METHODOLOGY

- Variables of the Study
- Objectives of the Study
- Hypotheses of the Study
- Design of the Study
- Procedure
- Data Collection Procedure
- Scoring and Consolidation of Data
- Statistical Techniques Used for Analysis
- Summary of the Procedure
Research Design is inevitable for the proper functioning of a research process. It facilitates the smooth sailing of the various actions to be accomplished in the research process regarding the steps, tools and procedures. As Sellitz, Wrightsman, and Cook (1976) says “Research design is the conceptual structures within which research is conducted: It constitutes the blueprint for the collection, measurement and analysis of data”.

This chapter details mainly the design of the study. It covers aspects like variables of the study, sample selected, tools used and the statistical techniques used in the analysis part. The present study is an attempt to compare the effect of Brain Based Learning Strategy and Circles of Learning Strategy over the Activity Oriented Method of teaching in terms of Achievement in Mathematics and Self Efficacy of Standard VII students. The study was conducted in two phases. In Phase I, a preliminary survey was administered on Upper Primary mathematics teachers. Phase I was followed by the Phase II in which the experiment was conducted. The details of the variables of the study, sample selected, tools-techniques and materials employed and the statistical techniques adopted are described in this chapter under the following major heads.

Variables of the Study
Objectives of the Study
Hypotheses of the Study
Design of the Study
Procedure
Scoring and Consolidation of Data
Statistical Techniques Used for Analysis
Variables of the Study

The details of the dependent, independent and control variables selected for the study is described below. The main focus of the present investigation was to measure the effect of two different strategies over the existing Activity Oriented Method of Teaching. For the proper selection of variables a thorough literature review was conducted. The methods selected were Brain Based Learning Strategy (BBLs), Circles of Learning Strategy (CLS) and Activity Oriented Method (AOMT). This required two experimental groups and one control group and hence the study was an experimental one.

Experimental designs vary in complexity and adequacy depending on such factors as the nature of the problem under investigation, the nature of data, facilities for carrying out the study, and especially the research sophistication and competence of the investigator. Although there are a number of combinations of the various experimental procedures, the investigator selected Non-equivalent Groups Pretest Posttest Control and Comparison Group Design. The experiment was conducted on two non-equivalent groups and the achievements of the two different treatments were compared with the existing Activity Oriented Method of Teaching.

Another independent variable selected for the study was Learning Styles. Learning Styles are unique for each person as individual difference. Learning Styles also affect the learning outcomes. According to Sarasin (1999), “teaching cannot be successful without knowledge of Learning styles and a commitment to matching them with teaching styles and strategies”. So the researcher incorporated Learning styles as another independent variable.
Independent Variables

The independent variables selected for the study were Instructional Strategies and Learning Styles.

Instructional Strategies.

Stones and Morris (1977) defined, “Instructional Strategies refer to a generalized plan for a lesson which includes structure, desired learning behaviour in terms of goals of instructional and an outline of planned tactics necessary to implement the strategy”. In the present study it comprises Brain Based learning Strategy, Circles of Learning Strategy and Activity Oriented Method of Teaching (Existing Method).

Brain Based Learning Strategy.

Brain Based Learning Strategy was the first strategy selected for the experiment. It refers to teaching methods, lesson designs, and school programs that are based on the latest scientific research about how the brain learns, including such factors as cognitive development—how students learn differently as they age, grow, and mature socially, emotionally, and cognitively. Brain-Based Learning involves accepting the rules of how the brain processes, and then organizing instruction bearing these rules in mind to achieve meaningful learning (Caine & Caine, 1994). According to Jensen (2008), Brain-Based Learning was related to teaching strategies and principles from an understanding of how the brain functions and learning with the brain in mind.

Circles of Learning Strategy.

Circles of Learning Strategy is a Cooperative Learning method in which students work together on a given academic tasks in small groups (usually four to five members) to help themselves and their group members to
learn together and achieve the goal to get rewarded in some way for performance as a group (Johnson , Johnson, & Holubec ,1994).

**Activity Oriented Method of Teaching.**

It refers to the present method of teaching insisted by Government of Kerala. Activity Oriented Method is presently followed in the Upper Primary classes of Kerala syllabus Schools.

**Learning Styles.**

Learning Styles is the general tendency to adopt a particular learning strategy (Entwistle, 1981). A learner does not learn unless he/she knows how to respond (Thelen, 1960). An Individual may not ultimately confirm knowledge until handled it in modalities one strongly trusts. In higher education field, technology provides new capabilities to reconstruct learning environments around specific Learning Styles. Learning styles are important because they are education- relevant expression of the uniqueness by the individual (Joyce, Weil, and Showers , 1992).

In the present study, Learning Styles is the general tendency of preference (Visual/ Auditory/ Kinesthetic) which was measured using a standardized Learning Style Inventory. Learning Style Inventory was used to identify the individual’s preferred Learning Styles used in different situation related to learning.

**Dependent Variables**

The present study was aimed to find out the effectiveness of Brain Based Learning Strategy and Circles of Learning Strategy over Activity Oriented method of Teaching and to study the effect of three Instructional Strategies and Learning Styles in case of Achievement in Mathematics and Self Efficacy of Standard VII students of Kerala State.
Achievement in Mathematics.

Achievement in Mathematics measured in Objective wise scores viz., Remembering, Understanding, Applying, Analysing, Creating and Evaluating and a Total score, of standard VII Students, were selected as the Dependent Variables. A comparison on the scores of the three strategies in Achievement in Mathematics was done to find out the effectiveness of selected strategies.

Self-Efficacy.

Self-Efficacy was the second dependent variable measured in this study. It plays a key role in human functioning and it also effect students’ innovation and learning. Self-Efficacy is the belief in one’s own ability (Bandura, 1997). In the present study, the researcher also tried to find out the effectiveness of Instructional Strategies and interaction of Instructional Strategies and Learning Styles on the Self-Efficacy of Standard VII Students.

Control Variables

The investigator anticipated some attributes of the subjects that might intervene in the experimental situation as the outcomes of the treatment might be affected by these factors. To overcome this problem, these variables were controlled statistically using ANCOVA. Variables controlled for this experimental study were Pre-Experimental Status of the students in terms of Achievement in Mathematics and Self-Efficacy, Verbal Intelligence, Non-verbal Intelligence, and Classroom Environment.

Objectives of the Study

The specific objectives formulated are as follows:

1. To identify the prevailing and innovative Instructional Strategies adopted by Teachers’ to teach Mathematics at Upper Primary School Level.
2. To find out the issues (if any) experienced by the Mathematics Teachers in implementing innovative Instructional Strategies at Upper Primary School Level and to suggest measures (if any) to overcome the constraints in implementing the innovative Instructional Strategies at Upper Primary School Level.

3. To study whether there exists any significant difference in the mean Achievement in Mathematics (Total and Objective wise scores) of the Experimental and Control groups for the Total sample, Boys and Girls.

