Chapter 4

Methodology

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Chapter-4

Methodology

4.1 Methodology: A Precept

Research is an intellectual and creative endeavor to discover, to develop and verify knowledge. It entails objectives and systematic effort to offer solutions to the problems and to formulate Policies and Programmes. Research is a scientific inquiry that is designed to collect, analyze and use data to understand, describe, predict or control an educational or psychological phenomenon or to empower individuals in such context. (Mertens, 2010).

Methodology of research is the description and rationale of the diverse phases of conducting a research. It details the varied sequential stages that are generally adopted by the researcher to inquire into the research problem along with the logic behind them. Thus the researcher should formulate the methodology best suited to the nature of the problem under study, research hypothesis, theoretical constructs and feasibility to evolve the most valid and reliable findings.

In the present study the locale of the study, design of the study, procedure of the study, statement of the problem, objectives of the study, major hypotheses of the study, operational definitions, types of schools, population and samples of the study, tools used and statistical techniques employed are dealt with in detail.

4.2: Locale of the Study: The present study has been conducted at Bangalore city. Two schools are selected using convenience sampling. Two schools are of state board and they are co-educational Institutions.
4.3 **Statement of the Problem:** In the present study the researcher had developed Interactive Multimedia strategies for teaching Mathematics based on selected topics. She has studied the effect of IMMS on AIM and CTA of students hence the present study was entitled as

“The effectiveness of Interactive Multimedia Strategies on achievement in mathematics and Critical Thinking ability of standard IX students”

4.4 **Operational definitions**

1. **Interactive Multimedia Strategies(IMMS):** The Strategies which were used to teach the selected topics of Standard IX Mathematics using array of Multimedia such as Charts, Flip over Charts, Models, videos, Graphic Organizers, Power Point Presentations and other Teaching Aids.

2. **Treatment:** The researcher varied the method of teaching during experimentation in order to find out the effectiveness of Interactive Multimedia Strategies (IMMS).

The investigator taught the experimental group with IMMS which was developed and validated by the researcher and the control group was taught by the traditional method of teaching.

3. **Interactive:** The Strategies were planned under IMMS for the interaction between the teacher and pupil in the classroom in teaching of Mathematics.

4. **Achievement:** According to Carter V. Good (1973), achievement means accomplishment or proficiency or performance in a given skill or body of knowledge, helps in declaring the examinee successful or unsuccessful, choosing the students for various professional and academic courses and selecting the candidates for different jobs”.
Achievement in Mathematics means the extent to which a student have achieved something, acquire certain information, demonstrated proficiency in certain skills usually as a result of instruction in the subject of mathematics. In the present study, it is represented by the scores of students in the achievement test in Mathematics prepared and validated by the researcher.

5. **Intelligence:** Intelligence is the person’s ability to form perceptual relations to reason by analogy independent of languages and formal schooling. In the present study, the Intelligence of the students is represented by the scores of Standard Progressive Matrices (SPM) prepared by Raven.(1998)

6. **Critical Thinking Ability (CTA):** According to*(Scriven, 1996)* “Critical thinking is the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action"

From the above definition CTA is defined as “the means drawing favorable judgment and encouraging a person to think deeply, to seek clarification or understand objects, involves a collection of thinking operations which help a person to determine the merit and demerits of an object”. It is represented by the scores of CTA developed and validated by the researcher.

**4.5 Objectives of the Study:** The Present study was designed keeping the following objectives in view:

1. To develop the Interactive Multimedia Strategies (IMMS) based on selected topics of Standard IX Mathematics Syllabus.

2. To study the effect of Interactive Multimedia Strategies (IMMS) on the Achievement in Mathematics of the students of Standard IX.
3. To study the effect of IMMS on the Critical Thinking Ability (CTA) of Students of Standard IX.

4. To find the relationship between Critical Thinking Ability (CTA) and Achievement in Mathematics (AIM) of the Students of Standard IX.

