and female students by considering Pre- Mathematics Achievement as covariate

H 1(c). There is no significant effect of Interaction between Treatment and Gender on Mathematics achievement of students by considering Pre-Mathematics Achievement as covariate

H 1(d). There is no significant effect of Mathematics Anxiety on Mathematics Achievement of students by considering Pre-Mathematics Achievement as covariate

H 1(e). There is no significant effect of Interaction between Treatment and Anxiety on Mathematics achievement of students by considering Pre-Mathematics Achievement as covariate

H 2(a). There is no significant difference in the adjusted means scores of Mathematical Creativity of Experimental and Control Groups by considering Pre- Mathematical Creativity as covariate

H 2(b). There is no significant difference in the adjusted means scores of Mathematical Creativity of male and female students by considering Pre- Mathematical Creativity as covariate

H 2(c). There is no significant effect of Interaction between Treatment and Gender on Mathematical Creativity of students by considering Pre-Mathematical Creativity as covariate

H 2(d). There is no significant effect of Mathematics Anxiety on Mathematical Creativity of students by considering Pre-Mathematical creativity as covariate

H 2(e). There is no significant effect of Interaction between Treatment and Anxiety on Mathematical Creativity of students by considering Pre-Mathematical Creativity as covariate
7.7.0 SAMPLE

The samples used at two stages were different but from the same population. Population for the study was students of grade IX studying in government school of Punjab state.

7.7.1 Sample for standardization of the achievement test.

There are three circles of Punjab. Out of these three circles, Faridkot circle was selected as random. Then in Faridkot circle, Moga district was selected randomly from the six districts. There were many secondary as well as senior secondary schools in Moga district. At this stage, the sample for standardization of the achievement test was taken from the students studying in class 9th of Moga district. Of the available schools two schools Govt Sen. Sec. School, Bilaspur and Govt High School, Manava, affiliated to Punjab School Education Board, Mohali, were selected randomly.

7.7.2 Sample for Experimentation

There are three circles of Punjab. Out of these three circles, Faridkot circle was selected randomly. Then in Faridkot circle, Moga district was selected randomly from the six districts. There are four blocks of Moga district, Moga block-I, Moga block-II, Nihal Singh wala block and Dharmkot block. Due to experimental study, the study was confined to single school chosen purposively. Govt. Sen. Sec. School, Khosa Pando of Moga block-II was selected purposively for experimentation. The school is affiliated to PSEB Mohali. The Sample comprised 60 students of class 9th. The medium of instruction was Punjabi. There were two sections of 9th class. The intact original groups of the schools were assigned as control group and experimental group. That is the section A of the school was assigned as experimental group and section B was assigned as control group. Section A and B contains both boys and girls. Thus on the whole there were 31 students in section A and 29 students in section B. Thus the total sample was comprised of 60 students. The sample split for experimentation is given in figure 7.7.1.
7.8.0 DESIGN

The present study was predominantly experimental in nature. The study was designed on the lines of non equivalent control group quasi-experimental design. The data was analyzed by 2x2 factorial designs ANCOVA. The pre-test scores were controlled to check the initial differences in experimental and control group taken as intact sections. The layout of four sets of ANCOVA is as given in fig 7.8.1:
After the completion of experimental study, the extreme cases in both the experimental and control groups were identified. Qualitative case studies of these cases were conducted to validate the results from the quantitative analysis. The mixing of the results from quantitative and qualitative analysis led to study the effect of experimentation on data of high average and low achievers separately.