4. To study whether there exists any significant difference in the mean Gain score of Achievement in Mathematics of the Experimental and Control groups for the Total sample, Boys and Girls.

5. To study whether there exists any significant difference in the mean Self Efficacy of the Experimental and Control groups for the Total sample, Boys and Girls.

6. To study whether there exists any significant difference in the mean Gain score of Self Efficacy of the Experimental and Control groups for the Total sample, Boys and Girls.

7. To study the effectiveness of Brain Based Learning Strategy (BBLSS) over Activity Oriented Method of Teaching (AOMT), if any, in terms of Achievement in Mathematics of standard VII Students.

8. To study the effectiveness of Circles of Learning Strategy (CLS) over Activity Oriented Method of Teaching (AOMT), if any, in terms of Achievement in Mathematics of standard VII Students.

9. To study the effectiveness of Brain Based Learning Strategy (BBLSS) over Circles of Learning Strategy (CLS), if any, in terms of Achievement in Mathematics of standard VII Students.

10. To study the effectiveness of Brain Based Learning Strategy (BBLSS) over Activity Oriented Method of Teaching (AOMT), if any, in terms of Self- Efficacy of standard VII Students.
11. To study the effectiveness of Circles of Learning Strategy (CLS) over Activity Oriented Method of Teaching (AOMT), if any, in terms of Self-Efficacy of standard VII Students.

12. To study the effectiveness of Brain Based Learning Strategy (BBLS) over Circles of Learning Strategy (CLS), if any, in terms of Self-Efficacy of standard VII Students.

13. To study the main effects of the Instructional Strategies and Learning Styles on Achievement in Mathematics (Total and Objective wise scores) of standard VII Students for the Total sample, Boys and Girls.

14. To study the interaction effect of the Instructional Strategies and Learning Styles on Achievement in Mathematics (Total and Objective wise scores) of standard VII Students for the Total Sample, Boys and Girls.

15. To study the main effects of Instructional Strategies and Learning Styles on Self Efficacy of standard VII Students for the Total sample, Boys and Girls.

16. To study the interaction effect of Instructional Strategies and Learning Styles on Self Efficacy of standard VII Students for the Total sample, Boys and Girls.

Hypotheses of the Study

The present study was designed to test the following hypotheses.

1. There will be no significant difference in the mean Achievement in Mathematics (Total and Objective wise scores) of the Experimental and Control groups for the Total sample, Boys and Girls.

2. There will be no significant difference in the mean Gain score of Achievement in Mathematics of the Experimental and Control groups for the Total sample, Boys and Girls.
3. There will be no significant difference in the mean Self Efficacy of the Experimental and Control groups for the Total sample, Boys and Girls.

4. There will be no significant difference in the mean Gain Score of Self-Efficacy of the Experimental and Control Groups for the Total sample, Boys and Girls.

5. Students taught through Brain Based Learning Strategy (BBLs) will not differ significantly from Students taught through Activity Oriented Method of Teaching (AOMT) in terms of Achievement in Mathematics.

6. Students taught through Circles of Learning Strategy (CLS) will not differ significantly from Students taught through Activity Oriented Method of Teaching (AOMT) in terms of Achievement in Mathematics.

7. Students taught through Brain Based Learning Strategy (BBLs) will not differ significantly from Students taught through Circles of Learning Strategy (CLS) in terms of Achievement in Mathematics.

8. Students taught through Brain Based Learning Strategy (BBLs) will not differ significantly from Students taught through Activity Oriented Method of Teaching (AOMT) in terms of Self Efficacy.

9. Students taught through Circles of Learning Strategy (CLS) will not differ significantly from Students taught through Activity Oriented Method of Teaching (AOMT) in terms of Self Efficacy.

10. Students taught through Brain Based Learning Strategy (BBLs) will not differ significantly from Students taught through Circles of Learning Strategy (CLS) in terms of Self Efficacy.

11. There will be no significant main effects of Instructional Strategies and Learning Styles on Achievement in Mathematics (Total and Objective wise scores) of standard VII Students for the Total sample, Boys and Girls.
12. There will be no significant interaction effect of Instructional Strategies and Learning Styles on Achievement in Mathematics (Total and Objective wise scores) of standard VII Students for the Total sample, Boys and Girls.

13. There will be no significant main effects of the Instructional Strategies and Learning Styles on Self-Efficacy of standard VII Students for the Total sample, Boys and Girls.

14. There will be no significant interaction effect of the Instructional Strategies and Learning Styles on Self-Efficacy of standard VII Students for the Total sample, Boys and Girls.

**Design of the Study**

The present study was meant to study the effectiveness of Brain Based Learning Strategy and Circles of Learning Strategy over Activity Oriented Method of Teaching and to study the main and interaction effects of Instructional Strategies and Learning Styles in terms of Achievement in Mathematics and Self Efficacy. So, the present study has been conducted by employing the Experimental Design. The experimental design selected is explained as follows.

**Research Design Selected**

The study was conducted employing the experimental design, specifically the Quasi Experimental Design. The particular design selected was the Non-Equivalent Groups Pre test – Post test Control and Comparison Group design. This design incorporates two experimental groups (Experimental Group I & Experimental Group II) and one control group.

Experimental Group I was taught through the Brain Based Learning Strategy (BBLS) and Experimental Group II was taught through Circles of Learning Strategy of Co-operative Learning (CLS). The Control group was
taught through the existing Activity Oriented Method of Teaching (AOMT) employed in Upper Primary Classes of the State using Kerala syllabus.

The design selected for the study is illustrated as follows,

(McMillan & Schumacher, 2010)

Where

$O_1, O_3, O_5$ and $O_7, O_9, O_{11}$ are the Pre Test Scores of Achievement in Mathematics and Self Efficacy respectively.

$O_2, O_4, O_6$ and $O_8, O_{10}, O_{12}$ are the Post Test Scores of Achievement in Mathematics and Self Efficacy respectively.

\[
\begin{align*}
O_2 - O_1 & \\
O_4 - O_3 & \\
O_6 - O_5 & \\
O_8 - O_7 & \\
O_{10} - O_9 & \\
O_{12} - O_{11} &
\end{align*}
\]

Gain Scores of Achievement in Mathematics

Gain Scores of Self Efficacy

A & B - Experimental Groups

C - Control Group

$X_1$ - Application of the Experimental Treatment I (BBLS)

$X_2$ - Application of the Experimental Treatment II (CLS)

$X_3$ - Application of the Control Treatment (AOMT)
Procedure

The procedure adopted for the study is described in the following sections. Sample of the Study, Topics selected for the study, Tools, Techniques and other Learning Materials administered, Execution of the treatment, and Statistical techniques applied for the analysis are detailed in this section.

Sample for the Study

Standard VII Students studying under Kerala state Syllabus was considered as the population for the study. Since the study was experimental one, the investigator felt it difficult to conduct the experiment over a large sample. The investigator therefore selected three intact class divisions of standard VII Students from two schools, as Experimental Groups I & II and the Control group. Since random assignment of subjects from the school population was not possible, the Experimental group I, Experimental group II, and Control group were selected randomly for Experimental and Control treatments. Certain aspects of the three groups were considered in the selection to make sure the equivalence of the groups. These aspects are described as follows:

Rural-Urban Locality.