5. To find the differential effect of IMMS on the post test scores of AIM of
a) Students of Standard IX with high and low Intelligence.
b) Boys and girls of the Standard IX

6. To find the differential effect of IMMS on the gain scores of CTA of
a) Students of Standard IX with high and low Intelligence.
b) Boys and girls of the Standard IX

7. To find out the Interaction effect of Gender and Intelligence on the post test means scores AIM of students of Standard IX.

8. To find out the Interaction effect of Gender and Intelligence on the Gain Scores of CTA of students of Standard IX.

9. To find out the Interaction effect of boys and girls on the post test means scores of AIM of students of Standard IX.

10. To find the effect of IMMS on AIM of experimental group after delayed post test.

11. To find the Effect of the IMMS on the gain scores of CTA of experimental group after delayed post test.
4.6 Hypotheses:

Based on the objectives of the study the researcher formulated the following hypotheses in the present study.

**Hypothesis -1**

There is no significant difference between of mean post test scores of Achievement in Mathematics of experimental and control group.

**Hypothesis-2**

There is no significant difference between the mean gain scores of Critical Thinking Ability of experimental group and control group.

**Hypothesis-3**

There is no significant relationship between Critical Thinking Ability and Achievement in Mathematics of the students of Standard IX of Bangalore city.

**Hypothesis-4**

There is no significant difference between post test mean scores of Achievement in Mathematics of students having high and low Intelligence.

**Hypothesis-5(a)**

There is no significant difference between students of Standard IX having high and low intelligence in their mean post test scores of Achievement in Mathematics

**Hypothesis-5(b)**

There is no significant difference between boys and girls of Standard IX in their mean post test scores of Achievement in Mathematics.

**Hypothesis-6(a)**

There is no significant difference between students of Standard IX having high and low intelligence in their mean post test scores of CTA.
Hypothesis-6(b)
There is no significant difference between boys and girls of Standard IX in their mean post test scores of CTA.

Hypothesis-7
There is no significant interaction effect of gender and intelligence on the post test mean scores of AIM of students of Standard IX.

Hypothesis-8
There is no significant interaction effect of gender and intelligence on the gain scores of CTA of students of Standard IX.

Hypothesis-9
There is no significant difference between boys and girls on post test mean scores AIM of standard IX

Hypothesis-10
There is no significant difference between the post test mean scores of delayed post test with respect to AIM of the experimental group of standard IX

Hypothesis-11
There is no significant difference between the post test mean scores of delayed post test with respect to CTA of the experimental group of standard IX

4.7 Variables of the study:

Variables are the conditions or characteristics that the researcher manipulates, controls or observes (Best and Kahu, 2007). They are the vital aspects of a study and are mainly of two types; Independent and dependant variable

Variables of the study:

1. **Independent variable**: Treatment using IMMS

2. **Dependent Variables**: In the Present study the dependent variable were
a) Achievement in Mathematics

b) Critical Thinking Ability

III. Moderate variables:

a) Intelligence

b) Gender

4.8 Population and sample

Population: All the students of standard IX located in Bangalore city constitute the population of the study.

4.9 Sample: Multistage sampling was used in selecting the sample, in the first stage the schools were chosen according to convenience sampling because only the schools which co-operate had to be selected.

In the second stage the students were chosen according to random sampling technique. In each school, there was one experimental group and control group. The researcher has selected two private schools in different areas of Bangalore city. One school from Bangalore north zone and the other school in Bangalore south zone, the schools chosen for the study were Co-Educational Institutions.

Table 4.9.1 Details of the sample selected for the study

<table>
<thead>
<tr>
<th>Group</th>
<th>No of schools</th>
<th>Boys</th>
<th>Girls</th>
<th>Total no of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exp</td>
<td>2</td>
<td>46</td>
<td>34</td>
<td>80</td>
</tr>
<tr>
<td>Controls</td>
<td>2</td>
<td>36</td>
<td>44</td>
<td>80</td>
</tr>
</tbody>
</table>
4.10 Description of tools:

The Tools used for the collection of data on the different variables of this study.

