Method of Study
A theoretical framework of variables, significance of problem, development and description of various tools had been discussed in previous chapters. The present chapter deals with method of study, which focuses around the tools used, the samples, design of the study, procedure and statistical techniques used for data analysis.

**TOOLS USED**

1. Computer based Mastery learning packages (Developed and Validated by the Investigator).
2. Entry Behavior Test (Developed and Validated by the Investigator).
3. Formative Test (Developed and Validated by the Investigator).
4. Criterion Test (Developed and Validated by the Investigator).
6. A Study process Questionnaire (Developed by Biggs).
7. Computer Knowledge Test (Developed and Validated by the investigator).

**SAMPLE**

Sampling is an important aspect of life in general and enquiry in particular. On the basis of fragmentary evidence, judgments are made about people, places & things (Garette, 1966; 1981; Edwards, 1968; Smith, 1975). The adequacy of a sample i.e. its lack of bias, depends upon our knowledge of population as well as method used in drawing the sample. Population refers to all cases under investigation and a sample is an actual subset of observations drawn at random from a population. A population is the theoretical set of all possible observations for a particular experiment (Calfee, 1975). If the observations are numbers, then
the population is described by the distribution function of the observations, which gives the probability of the occurrence for each possible numerical value. In statistical terminology, the items that make up a test constitute a sample from a much larger collection, or population of items that might have been used in that test (Ebel & Frisbie, 1991).

The sample thus can be described by a distribution of proportions propelling the distribution of function. The sampling distribution is the result of repeating a sampling operation many times with a fixed sample size & calculating a statistic which gives us a way of relating sample estimate to population parameter. It provides a way of determining the significance level of given result under the null hypothesis (Garrett, 1966; 1981; Ebel & Frisbie, 1991).

The size of population places on upper limit on the size of sample that can be drawn from it (Eble & Frisbie, 1991). The larger the population the most likely it is to be heterogenous i.e. include diverse and semi-independent areas of knowledge or ability. In order to achieve equally accurate results, a some what larger sample is required in a heterogenous domain than in a homogenous domain (Robson, 1996). A large sample will always yield a sample statistics closer to the population parameter than a more limited sample (Garrett, 1966; 1981). The larger the sample, the smaller the sampling errors & such errors are not caused by mistakes in sampling (Ebel & Frisbie, 1991).

A sampling procedure is representative if every sub class eventually occurs with same proportion in the sample as in the general population (Garrett, 1966). In probability sampling, statistical inference about the population can be made from respondents of samples. It is therefore, referred to as representative sampling where the sample is taken as a representative of population (Robson, 1996).

Various techniques have been devised for obtaining a sample, which are representative of its population. Most commonly used sampling techniques are:
Method of Study

- Random Sampling
- Stratified or Quota sampling
- Incidental Sampling
- Purposive Sampling

**RANDOM SAMPLING**

Random sampling means relying upon a certain technique of selection to provide an unbiased cross section from the larger group or population. It involves selection of the required number of person or cases from the sample. Random selection assures that the observations will be representative of performance of appropriate reference group and free of systematic bias. In random sampling, selection of the subjects is done in such a way that every subject in population is equally likely to be selected & assigned to a particular experimental group.

So Random Sampling:

1. Yields samples that are representative of population and that are free of systematic bias.

2. Avoidance of systematically bias, which generally occur when there is a non random selection procedure.

3. Ensures that for any sample of subjects there is no bias in assigning any person to any particular treatment group.

The criteria for randomness are met when:

1. Every individual in the population or supply has the same chance of being chosen for the sample.

2. The selection of one individual or thing in no way influences the choice of another.

Thus, randomness in a sample is assured when we draw similar and well shaken
Method of Study

up slips out of a hat or numbers in a lottery or a hand from a carefully shuffled deck of cards.

STRATIFIED SAMPLING

It is a technique designed to ensure representative and avoid bias by use of modified random sampling method. It is applicable when the population is composed of sub-groups / strata of different sizes so that a representative sample must contain individuals drawn from each category or stratum in accordance with the sizes of the sub groups. Within each stratum or sub-group, the sampling is random or as nearly as possible. It involves dividing the population into a number of groups or strata where members of a particular group share a particular characteristic. Stratum A, may be females & stratum B, males of the same age group say 10+ to 14+ years studying in IX grade.

INCIDENTAL SAMPLING

It is also referred to as accidental sampling. It is applied to those groups, which are used chiefly because they are easily or readily obtainable such as school children / college children, laboratory animals at all times in numbers and under conditions none of which may be of the experimenter’s choice.