The two schools selected were situated in rural areas of Malappuram district of Kerala State.

Gender.

The two schools were provided with co-education. It may affect the experiment results if boys only or girls only school were selected. So to get the proper inclusion of boys and girls, mixed divisions were selected for the study.
Instructional Efficiency

Equality of the instructional efficiency of the subjects of the two groups (classes) was ensured by comparing the results in the terminal examination in the previous year.

In the selection of the sample, the convenience of the schools to conduct the experiment and the physical distance between the two schools were also considered. The three classroom groups were equated based on their Pre-Experimental Status in terms of Achievement in Mathematics and Self-Efficacy, Verbal Intelligence, Non-verbal Intelligence, Classroom Environment and Socio-Economic Status. Appropriate tools were used for this purpose.

Allocation of Experimental and Control Groups.

As the study needed two experimental groups and one control group, two classes were selected from one school and one class from another school was selected according to the availability and feasibility. Details of the schools selected for the Experiment are given in Table 1.

Table 1
Details of Schools Selected for the Study

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Name of School</th>
<th>Nature of Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Govt Model School, Calicut University</td>
<td>Experimental Group I</td>
</tr>
<tr>
<td>2</td>
<td>A.M.U.P. School, Puthur Pallikal</td>
<td>Experimental Group II</td>
</tr>
<tr>
<td>3</td>
<td>A.M.U.P. School, Puthur Pallikal</td>
<td>Control Group</td>
</tr>
</tbody>
</table>

Actual number of subjects in the Experimental groups and Control groups at the beginning of the experiment are shown in Table 2.
Table 2  
**Details of Sample Selected for the Study**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Experimental Group I (BBLS)</th>
<th>Experimental Group II (CLS)</th>
<th>Control Group</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>30</td>
<td>25</td>
<td>23</td>
<td>78</td>
</tr>
<tr>
<td>Girls</td>
<td>18</td>
<td>15</td>
<td>17</td>
<td>50</td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
<td>40</td>
<td>40</td>
<td>128</td>
</tr>
</tbody>
</table>

The Experimental Group I was taught through the Brain Based Learning Strategy, the Experimental group II was taught through Circles of Learning Strategy and the Control Group, through the Activity Oriented Method of Teaching.

**Selection of Topics for the Treatment**

The topics for treatment in the present experiment were selected from the syllabus of Mathematics prescribed for standard VII Students of Kerala state for the academic year 2015-2016. Before the selection of the topics; the curriculum, syllabus, text book and teachers’ text book prescribed for standard VII were studied carefully. In addition, necessary details regarding the topics were sought from experts and concerned teachers. Thus three topics selected for the treatment were ‘Unchanging Relations’, ‘Repeated Multiplication’ and ‘Area of a Triangle’ and these topics were again divided into sub units. Each topic and the sub units are as follows.

1. **Unchanging Relations**
   a) Number Relations
   b) Number Theory
   c) Arithmetic and Algebra
d) Two Operations, One result

e) Theory and Practice

f) Calendar Math

2. **Repeated Multiplication**

a) Power of Products

b) Power of ten

c) Sum of powers

d) Factorization

e) Powers of fraction

f) Power to decimal

g) Division Rule

h) Factors

3. **Area of a Triangle**

a) Halving

b) Rectangle and Triangle

c) Parallelogram and Rectangle

d) Square Parts

Each lesson was selected with immense care and thorough examination and found amenable to Brain based Learning Strategy, Circles of Learning Strategy, and Activity Oriented Method of Teaching. For the Experimental group I, Experimental group II, and Control group, thirty five Lesson Transcripts each in English language using respective lesson patterns were prepared with each having time duration of 40 minutes.

The draft Lesson Transcripts of both Brain Based Learning Strategy and Circles of Learning strategy were tried out by the investigator on 30 students of standard VII to work out its application. Before the beginning of the tryout, the investigator created a good rapport with the Students. The need and purpose of the new mode of learning strategies were made clear to the
students. The investigator also explained the main objectives and features of both strategies and how instruction is designed in tune with both Strategies.

Teachers concerned in the school, were invited to attend the try out session and their opinion about the implementation was sought. On the basis of the suggestions given by the teachers and the feedback from students, the draft Lesson Transcripts was modified, re-edited and finalised.

**Tools, Techniques, and Other Learning Materials Benefited for the Study**

Quality of a research undeniably depends on the exactness of the tools and the data collection procedure. Different tools and techniques were adopted at various stages of the data collection for the perfection of the study. They include both the tools developed by the investigator as well as developed by other authors and both are detailed in this section. The list of the tools, Techniques, and other Learning Materials used at various stages of data collection are listed below.

**Preliminary Phase.**

1. Semi-structured Interview Schedule for Upper Primary Mathematics Teachers (Hameed & Asha, 2013)

**Experimental Phase.**

2. Lesson Transcripts for Brain Based Learning Strategy (Hameed & Asha, 2014)
3. Lesson Transcripts for Circles of Learning Strategy of Co operative Learning (Hameed & Asha, 2014)
4. Lesson Transcripts for Activity Oriented Method of Teaching (Hameed & Asha, 2014)
5. Achievement Test in Mathematics- ATM used as Post Test (Hameed & Asha, 2014)
6. Learning Styles Inventory (Hameed & Meharunnisa, 2014)
7. Scale of Self-Efficacy used as Post Test (Hameed & Asha, 2014)
8. Verbal Group Test of Intelligence – VGTI (Kumar, Hameed & Prasanna, 1997)

Phase I- Preliminary Phase.

In the preliminary phase, the researcher conducted an interview on Upper Primary Mathematics Teachers to find out their views on Instructional Strategies using a Semi-Structured Interview Schedule.

*Semi-structured Interview Schedule for Upper Primary Mathematics Teachers (Hameed & Asha, 2013)*

In the present study the semi-structured interview schedule was employed to a selected sample of Upper Primary Mathematics teachers to obtain the background of the prevailing system of pedagogic transaction in Mathematics. The focus areas were:

- To understand the prevailing strategies adopted or experimented in teaching Mathematics at Upper Primary Level.
- The constraints experienced by teachers, if any, in implementing these strategies for Upper Primary Mathematics students.
- Suggestions to overcome the constraints, if any, and alternative measures to be taken.

To get information regarding the above aspects, a semi-structured interview schedule was prepared to give free expression of the respondent’s views on the thrust areas. An initial draft of the schedule with eight items was
prepared on the basis of exploration of material resources. It was given to the experts for further suggestions and modifications. Based on their suggestions, the schedule was modified with five questions in open-ended form.

A copy of the Semi Structure Interview schedule is attached in Appendix A.

**Phase II - Experimental Phase**

Before the experimental process, Pre Experimental status in terms of Mathematics and Self Efficacy were measured for two Experimental Groups and Control Group.