Thus the study follows mixed methods design. The design is executed with Sequential explanatory strategy. The layout of the design is as shown in figure 4.3.2

![Figure 4.3.2 Layout of Sequential explanatory strategy.](image)

**Procedure:**

The study was conducted into two parts i.e. quantitative part and qualitative part. Details of these parts are given below

**7.9.1 Quantitative part**

In quantitative part the study was conducted in three phases:

a) **Phase-I**

In the phase I, Faridkot circle was selected randomly out of three circles (Nabha, Patiala, Faridkot) in Punjab. Then in Faridkot circle, Moga district was selected randomly from six districts. Then from the different secondary and senior secondary schools of the Moga, Government senior secondary school, Khosa Pando of Moga block-II was selected purposively due to the support and permission for experimentation and data collection by the school authorities for experimentation. Permission was taken from the principal of Government senior secondary school, Khosa Pando. Permission was granted by the principal of the school to conduct the study in morning school timings. Class 9th was selected for treatment as the study was delimited to 9th class students.
In the phase-I original groups of 9th were assigned as control group and experimental group, i.e. section A was assigned as experimental group and Section B was assigned as control group in experimentation. This was done so to control the intervening effect which the students may discuss about the treatment given to them with each other in the rest of school hours. Both the original groups i.e. experimental group and control group were motivated to be regular during those days as they were told that they were going to taught mathematics in different and interesting ways. Most of the students of the school got motivated and ensured their regularity in the class.

On the day one of the data collection pre-achievement test was administered, on day two of data collection pre-mathematical creativity test was administered and on the day three of data collection pre-mathematical creativity test was administered to both the groups, i.e to experimental group and control group.

b) Phase-II

In the phase-II, from two groups, i.e. from experimental group and control group, experimental group was subjected to 40 hours treatment. The experimental group was exposed to treatment through concept mapping in which they were taught ten concepts, whereas control group was exposed to treatment by teaching through conventional method and the same topics were taken as for experimental group. The contents were selected from prescribed P.S.E.B mathematics text book as listed in table 7.8.1

Table 7.9.1:- Topics used for experimentation.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>तेघाण्ड (Lines)</td>
</tr>
<tr>
<td>2</td>
<td>बेट (Angles)</td>
</tr>
<tr>
<td>3</td>
<td>अलग-अलग वह अलग-अलग तेघाण्ड (Parallel and non parallel lines)</td>
</tr>
<tr>
<td>4</td>
<td>त्रिभुज सेह त्रिभुज (Triangles)</td>
</tr>
<tr>
<td>5</td>
<td>त्रिभुज के मेंढ़ह दिख पत्त त्रिभुज (Properties of triangles)</td>
</tr>
<tr>
<td>6</td>
<td>त्रिभुज के महबूबामला (Congruency of triangles)</td>
</tr>
<tr>
<td>7</td>
<td>चूंच चो -1 (Circles Part -1)</td>
</tr>
<tr>
<td>8</td>
<td>चूंच चो -2 (Circles Part -2)</td>
</tr>
<tr>
<td>9</td>
<td>चूंच चो -3 (Circles Part -3)</td>
</tr>
<tr>
<td>10</td>
<td>चूंच चो -4 (Circles Part -4)</td>
</tr>
</tbody>
</table>
The experimental group was exposed to treatment through concept mapping in which they were taught ten concepts. Each of the ten concepts/topics was given treatment for four hours resulting in 40 hours treatment. In each of the four hours treatment the experimental group students were exposed to concept for one and half hour followed by one and half hour monitored drill work for assimilation of concepts and then one and half hour for compilation and synthesis of the concepts. Whereas control group was exposed to treatment by teaching the topics through conventional method, during the same dates by the same teacher. Thus completing the whole phase-II in one and half month.

Phase III: - After the completion of phase II, post tests of achievement and mathematical creativity were administered to both groups (experimental group and control group).