PURPOSIVE SAMPLING

A sample, built up which enables the investigator to satisfy this specific needs in the project. The principal of selection in purposive sampling is the investigator’s judgment of typically of his interest. A sample may then be expressly chosen because in the light of available evidence. It mirrors some larger groups with reference to a given characteristics (Garrett 1966; 1981; Stodola and Storodahl; 1967).

Investigators following the Grounded Theory Approach (Glaser and Straus 1967; Strauss 1987; Robson, 1996) carry out initial sampling & from analysis of the results, extend the sample in ways guided by their emerging theory sometimes referred to as the theoretical sampling. Random sampling formulae apply more / less accurately to purposive samples (Garrett, 1966).
Method of Study

The sample in the present investigation was drawn at two levels

- The school Sample
- The Student Sample

**THE SCHOOL SAMPLE**

The School sample was drawn from representative secondary school of Batala (Distt. Gurdaspur) wherein the medium of instruction was English. A list of schools in the city Batala was procured from DEO’s office. To satisfy the real effort in experimental research, the logical statistical inferences of random sampling was initially employed. Following procedure was adopted for selecting schools. Name of schools were written down in separate sheets of papers of equal sizes. The names were folded and put into a box. The box was shaken up many times for easy shuffling. Another shuffling was done by hand as in the form of lottery. Then, the investigator draw out the slips one by one bearing name of each school. The principals of these school were approached. None of the Principal of these schools objected to conduct this research experiment. Rather, they welcomed the investigator. The names of schools along with number of students selected for the experiment have been listed in the table.

**Table 3.1**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of the school</th>
<th>Initial Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>R.D.Khosla D.A.V Model Senior Secondary School</td>
<td>197</td>
</tr>
<tr>
<td>2</td>
<td>D.A.V Centenary Senior Secondary School</td>
<td>186</td>
</tr>
<tr>
<td>3</td>
<td>Des Raj DAV Senior Secondary School</td>
<td>189</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>N = 572</strong></td>
</tr>
</tbody>
</table>
Method of Study

Following table 3.2 gives details of distribution of students in each school w.r.t. criteria of matching.

<table>
<thead>
<tr>
<th>Table 3.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution of Students in Schools w.r.t. Criteria of Matching</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>SPM</th>
<th></th>
<th></th>
<th>COMPUTER KNOWLEDGE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High</td>
<td>Average</td>
<td>Low</td>
<td>High</td>
<td>Average</td>
</tr>
<tr>
<td>School I</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>31</td>
<td>29</td>
</tr>
<tr>
<td>School II</td>
<td>32</td>
<td>28</td>
<td>29</td>
<td>30</td>
<td>31</td>
</tr>
<tr>
<td>School III</td>
<td>29</td>
<td>31</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>

These three schools were assessed on matching criteria of general background of the students, levels of intelligence (Through SPM) and their Computer Knowledge (Through Computer Knowledge Test). All these schools were found to be matching. Hence School I R.D.Khosla D.A.V Model Senior Secondary School was selected randomly for MLS1 group (MLS through computers). School II i.e. D.A.V Centenary Senior Secondary School was chosen for MLS 2 (MLS without computers) and Des Raj DAV Senior Secondary School was selected as Control Group and was taught through conventional group teaching by their own teacher.

- STUDENT SAMPLE

The initial student sample comprised of 572 students chosen from three randomly selected schools. 197 students were selected from R.D.Khosla D.A.V Model Senior Secondary School, 186 students were chosen from D.A.V Centenary Senior Secondary School and 189 students were taken from Des Raj DAV Senior Secondary School as shown in table 3.1. Intact sections were taken from each school. During the process of instruction, some students dropped out at
one stage or the other. The final sample comprised of N = 450 students as shown in the table 3.3.

Table 3.3
Final sample according to Instructional Treatment

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Instructional Treatment</th>
<th>No. of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MLS 1</td>
<td>150</td>
</tr>
<tr>
<td>2</td>
<td>MLS 2</td>
<td>150</td>
</tr>
<tr>
<td>3</td>
<td>CG</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>450</strong></td>
</tr>
</tbody>
</table>

Distribution of final sample according to Perseverance has been given in the following table 3.4.

Table 3.4
Distribution of Final Sample according to Perseverance

<table>
<thead>
<tr>
<th>Treatment Group</th>
<th>High Perseverance</th>
<th>Low Perseverance</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment I</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R.D.Khosla D.A.V Model Senior Secondary School</td>
<td>75</td>
<td>77</td>
<td>152</td>
</tr>
<tr>
<td>Treatment II</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D.A.V Centenary Senior Secondary School</td>
<td>75</td>
<td>73</td>
<td>148</td>
</tr>
<tr>
<td>Treatment III</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Des Raj DAV Senior Secondary School</td>
<td>75</td>
<td>75</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>225</strong></td>
<td><strong>225</strong></td>
</tr>
</tbody>
</table>

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Method of Study

Distribution of final sample according to Learning Approaches has been given in the following table 3.5.

