CHAPTER 3

THE RESEARCH PLAN
CHAPTER 3

The Research Plan

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CHAPTER 3

The Research Plan

3.0 Introduction

Research is a systematic effort towards the solution of a problem and also a systematic activity directed towards discovery and development of an organized body of knowledge. Research is always directly or indirectly related to human welfare and because of that it is an unending quest in search of truth.

According to Best and Kahn (1) "Research may be defined as the systematic and objective analysis and recording of controlled observations that may lead to the development of generalizations, principles, or theories, resulting in prediction and possibly ultimate control of many events."

According to Jack R. Fraenkel and Norman E. Wallen (2) the term research means any sort of "careful, systematic, patient study and investigation in some field of knowledge, undertaken to discover or establish facts and principles."
Various research methods are used for various types of researches.

3.1 **Research Methods**

Research is categorized into three groups according to its purpose. The first is fundamental research, the second is applied research and the third is action research.

Present research is of applied type, and is educational research too. When the researcher was thinking of research, she went through many books related to research in education. She found that every book presents a different system of classification. This provides evidence that there is no generally accepted scheme. The system of classification is not important in it, but has value in making the analysis of research processes more comprehensible.

All research studies involve observation and description of what happens under certain specific situation. The simple three point analysis can be used to classify educational research as—historical research, experimental research and descriptive research. Practically every study falls under one or a combination of these research methods.

3.1.1 **Descriptive Research**

Descriptive type of research is concerned with processes that are going on; trends that are developing; effects that are being felt; conditions that exist; beliefs,
attitudes or point of views that are held; or practices that prevail. The process of descriptive research involves interpretation of the meaning or significance of what is described.

There are more than one methods or approaches to solve a problem. Which method is to be followed depends on the nature of the problem and the method followed determines the extent of reliability of findings, and the success of the researcher. So from the very beginning the researcher had been very particular to see that no loop-hole will be left in choosing methodology.

In present study the researcher has decided to follow the descriptive type for her work to fulfill the objectives of present research. She wanted to find out learning styles, achievement in science and attitude of students towards learning science, and relationship between learning style, attitude towards learning science and achievement in science of 9th standard students. Descriptive type research is helpful for doing all this, so the researcher decided to adopt it.

The researcher studied characteristics of descriptive research because she had to proceed on the same way.

**Characteristics of descriptive research:-**

- Descriptive research involves hypothesis formation and testing.
• It uses the logical method of inductive-deductive reasoning to come to the generalization.

• It often uses method of randomization; it helps in reducing error while inferring population characteristics from observation of samples.

• In this type of research the variables and procedures are described utmost correctly.

• This type of research deals with relationship between nonmanipulated variables in a nature rather than artificial setting.

Descriptive type of research can also be further classified into two; the first one is ‘quantitative descriptive research’ and the second one is ‘qualitative descriptive research’.

In present research, the researcher had to work on the marks on achievement test, scores on attitude scale and the learning styles. Also she had to find out relationship between them. It was necessary for her to use statistics for analysis and interpretation of the collected data, so quantitative descriptive type was preferred in the present study.

Though this method of study is termed, as descriptive research, some authors call it as ‘survey research’ or ‘normative survey’. The research which obtains data to determine specific characteristics of a group is called as
survey research. The term 'normative' means the
determinations of normal or typical conditions or practices.
Still one thing is clear that this method is useful in studying
the present status of the object. It is primarily concerned with
the present although it very often considers past incidents or
events and their influences as that are related to current
situations.

There are three kinds of descriptive studies. The first
is assessment, second is evaluation and the third is
descriptive research, of which only one is actually research.

The critical distinctions of these three methods are that
all types of studies have different purposes and, therefore,
they approach the problem differently. The main distinction
is only descriptive research studies lead to generalizations
beyond the sample or situation studied.

These studies are not used exclusively, that means two
types of studies can be used for a single research in
combination. In present research descriptive assessment is
employed.

This chapter reports the details of the method of the
study, including techniques of sample selection,
developments of the research tools, techniques used in data
collection and data analysis.
3.2 Sample

Generally, it is not possible to study the entire population in one research study. One reason of it is, when the population is very large it is not possible to contact every individual unit. And the another and important reason is, when dependable results can be obtained by studying a small portion of the population, then there is no need to work on the whole population. This saves wastage of time, money and efforts. By using inferential statistics one can draw inferences about larger populations on the basis of information obtained from smaller groups selected from the population.