Controls:-For best possible experimental results the controls in the form of same teacher, same duration of teaching and intact sections from the same school for both groups were assured. Teaching done by the same teacher controls the intervention effects of teaching styles, knowledge base, motivation power and effectiveness of the drill work. The same duration of teaching control the intervening effect of perception and assimilation ability. The original formation of the regular class sections controlled the learning of concept mapping through peer learning amongst the subjects of experimental and control group. Whereas both groups from the same school assured the control on socio-cultural and economic factors. The phases of procedure are given in table 7.9.2

Table 7.9.2 Phases of procedure for experimental group and control group.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Experimental Group</th>
<th>Control Group</th>
</tr>
</thead>
</table>
| Phase-I (pre-test) | Achievement Test  
Mathematics Anxiety Test  
Mathematical Creativity Test | Achievement Test  
Mathematics Anxiety Test  
Mathematical Creativity Test |
| Phase–II (Treatment ) | Exposure through concept mapping. | Exposure through conventional method. |
| Phase-III Post-test | Achievement Test  
Mathematical Creativity Test | Achievement Test  
Mathematical Creativity Test |
Summary

7.9.2 Qualitative part

In qualitative part four case studies were done. The base of the case studies were the scores of the eight class final exam i.e. case studies of highest scorer in 8th class among the experimental group and the highest scorer in 8th class among control group, lowest scorer in 8th class among experimental group and lowest scorer in 8th class among control group. Among these cases the comparison of pre-test scores and post test-scores in mathematical achievement, comparison of pre-test scores and post-test scores of mathematical creativity test were done. In addition to this the general facts, family factor, physical health, personal history, opinion of parents, opinion of teachers, opinion of peer group, academic record, co-curricular activity record, class test performance of the cases under study before and after the experimentation, introspection report by the cases, study habits and general behaviour were considered.

7.10.0 TOOLS

In the present study, following tools were used to collect the data:

1. Modules based on concept mapping (developed by investigator) were administered on experimental group.

2. Achievement test in mathematics (developed by investigator) was administered to study the achievement of students in mathematics.

3. Mathematics anxiety scale (Sharma, Yogesh and Sansanwal; 2011) was administered to study the anxiety of the students in mathematics.

4. Mathematical creativity test (Sharma, Yogesh and Sansanwal; 2012) was administered to study the creativity of students in mathematics.

7.10.1.0 Modules based on concept mapping

Modules based on concept mapping were prepared by the investigator for teaching mathematics to 9th class students of experimental group. For the selection of topics, discussions were done with school teachers. Monthly distribution of mathematics syllabus given by P.S.E.B was also considered while selecting the topics. The list of topics selected is given in the table 7.10.1
Table 7.1.1: List of three modules (topics) based on concept mapping.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Modules (topics) based on concept mapping</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>त्रिभुज (Lines)</td>
</tr>
<tr>
<td>2</td>
<td>त्रिभुज से निकटतम संदर्भ (Triangles)</td>
</tr>
<tr>
<td>3</td>
<td>वृत्त (Circle)</td>
</tr>
</tbody>
</table>

7.10.1.1 Development of modules

First draft

After the discussion done with school teachers and keeping the monthly distribution of syllabus given by P.S.E.B, the initial draft of modules was prepared. In this draft first of all three modules of chapters: - 1) Straight line covering the concept of lines, angles, parallel lines and non-parallel lines; 2) Triangles covering the concept of triangles, properties of triangles and congruency of triangles and 3) Circles covering all concept included in the syllabus from 9th class text were prepared.

Second draft

In the second draft of the three modules namely Straight lines, Triangles and circles were divided into its further sub topics as given in the table 7.10.2. These 10 modules were made in such a way that each and every part of the topic is covered.

Table 7.10.2 List of ten modules (topics) based on concept mapping

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Modules (topics) based on concept mapping</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>त्रिभुज (Lines)</td>
</tr>
<tr>
<td>2</td>
<td>त्रिभुज (Angles)</td>
</tr>
<tr>
<td>3</td>
<td>लांब तथा अक्षरीय त्रिभुज (Parallel and non parallel lines)</td>
</tr>
<tr>
<td>4</td>
<td>त्रिभुज से निकटतम संदर्भ (Triangles)</td>
</tr>
<tr>
<td>5</td>
<td>त्रिभुज से अक्षरीय त्रिभुज (Properties of triangles)</td>
</tr>
<tr>
<td>6</td>
<td>त्रिभुज से अक्षरीय त्रिभुज (Congruency of triangles)</td>
</tr>
<tr>
<td>7</td>
<td>वृत्त क्षेत्र -1 (Circles Part -1)</td>
</tr>
<tr>
<td>8</td>
<td>वृत्त क्षेत्र -2 (Circles Part -2)</td>
</tr>
<tr>
<td>9</td>
<td>वृत्त क्षेत्र -3 (Circles Part -3)</td>
</tr>
<tr>
<td>10</td>
<td>वृत्त क्षेत्र -4 (Circles Part -4)</td>
</tr>
</tbody>
</table>
7.10.1.2 Validation of modules