Table 3.5
Distribution of Final Sample according to Learning Approaches

<table>
<thead>
<tr>
<th>Treatment Group</th>
<th>Deep Approach</th>
<th>Surface Approach</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment I</td>
<td>R.D.Khosla D.A.V Model Senior Secondary School</td>
<td>83</td>
<td>67</td>
</tr>
<tr>
<td>Treatment II</td>
<td>D.A.V Centenary Senior Secondary School</td>
<td>82</td>
<td>66</td>
</tr>
<tr>
<td>Treatment III</td>
<td>Des Raj DAV Senior Secondary School</td>
<td>85</td>
<td>67</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>250 200 450</td>
</tr>
</tbody>
</table>

In each combination cell for the three variables, the sample distribution was as follows:

Table 3.6
Distribution of Final Sample on the basis of Perseverance, Learning Approaches and Instructional Treatment

<table>
<thead>
<tr>
<th>School</th>
<th>High Perseverance</th>
<th>Low Perseverance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DA</td>
<td>SA</td>
</tr>
<tr>
<td>Treatment Group I R.D.Khosla D.A.V Model Senior Secondary School</td>
<td>39</td>
<td>36</td>
</tr>
<tr>
<td>Treatment Group II D.A.V Centenary Senior Secondary School</td>
<td>40</td>
<td>35</td>
</tr>
<tr>
<td>Treatment Group III Des Raj DAV Senior Secondary School</td>
<td>38</td>
<td>37</td>
</tr>
<tr>
<td>Total</td>
<td>117</td>
<td>108</td>
</tr>
</tbody>
</table>
DESIGN OF THE STUDY

A research design is the plan, structure and strategy of investigation to obtain answers to research problem and to control variance (Lindquist, 1956). The term ‘Experimental Design’ is used in Fisher Tradition; to state statistical principles underlying experimental designs and their analysis. It contain activities like procedure for selection of factors and their levels of manipulation, identification of extraneous variables that need to be controlled, procedures for handling experimental units, selection of criterion measure, selection of specific design and analysis of data (Brooker, 1999). The design is the general structure of experiment, not its specific content (Myers, 1980). The designer of an experiment has to do the planning of experiment so that the experiment, on completion fulfils the objectives of the research (Brooker, 1999).

The present study employed an experimental method with pre – test - post - test design. It employed a 3 x 2 x 2 factorial design wherein the data were analyzed through 3 x 2 x 2 ANOVA.

Instructional Strategy was treatment variable (independent) which was studied at three levels:

1.  Mastery Learning Strategy with computers (MLS 1)
2.  Mastery Learning Strategy without computers (MLS 2)
3.  Convention Group Learning (CGL)

Perseverance and Learning Approach were two independent variables. Both these independent variables were studied at two levels each i.e

Impact of these three independent variables was studied on achievement in Chemistry (achievement being the dependent variable). The schematic layout of design has been given below:
...Method of Study

The schematic layout of 3 x 2 x 2 design has been given below

Where MLS = Mastery Learning Strategy
HP = High Perseverance
LP = Low Perseverance
DA = Deep Approach
SA = Surface Approach
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However, a comparison was also done with Pooled MLS scores Vs. Conventional Group Learning by employing a 2 x 2 x 2 factorial design. The schematic layout of the 2 x 2 x 2 design has been given below:

CONTROLS FOR EXPERIMENT

Identification and control of relevant variables are two of the most critical tasks confronting most researchers (D’Amoto, 1970). Although, the controls known as potentially relevant variables is often not difficult to accomplish, their identification frequently requires insight and ingenuity (Church, 1964; Rescoria, 1967; Solomon & Lessac, 1968; Seligma, 1969). The reason, experimenter wishes to control known and potentially relevant variables is to avoid repetition and contamination (Seigma, 1969). The experimental research aims at to determine how independent variables of the study effect the dependent variables (D’Amoto, 1970). The measures falls into three control techniques:

- Matching
- Randomization
- Counterbalancing

In Matching techniques, Investigator controls the relevant variables for a particular experiment being investigated (Church, 1964; Scriven, 1967; D’Amoto, 1970). Counter balancing techniques on the other hand, can provide
Method of Study

either type of control i.e Equalization of effects of relevant variables in single experiment or over the long run (Rescorla, 1967).