Experimental treatments were conducted to Experimental group I with Brain Based Learning Strategy and Experimental group II with Circles of Learning Strategy. Control group was taught using the prevailing Activity Oriented Method of Teaching. After the treatments, post tests for Achievement in Mathematics and Self Efficacy was conducted.

Other data for Learning Styles, Verbal Intelligence, Non Verbal Intelligence, Classroom Environment and Socio Economic Status were collected during this phase.

*Lesson Transcript for Brain Based Learning Strategy (Hameed & Asha, 2014).*

The investigator prepared Lesson Transcripts for Brain Based Learning Strategy for the selected chapters from VII standard Mathematics text book of Kerala syllabus. The chapters selected for the treatment were divided into 20 sub units. The topics selected and the specific objectives set for each learning unit were the same for the two Experimental groups and the Control group.
Lesson Transcripts for Brain Based Learning Strategy is developed by the investigator for treatment in the Experimental Group I. Brain-based research demonstrates that, in order for teachers to have the fullest impact on their students, they must connect with students on two separate but overlapping levels: academic (content at grade level) and emotional (effective interpersonal interactions). In both cases, these connections have a neurological foundation that involves making new neural connections, strengthening existing neural connections, and creating neural networks, sometimes referred to as neural superhighways (Connell, 2005). The seven staged Brain based lesson planning outlined by (Jensen, 2008) are as follows:

a) **Pre-Exposure.**

This phase provides the brain with an overview of the new learning before really digging into the concept. Pre-exposure helps the brain develop better conceptual maps.

b) **Preparation.**

This is the phase where the learner create the curiosity or the excitement. In this, the teacher provides the context for the learning process.

c) **Initiation and Acquisition**

This is the stage of immersion. Instead of flooding with content a varied way is practised. One bite at a time presentation, provide an initial virtual overload of ideas, details, complexity and meanings. It allows a sense of temporary overwhelm to occur in learners. This will be followed by anticipation, curiosity and determination to discover meaning for one self. Over time it all gets sorted out by the learner. It is like the real world outside the classroom.
d) **Elaboration.**

This is the process stage. It requires genuine thinking on the part of the learner. This is the time to make intellectual sense of the learning.

e) **Incubation and Memory Encoding.**

This phase emphasises the importance of down time and review time. The brain learns most effectively over time, not all at once.

f) **Verification and confidence check.**

This phase is not just for the benefit of the teacher. Learners need to confirm their learning for themselves, as well. Learning is best remembered when the student possesses a model or metaphor regarding the new concepts and materials.

g) **Celebration and Integration.**

In this celebration phase, it is critical to engage emotions. Make it fun, light and joyful. This step insists the importance for love of learning.

Model Lesson Transcript for Brain Based Learning Strategy with detailed description in English is given as Appendix B.

**Lesson Transcripts for Circles of Learning Strategy of Cooperative Learning (Hameed & Asha, 2014).**

The investigator prepared Lesson Transcripts for Cooperative Learning Strategy, following the steps proposed by Johnson and Johnson (2002) for their Circles of Learning model. Three topics from VII standard Mathematics text book of Kerala syllabus were selected for the treatment and these were divided into 20 sub units.
Essential components of Cooperative Learning are positive interdependence; face to face promotive interaction, individual accountability, and interpersonal and small group skills. In cooperative learning situations the teacher forms learning groups, teaches basic concepts and strategies, monitors how the learning groups function, intervenes to teach small group skills, provide task assistance when needed, evaluates students’ learning using a criterion-referenced system, and ensures the group that groups process how effectively members worked together. Students look to their peers for assistance, feedback, reinforcement, and support.

This Circles of Learning Strategy works in six stages. These steps are discussed as follows (Johnson, Johnson, & Holubec, 1994).

a) Specifying the instructional objectives.

Teachers must specify both academic and social skill objectives at the correct level for the students and matched to the right level of instruction according to a conceptual or task analysis.

b) Making pre-instructional decisions.

In this stage, the teacher makes decision on the size of the group, assigning students to groups, arrangement of the room, choosing instructional materials and assigning roles to ensure interdependence.

c) Explaining the task and goal structure.

Teacher explains the academic task in this step. Along with this teacher explains the assignments and procedures to follow in completing the task.

d) Setting the cooperative lesson in motion.

As the groups work together, it’s the duty of the teacher to monitor the students at work and intervene when necessary.
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e) Monitoring the effectiveness of cooperative learning groups and intervening as necessary.

In this stage teacher interacts more skilfully. Teacher should monitors student behavior, provides task assistance and intervene to teach social skills.

f) Evaluating learning and processing interaction.

In this final stage, teacher provides closure to the lesson by summarizing the major points. At the end, the students should be able to summarize what they have learned and understand how they will use it in future lessons. Then the Teacher evaluates the quality and quantity of students learning and how well the group has functioned.

The Seating Arrangement.

Johnson and Johnson (1975) have suggested a clear out line for the type of seating arrangement to be used in the classroom to facilitate cooperation among Students. In a Cooperative Learning situation, the seating arrangement has to be organised in accordance with students’ access to students, to other groups, to the teacher and learning materials. Research on Cooperative Learning in elementary schools has found that its effectiveness depends on how it is organised (Slavin, 1988). Teaching and Learning can be powerfully influenced by the classroom organisation especially in the primary level (Cohen, Manion, & Morrison, 1996).
An English version of the Model Lesson Transcript on Circles of Learning Strategy is presented as Appendix C.

Lesson Transcript for Activity Oriented Method of Teaching (Hameed & Asha, 2014).

Activity Oriented Method of Teaching is a technique adopted by a teacher to emphasize his or her method of teaching through activity in which the students participate rigorously and bring about efficient learning experiences. It is a child-centered approach. It is a method in which the child is actively involved in participating mentally and physically. Learning by doing is the main focus in this method. Learning by doing is imperative in successful learning since it is well proved that more the senses are stimulated, more a person learns and longer he/she retains. Pine (1989) mentions that in an activity based teaching, learners willingly with enthusiasm internalize and

Figure 1. Seating Arrangement for the Circles of Learning Strategy
implement concepts relevant to their needs. So our understanding on the activity method by now should mean any learning that is carried out with a purpose in a social environment, involving physical and mental action, stimulating for creative action or expression.

Kerala Curriculum Framework (KCF, 2007) reports, “Activity-Based Learning is not a point of debate that learning is activity-based. What we hear, we forget. We may remember what we see. But when we do something, we understand it fully. But there is every chance to conclude that activities like playing, songs, dramatisation, experiments in which the learners’ physical participation is needed alone can be termed as activities”. The problem of such an attitude is that activities are taken up for the sake of activities. A good learning activity has to:

- help in forming concepts and developing skills
- ensure participation of all
- motivate the cognitive development of the child
- be planned so that the learner must feel it enjoyable and challenging
- be suitable to the age and nature of the learner.