1. Check list (adapted from Mercedes, 2009) was used to validate the developed modules of mathematics. The check list contained items on objectives of modules and regarding the content of modules. Sample of the format of check list to validate modules has been appended in the appendix….

2. Copies of the developed modules were sent to experts (10 school teachers and 5 Teacher educators) for their evaluation on the check list and suggestions were gathered for the improvement of modules.

3. They were also requested to give their suggestions in writing to improve the modules.

4. Suitable modifications on the modules were made and the final draft was prepared.

The accomplished checklist from the school teachers and teacher educators were carefully examined. The researcher was guided by the following values of composite mean and their meaning as to elucidation of the results from the data gathered:

- 3.50 - 4.00 - To a very great extent
- 2.5 – 3.49 - To a great extent
- 1.50 – 2.49 - To a moderate extent
- 0 – 1.49 - To a least extent

7.10.1.3 Assessment of objectives

Prepared modules were evaluated by TE and ST. Adopted checklist was used for the purpose of evaluation. The main characteristic of evaluation was the assessment of the objectives. This includes whether each module was accompanied by objective, wording of objectives are clear and easily understandable, how realistic and measureable they are, whether they are attainable or not.

From the data obtained the average scores of teacher educators interpreted the assessment of modules as to *a very great extent* and average scores of school teachers interpreted the assessment of modules as to *a very great extent*. The composite mean of the assessment of objectives assessed by teacher educators and school teachers interpreted the assessment of modules as to *a very great extent*. 

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7.10.1.4 Assessment of content

Again the prepared modules were evaluated by TE and ST. Adopted checklist was used for the purpose of evaluation. The main characteristic of evaluation was the assessment of the content. This includes that the assessment of consistency between objectives and the content of the modules, assessment of accuracy of the information provided in the module, assessment of the contents that they leads to the attainment of the objectives of the course, assessment of the maps which enhance the understanding of concepts, assessment of adequate presentation of the concepts and the accuracy of the links and arrows given in the maps.

From the data obtained the average scores of teacher educators interpreted the assessment of the content of modules as to a great extent and average scores of school teachers interpreted the assessment of the content of modules as to a very great extent. The composite mean of the assessment of content assessed by teacher educators and school teachers interpreted the assessment of the content of modules as to a very great extent.

7.10.2.0 Achievement Test in Mathematics

Achievement test in mathematics was prepared by investigator and has total of 54 items in the final draft after considering the Discriminating powers (DP) and Difficult value (DV) of the items in the mathematics Achievement Test. The items of achievement test in mathematics are written only in Punjabi language.

The items of achievement test in mathematics pertain to knowledge, understanding and applications.

7.10.2.1 Time limit

The time required for completing all the 54 items was to be completed in one hour.

7.10.2.2 Scoring

Like other multiple choice questions test, achievement test in mathematics also have one mark for correct answer and the total marks for test is 54. The answer key of the achievement test in mathematics is given in the ANEXURE.
7.10.2.3. Spilt half Reliability

In the split half method the self correlation of the half test as found by Pearson’s Product moment coefficient of correlation was 0.81

7.10.2.4. Validity

Face validity and content validity of the achievement test in mathematics was done. The final test items were given to 5 experts with a request to state their opinions and judgements regarding the suitability of the test items. Experts showed no doubt over any test items. Therefore the face validity was ensured. Content validity was established by approaching 10 experts in the field of mathematics. All the topics and contents of the modules were provided to the experts. All the experts have reported that none of the item of the test was deviating from the given topics and the content. Therefore the content validity was ensured.