In the present study, controls were exercised using these two control techniques:

- **Matching** of the group was one control where, groups were matched on all the relevant variables as intelligence and knowledge of computers. Since the experimenter could not administer the treatment exactly in the same period of time, there remained a gap of almost thirty days for each school. The limitations were overcome by employing a $2 \times 2 \times 2$ Anova on gain scores.

- **Randomization** was another control, which was exercised at two levels. One for the selection of school and two, for the allocation of student to various treatment groups.

**PROCEDURE**

Two main stages were adopted as the procedure of experiment

**Stage I** Selecting the Sample

**Stage II** Conducting the Experiment

**STAGE I SELECTING THE SAMPLE**

The sample was selected at two levels; School Level and Student Level. Three schools with $N = 450$ students were selected for conducting the Experiment

**STAGE 2 CONDUCTING THE EXPERIMENT**

It includes five phases

- Phase 1 Matching the groups
- Phase 2 Administration of Pre-Test
- Phase 3 Implementation of Instructional Programs
- Phase 4 Administration of Post-Test
- Phase 5 Scoring and Analysis of data.
Phase 1 Matching The Groups

Before implementation of Mastery Learning Strategy, the tools for matching the groups i.e. Test for Entry Behaviour, Standard Progressive Matrices and Computer Knowledge Test were administered. Entry Behaviour describes the behaviour, students must have acquired, before they can be instructed for a particular new terminal behaviour. It depicts the initial point where instruction must always begin and is different from terminal behaviour where the instruction concludes. The scores of Entry Behaviour Test, given to selected students, were used to determine whether or not students had adequate Entry Behaviour required for the instructional treatments.

Students were also matched on intelligence to know their level of intelligence for further treatment. Computer Knowledge was also checked as it is the pre-requisite for Mastery Learning Treatment I, where the students were supposed to work on MLS with computers.

School wise date schedule for test administration for pre testing of student is given in the following table.

Table 3.7
School-wise Date Schedule for Pre-testing of the Students

<table>
<thead>
<tr>
<th>Name of the School</th>
<th>EB Test</th>
<th>SPM</th>
<th>Test on Computer Knowledge</th>
<th>Scale of Perseverance</th>
<th>Learning Approach Questionnaire</th>
</tr>
</thead>
</table>
Method of Study

Phase 2  Administration of Pre-Test

Since the experiment employed a Pre-test – Post-test design, final analysis was done on achievement gain scores, in relation to Perseverance and Learning Approaches. Pre test was given to all the students of experimental and control groups. No time limit was imposed as to get an exact Pre experiment information regarding knowledge of students on topics to be taught through Mastery Learning Strategies. Scoring was done to obtain the pre-experiment information about the students.

Phase 3  Implementation Of Instructional Programs

In Mastery Learning Strategy, the acquisition of subject matter involves a chain of learning in a way that no single link could be broken out without all the subsequent links being lost (Torshen, 1977). Each student needs access to information appropriate for his own level, if he is to obtain a maximum benefit from the time he spends in school where instruction in basic skills and knowledge continues until he has developed adequate competence. Mastery Learning also believes that it is the task of the teacher to design his/her instruction so that all who can learn well, do learn well (Block, 1974). Bloom’s Mastery Learning Strategy as well as Keller’s Personalized System of Instruction have different advantages and what can do, Computer Assisted Instruction can also do the same. Computer assisted instruction was a technique, where computers act as a teacher to provide the students the same, what is required through curriculum. So two formats of Mastery Learning viz Mastery Learning with computers and Mastery Learning without computers was incorporated into Mastery Learning Strategy by the investigator.

One treatment group was taught through Mastery Learning Strategy with computers and was called as MLS - 1.

The second treatment group was taught through Mastery Learning Strategy without computers and was called as MLS - 2.
Method of Study

The control group was taught by their regular (Science) teacher in the conventional way.

Both the MLS1 and MLS2 were taught by investigator herself so that fine strategic differences could be taken care of. The sequence of events through these two combined strategies of mastery learning as well as conventional group learning was as follows:

For MLS - 1

Step 1 Students were motivated and encouraged to participate in ML experiment.
Step 2 Mastery learning packages were given to students. Through computers students were redirected to read more material, if they did not obtain mastery in the first attempt.
Step 3 Each lesson content was recapitulated and summarized at moderate intervals.
Step 4 Unit wise tests were administered at the end of each unit.
Step 5 Investigator herself taught the group following the guidelines developed in lessons.
Step 6 The time schedule for MLS1 was similar to MLS2

The sequence of instructional events followed was:

- **Instructions by the investigator:**
  Investigator had validated the instructional packages along with the formative tests for each unit. A final summative test has also been developed. Remedial and enrichment material had been also designed. The main concern of the investigator is now implementing the instructional packages. With a minor percentage of sample here and there, the students were uniformly distributed. To avoid contamination of effect of the treatment, it was decided that one instructional treatment be implemented to a specific group of students.
Method of Study

- **Sitting arrangement**
  The sitting arrangement was done according to the number of students. Each student was provided with a computer with instructional material in the computer lab itself.