Apart from this, due representation should be given to content and the learning points to be conveyed. One model Lesson Transcript in English version is presented in Appendix D.

*Achievement Test in Mathematics – ATM (Hameed & Asha, 2014)*.

This test is meant to measure the entry behaviour and terminal behaviour of the students in terms of Achievement in Mathematics (Total and Objective wise). The test is constructed by the investigator, on the topics selected for treatment, as explained earlier. The test is based on the Revised Blooms Taxonomy of Educational Objectives suggested by Anderson, Krathwohl, and Bloom (2001). In the present study, this test was used as the
Pretest and Posttest. The procedure followed for the construction of the Achievement Test in Mathematics is described in the following sections.

Planning of the test.

In this stage, the investigator studied thoroughly the curriculum, syllabus, hand book for teachers and text book of Mathematics for standard VII students for the academic year 2015-2016. Apart from Text book, the investigator made use of available source books for framing the items for the test. Educational Measurement and Evaluation (Nunnally, 1972) and Taxonomy of Educational Objectives (Bloom, 1979) were used for reference purpose.

For guidance, the investigator consulted with subject experts and experienced teachers in Mathematics. For the Achievement Test, the investigator planned to prepare a test consists of 60 items for a time duration of one hour.

Preparation of the test.

Items for the Achievement Test in Mathematics were prepared on the basis of the major objectives of cognitive domains as per the Revised Blooms Taxonomy namely Remembering, Understanding, Applying, Analysing, Creating and Evaluating. When the test was prepared, due weightage was given to objectives, content and difficulty level of items.

a) Weightage to Objectives.

The weightage given to different objectives for the Achievement Test in Mathematics is given in the Table 3.
Table 3

*Weightage to Objectives*

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Objectives</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Remembering</td>
<td>4</td>
<td>6.66</td>
</tr>
<tr>
<td>2</td>
<td>Understanding</td>
<td>13</td>
<td>21.66</td>
</tr>
<tr>
<td>3</td>
<td>Applying</td>
<td>17</td>
<td>28.33</td>
</tr>
<tr>
<td>4</td>
<td>Analysing</td>
<td>18</td>
<td>30</td>
</tr>
<tr>
<td>5</td>
<td>Creating</td>
<td>4</td>
<td>6.66</td>
</tr>
<tr>
<td>6</td>
<td>Evaluating</td>
<td>4</td>
<td>6.66</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>60</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

b) *Weightage to Content.*

The investigator analysed and divided the entire content into three units and tried to give adequate weightage to each units. The weightage given to each sub unit is given in Table 4.

Table 4

*Weightage to Content*

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Units &amp; Subunits</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Unchanging Relations</td>
<td>27</td>
<td>45</td>
</tr>
<tr>
<td>2</td>
<td>Repeated Multiplication</td>
<td>29</td>
<td>48.3</td>
</tr>
<tr>
<td>3</td>
<td>Area of a Triangle</td>
<td>4</td>
<td>6.7</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>60</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
c) **Weightage to Difficulty Level.**

Weightage given to the difficulty level is presented in the following table. Marks allotted for easy, average and difficult questions are presented in Table 5.

**Table 5**

*Weightage to Difficulty Level*

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Difficulty Level</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Easy</td>
<td>16</td>
<td>26</td>
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<tr>
<td>2.</td>
<td>Average</td>
<td>33</td>
<td>56</td>
</tr>
<tr>
<td>3.</td>
<td>Difficult</td>
<td>11</td>
<td>18</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>60</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

**d) Blue Print.**

The investigator prepared a blue print for the final test based on the weightage given to the Instructional Objectives, Content and Difficulty Level. The blue print for the Achievement Test in Mathematics incorporating weightages given to instructional objectives and content area is presented in Table 6.
Table 6  
*Blue Print for Achievement Test in Mathematics*

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Remembering</th>
<th>Understanding</th>
<th>Applying</th>
<th>Analysing</th>
<th>Creating</th>
<th>Evaluating</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Form of Questions</strong></td>
<td><strong>Objective</strong></td>
<td><strong>Objective</strong></td>
<td><strong>Objective</strong></td>
<td><strong>Objective</strong></td>
<td><strong>Objective</strong></td>
<td><strong>Objective</strong></td>
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<tr>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unchanging Relations</td>
<td>1(2)</td>
<td>1(11)</td>
<td>1(10)</td>
<td>1(3)</td>
<td>1(1)</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Repeated Multiplication</td>
<td>1(4)</td>
<td>1(10)</td>
<td>1(4)</td>
<td>1(7)</td>
<td>1(1)</td>
<td>1(3)</td>
<td>29</td>
</tr>
<tr>
<td>Area of a Triangle</td>
<td>1(1)</td>
<td>1(2)</td>
<td>1(1)</td>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>4</td>
<td>13</td>
<td>17</td>
<td>18</td>
<td>4</td>
<td>4</td>
<td>60</td>
</tr>
</tbody>
</table>

Note: All questions carry one mark, number of questions is mentioned inside the bracket.
The Try out.

The draft test with 82 multiple choice items was tried out by the investigator on a representative sample of 135 students in three class divisions of standard VII in a school other than the Experimental and Control subjects were selected. Before the administration of the test, the purpose of the test was made clear to the subjects. The draft test materials and response sheets in sufficient numbers were provided to the students. The test included all the necessary guidelines about the test and additional information needed were given by the investigator. All the 135 response sheets were scored as per the scoring key. Incomplete response sheets were deleted and 122 response sheets were selected for item analysis.

Item Analysis.

The procedure suggested by Ebel and Frisbie (1991) was employed for item analysis. The selected response sheets were arranged in the descending order of the magnitude of scores. The scores obtained by the upper 33 subjects (27%) and lower 33 subjects (27%) were taken as the upper group and lower group respectively. For the selection of the items in the final test, the difficulty index and discriminating power of each item were found out.

a) Difficulty Index.

The difficulty index of an item was considered as the percentage of the group to which the subjects have given the correct response, that is, the larger the index, the easier the item. The following formula suggested by Ebel and Frisbie (1991) was employed to calculate the difficulty index of each item.
Difficulty Index = \( \frac{U+L}{2N} \)

where

U - The number of correct responses in the upper group
L - The number of correct responses in the lower group
N - The number of subjects in each group.

\[b) \] Discriminating Power.

The higher the average discrimination index for items in a test, the more variable the scores are likely to be and the more reliable the scores are expected to be (Ebel & Frisbie, 1991). Formula used for calculating the discriminating power of each item is as follows.

\[
\text{Discriminating Power} = \frac{U-L}{N}
\]

where,

U - The number of correct responses in the upper group
L - The number of correct responses in the lower group
N - The number of subjects in each group.