7.10.3.0 Mathematics Anxiety Scale

Mathematics Anxiety refers to negative emotion that people get from environment. on the basis of review of studies, Mathematics Anxiety has been operationally defined as a learned phenomenon on account of which an individual has negative Cognito-Affective Reactions(worry-fear/tension/physiological reactions etc.) towards mathematics, mathematics Anxiety has two dimensions- Cognitive and Affective(Liebert and Morris,1967). Cognitive dimension is worry that is displayed through negative expectations and preoccupation with self-deprecatory thoughts about mathematics/Mathematics linked situations (Morris and Liebert, 1970)

In the present study an attempt was made to assess Mathematics Anxiety of IX class students of government senior secondary school affiliated to Punjab School Education Board, Mohali. The Mathematics Anxiety Scale comprised of 44 items pertaining to cognitive and affective dimensions. There were 22 positive and 22 negative statements to be responded on a three point scale.

7.10.3.1 Time Limit

There was no time limit but generally students took 30 minutes.

7.10.3.2 Scoring

There were 22 positive statements and 22 negative statements. The weightage given for positive statement was 1,2 and 3 for Yes, Undecided and No, while, in case
of negative statements the weightage was given 3, 2 and 1.

7.10.3.3 Interpretation

For interpretation, criteria are given in the table 7.10.3

**Table 7.10.3 Interpretation criteria for mathematics anxiety scale.**

<table>
<thead>
<tr>
<th>Score Range</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 61</td>
<td>Low Mathematics Anxiety</td>
</tr>
<tr>
<td>Between 61 and 92</td>
<td>Average Mathematics Anxiety</td>
</tr>
<tr>
<td>Above 92</td>
<td>High Mathematics Anxiety</td>
</tr>
</tbody>
</table>

7.10.3.4 Reliability

Reliability of Mathematics Anxiety scale was established with the help of Test-Retest Reliability Method and Split-Half Reliability Method by Sharma and Sansanwal. The reliability coefficients found were high, so Mathematics Anxiety Scale was considered Reliable.

7.10.3.5 Validity

The Content Validity of the Mathematics Anxiety Scale was established by having a discussion with the expert from the fields of Psychology and mathematics Education done by Sharma and Sansanwal. On the basis of expert opinion, it was found that the Mathematics Anxiety scale could assess Mathematics Anxiety. On the basis of Content and Criterion validity established, the Mathematics Anxiety Scale was found to be valid.

**7.10.4.0 Mathematical Creativity Test**

The Mathematical Creativity test prepared by Sharma and Sansanwal has total 18 items. The items are equally divided into three parts A, B and C. Each part of mathematical creativity test has a separate reusable booklet. The items of mathematical creativity test were written in three languages – English, Hindi and Punjabi. The Items pertain to overcoming fixation, problem posing and problem solving/testing solutions.
7.10.4.1 Time Limit

The time required for part A, part B, part C is 35 minutes, 31 minutes and 22 minutes respectively. Further the time limit is mentioned for each separate item. The time for each item ranges from three to six minutes.

7.10.4.2 Scoring

Like other test of creativity, the scoring of Sharma and Sansanwal mathematical creativity test cannot be done in a simple way. For scoring of Sharma and Sansanwal mathematical creativity test separate system of scoring procedure has been advised. The Mathematical Creativity is the sum of subject’s scores on all the items. The items are scored for Fluency, Flexibility and Originality aspects of Mathematical creativity.

Fluency: Total number of valid/Acceptable responses.

Flexibility: Scores is obtained by counting the number of different categories of responses given by the subject.

Originality: Weightage criteria is given in table 7.10.4

Table 7.10.4 Weightage Criteria for Originality.