1. Raven’s Standard Progressive Matrices (1998) to measure the Intelligence of the Students.

2. Critical Thinking Ability Test was developed and validated by the researcher to measure the Critical Thinking Ability of the Students.

3. Achievement test in Mathematics was developed and validated by the researcher to assess the Performance of the Students.
A) Raven’s Standard Progressive Matrices (1998)

Raven’s SPM is a test of observation skills and clear-thinking ability. It offers insight about someone’s capacity to observe, solve problems, and learn. The test has a total of 60 items presented in 5 sets (A–E), with 12 items per set.

The SPM or SPM Plus score can be used as an indication of a candidate’s potential for success in professional, management and high-level technical positions that require clear thinking, problem identification, holistic situation assessment, and monitoring of tentative solutions for consistency with all available information. The SPM or SPM Plus score also can be used for developmental purposes in occupational and educational settings. The nonverbal aspect of each test minimizes the impact of cultural or language bias.

The Raven’s SPM and SPM Plus each produces a single raw score as well as percentile rank to indicate the candidate’s educative ability or the ability to think clearly and extract meaning out of events, compared to a norm group.

The standard progressive matrices (set A, B, C, D ) or SPM is a test of a person’s capacity at the time of the test to apprehend figures presented for his observation, see the relation between them, conceive the nature of his figure, completing each system of relations presented, by it is a non-verbal culture free test of intelligence . It can be used for both high school and college students. The test consists of five sub tests namely A,B ,C, D and E . Under each sub test, there are twelve figures against each incomplete pattern six possible figures are given. Among these, one will be the most suitable figure to complete the large figure. The complexity of the test increases from test A to E. This test has high reliability 0.71 and validity.
Scoring procedure: the tool consists of 60 questions in total and each question carries one mark and equal weightage is given to all the questions. Total marks 60 for 60 questions.

B) Critical thinking ability test: Tool to assess the level of the CTA was developed and validated by the researcher. It is based on the components of CTA are

1. Distinguishing relevant from irrelevant information, claims and reasons:

Here the students are expected to decide whether the example/ cause/ principal given is related to the situation or statements given. The questions are constructed in which way that in which some statements are given, against each statement, four alternatives a, b, c & d are given. The students have to select the appropriate statement from the given alternatives.

2. Determining the accuracy of a factual claim

Here the students are expected to determine whether or not a factual statement is true and consistent with other know facts in terms of accuracy, in which some incomplete statements are given against each incomplete statement, four alternatives a, b, c and d is given. The students have to select the most accurate answer.

3. Identifying the unstated Assumption

Any unwritten idea or reason or principle which are supposed to be true without proof or documentation in which some situations are provided to the students below at the end the questions are also given along with their respective answers.
The students are expected to identify the assumptions/assumptions which help further helps in accepting the answer as correct.

4. **Determining the strength of an argument or claim:**
The students are expected to identify the quality or merit or reasons given in support of a conclusion.

Critical Thinking Ability tool was developed to assess cognitive presence depends on the use of the components of critical thinking ability to reflect educational practice. It is important to recognize that cognitive presence focus on higher order thinking abilities.

The researcher prepared the tool based on the selected components of critical thinking ability. The tool was prepared on four components of critical thinking ability. For each component, twenty items were prepared and given to the experts for examining the suitability of each item for inclusion in the test and also discussed in detail i.e each statement with the experts of Mysore University and other university and collected their opinion, and then it was further modified. The modified tool was used for the pilot study and refinement done accordingly. The final version of the tool consists of four components, under each component, ten items were present.

**Item analysis:** the preliminary format of the tool was tried out. For item analysis biserial co-efficient of correlation was computed and then final 40 questions were chosen. The final version of the tool consists of four components, under each component, ten items were present. This final version was used on a group of 95 students.

**Reliability:** This final version was used on a group of 95 students and reliability value is calculated using split half method and using spearmen-Brown Prophecy
formula. The reliability value is found to be 0.71 and the final tool consists of ten items under each components and totally there are 40 items all the items are open ended.