The difficulty index and discriminating power of each item are given in Table 7.
Table 7

*Difficulty Index and Discriminating Power of Items in the Achievement Test in Mathematics*

<table>
<thead>
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<th>Di</th>
<th>Dp</th>
<th>Selected Item</th>
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<th>Dp</th>
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</tbody>
</table>
### Draft of the Achievement Test in Mathematics-ATM (English Version)

The investigator decided to select from the total items of draft test having discriminating power more than 0.4 and difficulty index between 0.4 and 0.6 initially. The investigator has also considered some items having the difficulty index in between 0.40 and 0.65. Thus the investigator prepared the final test with 60 multiple choice items selected from the draft test. The time duration fixed for the test was one hour and the maximum score of the test was 60 marks.

<table>
<thead>
<tr>
<th>Item No</th>
<th>U</th>
<th>L</th>
<th>Di</th>
<th>Dp</th>
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<th>Dp</th>
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- U - The number of correct responses in the upper group; L - The number of correct responses in the lower group, Di - Difficulty Index, Dp – Discriminating power
Validity of the test.

For estimating the validity of the Achievement Test in Mathematics, Criterion Related Technique was used. For this purpose, the final test was administered on the students of two class divisions of standard VII from a school other than the Experimental and Control subjects were selected. The obtained response sheets were collected and scored. The marks obtained by the same sample in the second terminal examination in Mathematics were also collected. Then, using the Pearson's Product Moment Correlation, coefficient of the two sets of scores was calculated. The validity coefficient obtained was found to be 0.81. It suggests that this test is a highly valid one to measure the Achievement in Mathematics of standard VII Students.

a) Content Validity.

As the name indicates, this form of validity is estimated by evaluating the relevance of the test item individually and as a whole (Freeman, 1976). Content validity is most appropriately applied only to tests of proficiency and Academic Achievement. This type of test is designed to measure how well the individual has mastered a specific skill or course of study. For establishing the content validity of the Achievement Test, the investigator subjected the test items for experts' evaluation. As per the evaluation of the experts, the test content covers the significant concepts and comprehensive enough in terms of the instructional objectives. Thus, the content validity of the Achievement Test in Mathematics was established.

b) Face Validity.

To establish the face validity, items of the Achievement Test was subjected to experts' evaluation. The experts confirmed that the items in the Achievement Test were able to measure Achievement in Mathematics of standard VII Students.
Reliability of the Test.

Reliability of the Achievement Test was established using Test Retest Method. The same test was again administered on the same sample, from whom the data obtained for validation, after a period of three weeks. Thus two sets of scores, the original score and the retest scores, were obtained. The correlation coefficient of the two sets of scores was calculated using the Pearson's Product Moment formula. The coefficient of correlation was found to be 0.85. The obtained values for validity and reliability suggest that the test has acceptable psychometric qualities to measure the Achievement in Mathematics of standard VII Students. A copy of the final test of Achievement Test in Mathematics (English Version), Response sheet and its Scoring Key are given in Appendices H, I and J.

Learning Styles Inventory –LSI (Hameed & Meharunnisa, 2014).

Learning Styles differ from person to person. In the experiment researcher decided to use the Learning Styles Inventory developed by Hameed and Meharunnisa, (2014) which include Visual Auditory and Kinesthetic (VAK) structure of Learning Styles. It is a three point scale with 73 items in the draft and 52 items in final scale, Items in the Scale was developed on the basis of classification followed by Dunn & Dunn model of Learning Style (1999), Fleming & Mills (1992) and Reid (1987). Each statement consisted of three choices of response viz., ‘Always’, ‘Sometimes’ and ‘Never’ which were rated as 3, 2 and 1 respectively for positive items and in the reverse order for negative items.

This Inventory is used to identify the individual’s preferred Learning styles used in different situation related to learning. Three main types of learning styles used in this tool are Visual Style, Auditory Style and Kinesthetic Style.
Statements under each category are framed according to the characteristics of each Learning Style. This inventory consists of total 52 statements containing 14 from Visual, 17 from Auditory and 21 from Kinesthetic Learning Style. LSI has ensured the validity of 0.69 and reliability of 0.76 by the authors. The response sheet is given in Appendix K.

*Scale of Self-Efficacy (Hameed & Nitha, 2014).*

Bandura developed (1977; 1986), the concept of Self Efficacy which refers to learners’ beliefs about their ability to accomplish certain tasks. It is a key concept of Social Cognitive theory. Scale of Self Efficacy was used to measure students’ problem-solving ability, dealing with day to day learning-related tasks and to meet others expectation. Hence to find the effect of Instructional Strategies and Learning Styles of Self Efficacy, the investigator used this Scale on Self Efficacy. This tool was constructed on the four major aspects like Social Self Efficacy, Self Efficacy for Self Learning, Self Efficacy for Achievement, Self Efficacy to meet others’ expectation.

These dimensions deal with students’ efficacy to meet expectations of one self, parent, teachers and peers. The summated scores of all the 32 items (statements) provide the total score for a student. The authors have ensured the face validity and reliability was found to be 0.87.

A copy of the English version of the Scale of Self-Efficacy is given in Appendix L.

*Verbal Group Test of Intelligence - VGTI (Kumar, Hameed, & Prasanna, 1997).*

For the study, the Verbal Intelligence was measured using the Verbal Group Test of Intelligence (VGTI) developed by Kumar, Hameed, & Prasanna (1997). The test consists of five sub tests of twenty multiple choice
Methodology

127 items (Totally 100 items) belong to five components namely Verbal Analogy, Verbal classification, Numerical Reasoning, Verbal Reasoning and Comprehension, that could be completed by not more than one hour of time for the subjects having the age group of 10-15 years. Maximum score was 100 and minimum, zero. A composite score attained for the five sub tests is treated as the subjects' score of Verbal Intelligence.

Validity of the VGTI.

Test constructors established its validity using criterion related technique. Kerala University Verbal Group Test of Intelligence (Nair, Pillai, & Amma, 1968) was used as the external criterion. The obtained validity coefficients of Verbal Analogy, Verbal Classification, Numerical Reasoning, Verbal Reasoning, Comprehension and Intelligence-Total are respectively 0.54, 0.54, 0.52, 0.40, 0.46 and 0.65 and it possesses high level of content validity as reported by the test constructors.

Reliability of the VGTI.

Test constructors established its reliability using the Split-half Method and the reliability coefficient was corrected using Spearman Brown Prophecy formula. The reliability coefficients of Verbal Analogy, Verbal Classification, Numerical Reasoning, Verbal Reasoning, Comprehension and Intelligence-Total are respectively 0.66, 0.56, 0.72, 0.63, 0.47 and 0.82 which are found significant. A copy of the Response Sheet is attached as Appendix M.


Non-Verbal Intelligence of the subjects was measured by administering the standard form of the Raven's Progressive Matrices Test (Raven, 1958). This test of intelligence was used to estimate the subject's ability to discern and utilize a logical relationship presented by Non-Verbal
materials. The test consists of five subtests of twelve items each. In each item, a part of geometrical design is missing. Six or eight alternatives are given for each design. All those fit the missing part, but only one logically belongs to it. The test is a popular measure of the ‘g’ factor of intelligence.