<table>
<thead>
<tr>
<th>Percentage of Responses</th>
<th>Mark(s) Awarded</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

7.10.4.3 Reliability

Reliability of Sharma and Sansanwal mathematical creativity test was established with the help of Test-Retest Reliability Method. The Test-Retest Reliability Coefficient was found to be 0.86. The reliability coefficient was very high. The Cronbach’s alpha for the 18 items was 0.78, which indicates that the items from a scale that has reasonable internal consistency reliability. Therefore Sharma and Sansanwal mathematical creativity test was considered reliable.
7.10.4.4 Validity

The content Validity involves essentially the systematic examination of content of Sharma and Sansanwal mathematical creativity test to determine whether it covers a representative sample of the concept to be measured. The content validity of Sharma and Sansanwal mathematical creativity test was established by having a discussion with the experts from the field of Mathematics education. On the basis of expert opinion the Sharma and Sansanwal mathematical creativity test was found to be valid.

7.11.0 PROCEDURE FOR DATA COLLECTION

For data collection the intact original groups of the school i.e. the two sections of the 9th class were assigned as control group and experimental group. That is the section A was assigned as experimental group and section B was assigned as control group. The permission for conducting the experiment was taken from the principal of the school. Co-ordination was made with students and the objectives of the study were explained to the students. The experiment was divided into three phases.

Phase I:

In this phase pre –tests of Achievement test in mathematics, Mathematics Anxiety test and Mathematical Creativity Test were administered to the experimental group and control group.

Phase II:

In this phase experimental group was exposed to treatment through concept mapping in which they were taught ten concepts where as control group was exposed to treatment by teaching through conventional methods. Same topics were taken for experimental as well as control group.

Phase III:

In this phase post-tests of Achievement test in mathematics, Mathematics Anxiety test and Mathematical Creativity Test were administered to the experimental group and control group.
7.12.0 DATA ANALYSIS

Data analysis was objective wise in three phases:-

Phase I:

In this phase analysis of 2X2 factorial design ANCOVA on the data obtained from non equivalent control group quasi experimental design was done as below:

1. Analysis to study the effect of instructional strategy on mathematics achievement of IX grade students was done.
2. Analysis to study the effect of gender on mathematics achievement of IX grade students was done.
3. Analysis to study the interaction effect of instructional strategy (concept mapping / conventional method) and gender on mathematics achievement of IX grade students was done.
4. Analysis to study the effect of mathematics anxiety on mathematics achievement of IX grade students was done.
5. Analysis to study the interaction effect of instructional strategy (concept mapping/conventional method) and mathematics anxiety on mathematics achievement of IX grade students was done.
6. Analysis to study the effect of instructional strategy on mathematical creativity of IX grade students was done.
7. Analysis to study the effect of gender on mathematical creativity of IX grade students was done.
8. Analysis to study the interaction effect of instructional strategy (concept mapping / conventional method) and gender on mathematical creativity of IX grade students.
9. Analysis to study the effect of mathematics anxiety on mathematical creativity of IX grade students was done.
10. Analysis to study the interaction effect of instructional strategy (concept mapping/conventional method) and mathematics anxiety on mathematical creativity of IX grade students was done.
Phase II

In this phase Qualitative analysis of case studies of extremum gain cases of the experimental and control groups were done for analyzing the deeper affects. The cases were chosen from extremum bases as per table 7.12.1

Table 7.12.1 Base of cases for study

<table>
<thead>
<tr>
<th>Sr no</th>
<th>Group</th>
<th>Basis for case study</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Experimental</td>
<td>Highest score in 8th class</td>
</tr>
<tr>
<td>2</td>
<td>Control</td>
<td>Highest score in 8th class</td>
</tr>
<tr>
<td>3</td>
<td>Experimental</td>
<td>Lowest score in 8th class</td>
</tr>
<tr>
<td>4</td>
<td>Control</td>
<td>Lowest score in 8th class</td>
</tr>
</tbody>
</table>

Phase III

In this phase qualitative analysis of data of high, average and low achievers groups were done separately.