**Scoring procedure for critical thinking ability:**

For the components 1, 2, 3, and 4 each item, the expected answer will be in the form of open ended questionnaire as developed by the researcher. Each question carries one mark and equal weightage is given to all the components. Total marks are 40 for 40 questions.

**Uses of the scale:** the scale can be used for research and survey purposes. It can be used for individual assessment. It is self-administering and does not require the services of highly trained tester. It is eminently suitable for group and as well as individual testing.

5. **Achievement test in Mathematics:**

The achievement test had been prepared by the researcher taking subunits in arithmetic, algebra and geometry of standard IX mathematics. The questions were chosen from all the levels of difficulty and weightage was given to knowledge level, understanding level application level and skill level.
Weightage of objectives of Achievement in mathematics (AIM) Test

Table 4.8 weightage of objectives of Achievement in mathematics (AIM) test

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Weightage</th>
<th>No of questions</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>30%</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Understanding</td>
<td>40%</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Application</td>
<td>20%</td>
<td>08</td>
<td>08</td>
</tr>
<tr>
<td>Skill</td>
<td>10%</td>
<td>04</td>
<td>04</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
<td><strong>40</strong></td>
<td><strong>40</strong></td>
</tr>
</tbody>
</table>

Weightage to the content of Achievement in Mathematics (AIM) Test

Table 4.8.1Weightage to the content of Achievement in Mathematics (AIM) test

<table>
<thead>
<tr>
<th>Unit</th>
<th>Weightage</th>
<th>No of questions</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sets</td>
<td>20%</td>
<td>08</td>
<td>08</td>
</tr>
<tr>
<td>Matrix</td>
<td>20%</td>
<td>08</td>
<td>08</td>
</tr>
<tr>
<td>Factorization</td>
<td>20%</td>
<td>08</td>
<td>08</td>
</tr>
<tr>
<td>Circles</td>
<td>20%</td>
<td>08</td>
<td>08</td>
</tr>
<tr>
<td>Surface Area and Volume of Solids</td>
<td>20%</td>
<td>08</td>
<td>08</td>
</tr>
</tbody>
</table>
The researcher prepared Achievement test in Mathematics which is based on Criterion reference norms on the selected topics in mathematics of Standard IX of state board syllabus. The questions were constructed based on the four domains namely knowledge, understanding .application and skill. The researcher prepared 60 items and given to the experts and collected their opinions and further it was modified. The modified tool was used for the pilot study and refinement is done accordingly. The final version was conducted on 50 students and reliability value is established by using test –retest method and calculated by using spearmen-Brown Prophecy formula. The reliability value is found to be 0.76and the final tool consists of 40 questions.

**Scoring procedure for Achievement in mathematics test:**

Each question carries one mark and equal weightage is given to all the components. Total marks are 40 for 40 questions.

**Uses of the scale:** The scale can be used for research and survey purposes to assess the achievement in mathematics. It can be used for individual assessment. It is self administering and does not require the services of trainer. It is well suitable for the group and as well as individual testing.

**4.11 Design of the Study:** Post test equivalent group design was followed for testing the effectiveness of Interactive Multimedia Strategies on Achievement in mathematics. The researcher taught the experimental group using Interactive Multimedia strategies which was developed and validated by the researcher and used traditional method for control group.

Pre test and post test equivalent group design was followed to measure the effectiveness of Interactive multimedia strategies on Critical thinking Ability.
4.12 Procedure of the study:

In the first stage of the study, the researcher prepared the interactive multimedia strategies for the few topics of mathematics of standard IX syllabus. She also developed and validated the tool to assess the critical thinking ability and achievement in mathematics. In the second stage the researcher administered critical thinking ability test and Raven’s SPM to both control and experimental group. Then she taught the students of experimental group using interactive multimedia strategies and the students of control group by conventional method. Later she administered achievement in mathematics and critical thinking ability test to both experiment and control group. After a gap of 20 days the researcher administered achievement in mathematics and critical thinking ability test to experimental group. During the third stage the investigator analyzed and interpreted the data.