Students could work quietly at their own speed. It was made sure that those who attended the test understand what they must do, and hence clarification related to the test was made in between. In the case of Standard Progressive Matrices, score is equal to the number of items answered correctly. Maximum score of each set is 12 as there are 12 problems. Therefore, the maximum total score is 60 as there are five sets. The test gives the following classification of the participants based on the performance on this test.

*Intellectually superior:*

When the subjects’ score lies at or above the 95\textsuperscript{th} percentile for his age group, they are considered as intellectually superior.

*Above average intellectual capacity:*

When the subjects’ score lies in the 25\textsuperscript{th} and the 75\textsuperscript{th} percentile, they are considered as average intellectual.

*Below average intellectual capacity:*

If the score lies below the 25\textsuperscript{th} percentile, they are considered as below intellectual.

The reliability coefficients as reported by Raven (1958), vary from 0.80 to 0.90. Validity of the test has been estimated in a variety of usual ways. When Stanford Binet Test was used as the criterion, correlation varied from 0.50 to 0.86.

A copy of the response sheet is given as Appendix N.
**Classroom Environment Inventory (CEI), (Aruna, Sureshan & Unnikrishnan 1998).**

This inventory is meant for assessing the Classroom Environment developed and standardized by Aruna, Sureshan & Unnikrishnan (1998). The Classroom Environment Inventory was mainly based on the dimensions in the Classroom Environment Instrument developed by Fraser & Fischer, (1982). The individual dimensions used for the construction of classroom Environment Inventory are Material Environment, Cohesiveness, Task orientation, Innovation, Participation, Teacher support, Personalization, Independence, Order and Organizations, Teacher Control, Friction and Competition.

The validity of the Inventory was estimated by Criterion Related Technique which was found to be 0.536. For finding the reliability of the inventory, Test-Retest Method was adopted and the reliability coefficient was found to be 0.859 as reported by the authors. Yes / No options are given as the response and score ‘1’ for Yes and ‘0’ for No response. A copy of the English version of the response sheet is given in Appendix O.

**General Data Sheet for Assessing Socio-Economic Status (SES).**

To assess the Socio-Economic Status of the subjects of two Experimental groups and the Control group, this General Data Sheet was used. In order to collect the information regarding Income, Education and Occupation of parents, six columns each for father and mother are included in the General Data Sheet. The sub divisions and weightage of three categories are mentioned in Table 8.
Table 8
Weightage given for Monthly Income of Parents, Parental Education and Parental Occupation

<table>
<thead>
<tr>
<th>Monthly Income Level of Parents</th>
<th>Weigh-</th>
<th>Parental Education</th>
<th>Weigh-</th>
<th>Parental Occupation</th>
<th>Weigh-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upto 5000</td>
<td>5</td>
<td>Not received formal schooling</td>
<td>5</td>
<td>Unemployed</td>
<td>5</td>
</tr>
<tr>
<td>5001-10000</td>
<td>10</td>
<td>Standard I - IV</td>
<td>10</td>
<td>Unskilled</td>
<td>10</td>
</tr>
<tr>
<td>10001-15000</td>
<td>15</td>
<td>Standard V - VII</td>
<td>15</td>
<td>Semi skilled</td>
<td>15</td>
</tr>
<tr>
<td>15001-20000</td>
<td>20</td>
<td>Standard VIII-X</td>
<td>20</td>
<td>Skilled</td>
<td>20</td>
</tr>
<tr>
<td>20001-25000</td>
<td>25</td>
<td>PDC/Plus Two, TTC</td>
<td>25</td>
<td>Semi Professional</td>
<td>25</td>
</tr>
<tr>
<td>Above 25000</td>
<td>30</td>
<td>BA/ BSc/ B Com</td>
<td>30</td>
<td>Professional</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MBBS/M Ed/Engg / MBA/ PhD/ CA</td>
<td>35</td>
<td>Highly Professional</td>
<td>35</td>
</tr>
</tbody>
</table>

An English Version of the General Data sheet is given as Appendix P.

Data Collection Procedure

The data collection was conducted in two phases. In the first phase, the investigator collected the data from a representative sample of Upper Primary Mathematics Teachers regarding the usage of prevailing instructional strategies through a Semi structured Interview Schedule prepared by the investigator Appendix I. Data were collected from 90 teachers from Malappuram (45) district and Kozhikode (45) district of Kerala. Data were collected within a period of two months.
Administration of the Pretests and Experimental Treatment.

In the second phase, before starting the experiment Achievement Test in Mathematics and Scale of Self Efficacy were administered in two Experimental groups and the Control group as Pre-tests to measure the Pre Experimental status in terms of Achievement in Mathematics and Self Efficacy and the response sheets were collected.

The Experimental treatment was done in two groups. Experimental group I was treated with Brain Based Learning Strategy and Experimental group II, with Circles of Learning strategy.

a) Experimental group I.

Brain based learning is a comprehensive approach to instruction based on how current research in neuroscience suggests our brain learns naturally. It is a Meta concept that includes eclectic mix of techniques. For the preparation of lesson transcript for Experimental group I, the seven staged Brain based lesson planning outlined by Jensen (2008) was used.

b) Experimental group II.

For treatment in Experimental Group II, Circles of Learning strategy of Cooperative Learning was used. Before starting the experimental treatment in this group, the seating arrangement of the classroom was changed from conventional type to horse-shoe pattern. This arrangement ensured better Inter-group, Intra-group and Student-Teacher interaction. The investigator has tried to make it sure that the classroom activities in the Experimental group II were developed through the six phases suggested by Johnson, Johnson, and Holubec (1994) as integrated in the Lesson Transcripts for Circles of Learning strategy.
In both the experimental treatments, the selected three topics were divided into 18 sub units. Thus 18 subunits were taught using 35 periods.

c) Control Group.

The nature of the classroom seating arrangement was not changed in the Control group. Activity Based learning Strategy was employed to teach the select topics. The topics selected for treatment, and the time duration were the same for the Experimental groups and Control groups.

Administration of the Post Tests

After the completion of the treatments, both the Post Tests on Achievement in Mathematics and Scale of Self Efficacy were administered on the Experimental groups I & II and the Control group as Post tests which were already used as Pretests to measure the pre experimental status. This test was again administered to measure the post-treatment status of the subjects in terms of Achievement in Mathematics and Self Efficacy.

The data on the other Control Variables, viz., Verbal Intelligence and Non-verbal Intelligence, Classroom Environment and Socio-Economic Status were collected from both the Experimental groups and Control groups.