7.13.0 FINDINGS

The findings emerged from this study were given below:

1) The Instructional Strategy for Concept Mapping in Mathematics was not found to be superior to Traditional Method in Mathematics Teaching when Pre-Mathematics Achievement was taken as covariate.

2) Female students were not found to be significantly superior to male students in mathematics achievement when taught by Instructional Strategy for Concept Mapping in Mathematics

3) The Interaction between Treatment and Gender does not produce significant effect on Mathematics achievement of students when Pre-Mathematics achievement was taken as covariate

4) Mathematics Achievement was found to be independent of Mathematics Anxiety when groups were matched with respect to Pre-Mathematical Achievement
The Interaction between Treatment and Anxiety does not produce significant effect on Mathematics achievement of students when Pre-Mathematics achievement was taken as covariate.

The Instructional Strategy for Concept Mapping in Mathematics was not found to be superior to Traditional Method in fostering Mathematical Creativity when Pre-Mathematical Creativity was taken as covariate.

The male students were not found to be significantly superior to female students in mathematical creativity when taught by Instructional Strategy for Concept Mapping in Mathematics.

The Interaction between Treatment and Gender does not produce significant effect on Mathematical Creativity of students when Pre-Mathematical Creativity was taken as covariate.

Mathematical creativity was found to be independent of Mathematics Anxiety when groups were matched with respect to Pre-Mathematical Creativity.

The Interaction between Treatment and Anxiety does not produce significant effect on Mathematical Creativity of students when Pre-Mathematical Creativity was taken as covariate.

There is no positive effect of treatment on achievement in mathematics, in Post-hoc achievement and in mathematical creativity in high performance case.

There is positive effect of treatment on achievement in mathematics, in Post-hoc achievement and in mathematical creativity in low performance case.

The cases under study reported the interest of students in the use of concept mapping for the learning of other subjects also. They also used their learning through concept mapping in peer tutoring of their sibling.

Concept mapping was not found superior to traditional method in mathematics teaching to the low achievers.

Concept mapping was not found superior to traditional method in inculcating mathematical creativity in the low achievers.
16) Concept mapping was not found superior to traditional method in mathematics teaching to the high achievers.

17) Concept mapping was not found superior to traditional method in inculcating mathematical creativity in the high achievers.

18) Concept mapping was not found superior to traditional method in mathematics teaching to the average achievers.

19) Concept mapping was not found superior to traditional method in inculcating mathematical creativity in the average achievers.

7.14.0 IMPLICATIONS

The study has the following implications:-

1) Training for formation of concept maps of various subjects and how to use them in class room can be taken up by in department of education for in-service training of teachers.

2) Pre-service teachers can also be taught the basics of concept maps in their curriculum. Preparing concept maps may be included in the pre-practice preparatory programme and using the concept maps as a method can be made integral part of the practise teaching programme.

3) The publications of NCERT, SCERT and in different boards the source material can prepare their resource materials in the form of concept maps.

7.15.0 SUGGESTIONS FOR THE FURTHER RESEARCH

The solution of one problem tends to indicate many unresolved problems which need scientific probing. No single research can find solutions for all these problems. There is wide scope for further research in this field. The following are the suggestions for further research:

1) The modules constructed in the study were based on the Novakian model. But only one type i.e. hierarchical maps were used. Further studies may be conducted by using other type’s i.e. Sequential maps, multiway maps or cyclic maps suiting to contents.
Summary

2) In the further studies the mode of the assessment of learning outcomes in future studies may be more divergent and task oriented (discussion, group work etc).

3) Further research may be conducted to study the effect of concept mapping strategy on affective behavioural changes like study habits, leisure time utility, interest in subjects etc.

4) In further studies more stringent experimental controls may be applied to validate the findings of this study.

5) Comprehensive coverage of topics may be taken up for further studies. Even the sample for the study may be selected from the senior secondary class or upper elementary classes.

6) More studies are required on more divergent and inclusive samples to arrive at some empirical conclusion.

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