- **Teacher activities**
  The investigator and regular computer teacher were the observers of the student's practice without any suggestions so that individualistic learning could be ensured.

- **Process of Instructional Treatment**
  - The investigator started with a brief orientation of the students by providing them with the initial guidance.
  - The students were informed of what they have to learn by acquainting with instructional objectives. They were detailed about expected learning outcomes in terms of behaviours to give them knowledge about how they have to demonstrate learning.
  - The teaching – learning process was introduced to explain how they have to learn. The students were provided all the required conditions for individualistic learning.
  - The investigator started with initial instructional process.
  - The students who finished with their work early than the others, they were asked to guide the other students. The students were also provided with enrichment material already prepared by the investigator to keep these students busy.

- **Administering Formative Tests**
  - The formative test was given to the students after unit I. the students were informed about their status and worked individually to learn hard spots again.
  - The scores of the students were recorded by the investigator herself. Depending upon the scores (if, acceptable level is achieved) the students were directed to go to next unit or read the unit again (if, acceptable level is not achieved).
The response sheets of the students were collected and kept with the investigator for further feedback to the students.

Investigator was supposed to impart the instructions, monitor the practice of the students, record the progress of the students after completion of each unit, provide feedback to the students accordingly, provide help whenever and wherever is needed.

For MLS - 2

The sequence of all the steps for this strategy was almost same as for MLS1 except that the content material was the same, but students had to learn it without the help of computer.

- **Instructions by the investigator:**
  Investigator had validated the instructional packages along with the formative tests for each unit. A final summative test has also been developed. Remedial and enrichment material had been also designed. The main concern of the investigator is now implementing the instructional packages. With a minor percentage of sample here and there, the students were uniformly distributed. To avoid contamination of effect of the treatment, it was decided that one instructional treatment be implemented to a specific group of students.

- **Sitting arrangement**
  The sitting arrangement was done according to the number of students. Each student was provided with instructional material in the computer lab itself.

- **Teacher activities**
  The investigator and regular computer teacher were the observers of the student’s practice without any suggestions so that individualistic learning could be ensured.

- **Process of Instructional Treatment**
  - The investigator started with a brief orientation of the students by providing them with the initial guidance.
  - The students were informed of what they have to learn by acquainting with instructional objectives. They were detailed about
expected learning outcomes in terms of behaviours to give them knowledge about how they have to demonstrate learning.

- The teaching – learning process was introduced to explain how they have to learn. The students were provided all the required conditions for individualistic learning.
- The investigator started with initial instructional process.

- The students who finished with their work early than the others, were asked to guide the other students. The students were also provided with enrichment material already prepared by the investigator to keep these students busy.

**Administering Formative Tests**

- The formative tests were given to the students after unit I. the students were informed about their status and worked individually to learn hard spots again.
- The response sheets of the students were collected and kept with the investigator for further feedback to the students.
- Investigator was supposed to impart the instructions, record the progress of the students after completion of each unit, provide feedback and help whenever and wherever is needed.

**For Control Group**

**Step 1** The control group was taught by their Science (Chemistry) teacher in the conventional way.

**Step 2** Objectives and content of Five lessons were provided to teacher of the control group.

**Step 3** No unit test was conducted after the completion of each unit.

**Step 4** Time schedule followed for this group was similar to that of other two groups.
Phase 4  Administration Of post-test

After completion of all the five units, the post test was administered to all the students. Answer sheets were scored. Time limit was 1:30 hour for 70 questions.

Phase 5  Scoring

All the tools were scored according to their prescribed keys and data was subjected to statistical analysis.

STATISTICAL ANALYSIS

Following statistical techniques were employed for the purpose of data analysis:

1. Graphical presentations- Bar diagrams, Line graphs, Frequency curves were drawn.

2. Descriptive Statistics like Mean, SD on Intelligence, SPM, Entry Behaviour, Perseverance, Learning Approaches and Computer Knowledge were done.

3. One way ANOVA on Entry Behaviour, SPM , Perseverance, Learning Approaches and Computer Knowledge scores was done.

4. Three way analysis of covariance to study the impact of instructional treatment on learning out comes was employed.

5. Significant F-ratios were followed by t-test.

The analyses of data have been reported in the following chapter.