Before the administration of the tests, their purpose was made clear to the students and all necessary guidelines were given to the subjects. While administering the standardised tests, the instructions given in the manuals were strictly followed and explained to the subjects before taking the tools. The investigator worked out some examples from each tool on the blackboard for better understanding. Uniform procedure was adopted for the Experimental Group I and II and the Control group. All tests were administered by the investigator personally.
Scoring and Consolidation of Data

Specific directions given in the respective test manuals were strictly followed for scoring the response sheets collected. Responses of upper Primary Mathematics Teachers collected using the Semi structured Interview was scored initially. After that response sheets of Achievement Test in Mathematics, Scale on Self Efficacy in Mathematics, Learning Styles Inventory, Verbal Intelligence, Non-Verbal Intelligence, Classroom Environment Inventory, and General Data Sheet for Socio-Economic Status were scored according to the scoring keys provided. Response sheets, which were correct in all respects, were only taken into consideration. Thus 120 standard VII students were obtained as the final sample for the study. After scoring the response sheets, the scores obtained in each tool were tabulated and consolidated separately for the Experimental group I & II and Control group.

The following break-up given in Table 9 the actual number of subjects included in the final sample.

Table 9

*Final Breakup of the Sample*

<table>
<thead>
<tr>
<th>Sample</th>
<th>Experimental Group I</th>
<th>Experimental Group II</th>
<th>Control Group</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>24</td>
<td>23</td>
<td>25</td>
<td>72</td>
</tr>
<tr>
<td>Girls</td>
<td>16</td>
<td>17</td>
<td>15</td>
<td>48</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>120</td>
</tr>
</tbody>
</table>
Statistical Techniques Used for Analysis

The present study demanded the use of the following statistical techniques.

Percentage analysis.

Percentage analysis was done to identify the prevailing strategies used in Upper Primary Classes, constraints in implementing these strategies and suggestive measures for Mathematics Teaching in Upper Primary Classes.

Basic Descriptive Statistics.

Basic Descriptive Statistics such as Mean, Median, Mode, Standard Deviation, Skewness and Kurtosis of each variable like Pretests and Posttest scores of Achievement in Mathematics (Total and Objective wise) and Self Efficacy in Mathematics, Verbal Intelligence, Non-Verbal Intelligence, Learning Styles, Socio Economic Status, and Classroom Environment were calculated. Descriptive Statistics were calculated for Total Sample, Boys and Girls separately. Nature of the distribution was identified using the measured descriptive statistics.

One Way ANOVA.

One Way ANOVA was used to compare the relevant variables between the Experimental Groups I & II and the Control group for the total Sample, Boys and Girls. This statistical technique was mainly used to test whether the Experimental groups I and II and the Control group differ in Achievement in Mathematics and Self Efficacy, Gain scores with regard to Achievement in Mathematics and Self Efficacy without controlling the effects of the Covariates such as Pre-Experimental Status in terms of Achievement in Mathematics and Self Efficacy, Verbal Intelligence, Nonverbal Intelligence, Classroom Environment and Socio Economic Status of the students. For a
visual examination of the Comparisons of the relevant variables between the three groups, graphical representation of the results is utilized.

**Two Way Analysis of Variance**

The main and interaction effects of two Independent Variables (Instructional Strategies and Learning Styles) on the Achievement in Mathematics (Total and Objective wise) and Self Efficacy were estimated using Two Way Analysis of Variance with 3 x 3 factorial design. Instructional Strategies were classified into Brain Based Learning Strategy, Circles of Learning Strategy and Activity Oriented Method of Teaching while Learning Styles were Visual Style, Auditory Style and Kinesthetic Style. Hence Two way ANOVA, with 3 x 3 Design including two Independent Variables at three levels, were used to analyse the data.

**Two Way Factorial Analysis of Covariance**

This statistical technique was utilised to examine the effectiveness of Brain Based Learning Strategy and Circles of Learning Strategy over the Activity Oriented Method of Teaching in terms of Achievement in Mathematics and Self efficacy for standard VII Students. Analysis of Covariance is a statistical technique used to control for the effects of one or more uncontrolled variables and permit thereby a valued evaluation of the outcomes of the experiment (Ferguson, 1971). This technique is applied when there are one or more correlated variables existed with the Dependent Variable. In the present study, the technique of ANCOVA is employed to statistically control the effect of the covariates Pre experimental Status in terms of Achievement in Mathematics, Self Efficacy, Verbal Intelligence, Non Verbal intelligence and Classroom Environment. It can control the effects of any of the Covariates on the Dependent Variable using ANCOVA. The significant F values were subjected to Scheffe’s test of post hoc comparison.
**Scheffe' Test of Post-hoc Comparison.**

Scheffe' Test of Post-hoc Comparison was used to compare the adjusted criterion means of the Experimental groups I & II and the Control group after ANCOVA procedure to determine the advantageous group (Scheffe', 1959). In One Way ANOVA also Scheffe' Test was used to compare the criterion means between the three groups of Instructional Strategies. Again Scheffe’ Test was utilized in Two Way ANOVA process

**Effect size.**

Effect Size is simply a way of quantifying the effectiveness of an intervention, relative to some comparison, and may therefore be said to be a true measure of the significance of the difference. It is an important tool in reporting and interpreting effectiveness (Coe, 2000). It is knowledgeable to find the effect size along with the significance. In the present study the effect size was found to study:

- How much is the effect of Brain Based Learning Strategy on Achievement in Mathematics and Self-Efficacy.
- How much is the effect of Circles of Learning Strategy on Achievement in Mathematics and Self-Efficacy.

Effect size is determined using the formula:

\[
\text{Cohen’s } d = \frac{\text{Mean of Experimental group} - \text{Mean of Control Group}}{\text{Standard Deviation of Control Group}}
\]

Coe, (2000) considers the interpretation result as

- 0 - 0.20 - implies weak effect
- 0.21- 0.50 - implies modest effect
- 0.51 –1.0 - implies moderate effect
- > 1 - implies strong effect
All the related statistical calculations were done using the SPSS package.

**Summary of the Procedure**

The whole procedure adopted for the experiment is summarised is presented in the form of a flow chart in Figure 2
Flow Chart showing the Summary of Procedure

Variables

Independent Variables
- Instructional Strategies
- Learning Styles

Dependent Variables
- Achievement in Mathematics
- Self Efficiency

Control Variables

Pre-experimental Status in terms of Achievement in
- Verbal Intelligence
- Non Verbal Intelligence

Selection of the Sample (Standard VII Students)

Selection of the Experimental Group I, Experimental Group II & Control Group

Selection of Topics for Treatment

Preparation of Lesson Transcripts for Brain Based Learning Strategy, Circles of Learning Strategy and Activity Oriented Method of Teaching

Tools Used
- Scale of Self Efficacy
- Learning Style Inventory
- Verbal Group Test of Intelligence
- Standard Progressive Matrices Test
- General Data Sheet
- Classroom Environment Inventory

Pre Tests

Experimental Group I (Brain based Learning Strategy)

Experimental Group II/Circles of Learning Strategy

Control Group (Activity Oriented Method of Teaching)

Experiment

Post Test
- Achievement in Mathematics
- Self Efficacy

Scoring & Consolidation

Analysis

One Way ANOVA
- Effect Size
2 Way ANOVA
- ANCOVA
- Scheffe's Test of Post hoc Comparison

Results & Interpretation

Figure 2: Flow Chart showing the Summary of Procedure