4.12 Statistical Techniques used for Analysis of Data:

For the analysis of the data the following statistical techniques has been employed.

Descriptive Statistics

The descriptive procedure displays univariate summary statistics for several variables in the single table. Descriptive statistics was employed in the present study to get mean and other statistics for the various dependent variables measured.

Pearson’s Product Moment Correlation

Correlations measure how variables or rank orders are related. Pearson’s’ correlation co-efficient is a measure of linear associations. In the present study Pearson’s correlation has been done to find the correlation co-efficient between achievement and critical thinking ability test of students of experimental group.
**Independent Sample t-test**

The independent samples t-test procedure compares means for two groups of cases. Ideally for this test, the subjects should be randomly assigned to two groups, so that any difference in response is due to the treatment or lack of treatment and not to other factors. Independent sample t-test is being applied to find the significant difference between mean scores post test of achievement in mathematics of control group and experimental group of standard IX students in the respective variables.

**ANOVA:** In statistics, analysis of variance is a collection of statistical models, and their associated procedures, in which the observed variance in a particular variable is portioned into components attributable to different sources of variation. In its simplest form ANOVA provides a statistical test of whether or not the means of several groups are all equal, and therefore generalizes t-test to more than two groups. ANOVA are helpful because they possess an advantage over a two sample t-test. Doing multiple sample t-test would result in an increased chance of committing a type I error. For this reason ANOVA are useful in comparing two or more means.

In this study 2X2 ANOVA is used.
4.12 The Hypothesis and statistical techniques employed for analysis of the data

Table 4.12.1: Hypotheses and statistical techniques

<table>
<thead>
<tr>
<th>No.</th>
<th>Hypothesis</th>
<th>Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>There is no significant difference between the post test mean scores of achievement in mathematics experimental and control group</td>
<td>t-test</td>
</tr>
<tr>
<td>H2</td>
<td>There is no significant between the gain scores of critical thinking ability of experimental group and controlled group</td>
<td>t-test</td>
</tr>
<tr>
<td>H3</td>
<td>There is no significant relationship between critical thinking ability and achievement in mathematics of the students of standard IX of Bangalore city.</td>
<td>Co-efficient of Correlation</td>
</tr>
<tr>
<td></td>
<td>Hypothesis</td>
<td>Description</td>
</tr>
<tr>
<td>---</td>
<td>------------</td>
<td>-------------</td>
</tr>
<tr>
<td>H5(a)</td>
<td>There is no significant difference between students of Standard IX having high and low intelligence in their mean post test scores of Achievement in Mathematics</td>
<td></td>
</tr>
<tr>
<td>H5(b)</td>
<td>There is no significant difference between boys and girls of Standard IX in their mean post test scores of Achievement in Mathematics.</td>
<td></td>
</tr>
<tr>
<td>H6(a)</td>
<td>There is no significant difference between students of Standard IX having high and low intelligence in their mean post test scores of CTA</td>
<td></td>
</tr>
<tr>
<td>H6(b)</td>
<td>There is no significant difference between boys and girls of Standard IX in their mean post test scores of mean post test scores of CTA</td>
<td></td>
</tr>
<tr>
<td>H7</td>
<td>There is no significant interaction effect of gender and intelligence on the post test mean scores of AIM of students of Standard IX</td>
<td></td>
</tr>
<tr>
<td>H8</td>
<td>There is no significant interaction effect of gender and intelligence on the gain scores of CTA of students of Standard IX</td>
<td>Anova</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>H9</td>
<td>There is no significant difference between boys and girls on post test mean scores of AIM of standard IX</td>
<td>t-test</td>
</tr>
<tr>
<td>H10</td>
<td>There is no significant difference between the post test mean scores of delayed post test with respect to AIM of the experimental group of standard IX</td>
<td>t-test</td>
</tr>
<tr>
<td>H11</td>
<td>There is no significant difference between the post test mean scores of delayed post test with respect to CTA of the experimental group of standard IX</td>
<td>t-test</td>
</tr>
</tbody>
</table>