To study the whole population is rather impracticable. The statistical process makes it possible to draw generalizations on the basis of observations of the small proportion of population called sampling. The sampling generally refers to the method of selecting a small part, of a large population of subjects, in order to study the characteristics of the whole population.

According to Best and Kahn (3) “A sample is a small proportion of a population selected for observation and analysis.”
The process of sample selection is called as sampling. According to Lokesh Koul (4) "sampling is the process by which a relatively smaller number of individuals or measures individuals, objects, or events is selected and analyzed in order to find out something about the entire population from which it is selected."

Sampling methods can be classified into two broad categories, one is non-probability sampling and the other is probability sampling. The researcher decided to go for probability sampling.

There are many English medium schools in Pune recognized by the State Education Department and affiliated to S.S.C. Board for the purpose of examination. The researcher decided the schools which were running CBSC and ICSE not to be included in the sample. English medium schools which were implementing Maharashtra State Secondary and Higher Secondary Board's syllabus were decided to be included in the sample.

From those schools it was decided to select 10 percent schools by way of employing simple random sampling method. It includes many techniques such as lottery method, random number table. The researcher decided to use the lottery method. Where names of all schools were to be written on a separate chit and placed in a container and blindfolded drawn one name at a time until the sample of 10
percent was to be selected and class 9 from each school was to be considered as a cluster.

From the remaining schools one school was to be selected by the same method for determination of the reliability of the tools prepared.

### 3.3 Tools for data collection

To carry out any type of research investigation, data collection is an essential part of procedure, without which one cannot test the hypothesis. There are many different tools, methods and procedures available to aid in acquisition of data. The researcher has to choose appropriate tool that will yield necessary kind of information that can be effectively used.

In descriptive research studies, tests are frequently used to describe existing conditions at the particular time. In school surveys, achievement tests are used extensively, because tests yield quantitative descriptions that helps in precise analysis.

In present research three tools were used for data collection—

(i) Actually two achievement tests were used, one for testing achievement on science-I and another for testing achievement on science-II. Both of them were prepared by the researcher.
(ii) Attitude scale to test attitude towards learning science, which is also prepared by the researcher herself.

(iii) Learning style inventory prepared by David A. Kolb from Boston.

3.1.1 Achievement test:

The researcher was interested in finding out the achievement of 9th standard students. Achievement is nothing but the change in a desired direction that results from learning. Achievement can occur at different levels and can be result of study system of student.

Achievement test is a very important test in the school evaluation. According to Downier, \(^{(5)}\) “any test that measures the attainment or accomplishments of an individual after a period of training or learning is called an achievement test.”

Good’s Dictionary \(^{(6)}\) defines, an achievement test “as a test designed to measure a person’s knowledge, skills, understandings, etc., in a given field taught in school.”

The International Dictionary of Education \(^{(7)}\) defines achievement test as “a test designed to measure the effects of specific teaching in an area of curriculum.”

Super, D. E. \(^{(8)}\) defines an achievement test as “a proficiency test to ascertain what and how much has been learnt and how well a task can be performed, the focus being on evaluation of the part without reference to the future.”
From the above-mentioned definitions it can be concluded that, a satisfactory achievement test in science is one which would give reliable evidence of the extent to which the learner had achieved the previously decided objectives of instruction.

There are two types of achievement tests in science, that are (i) teacher made tests and (ii) standardized tests. As standardized tests for the related topics of science-I and science-II were not available; the researcher had to prepare achievement tests of her own on the second term syllabus of science-I and science-II of 9th standard.

The teacher-made tests can further be categorized into (i) oral tests, (ii) written tests and (iii) practical tests. The tests used in present study were written tests. Written tests can be further classified into essay-type; short answer type and objective-type. Objective-type tests can be classified on the basis of their form; those are recall type, recognition type and others.

Each type of test has its own advantages and disadvantages. Considering the advantages of all these types of tests, the researcher decided to include all types of questions in tests.

There are many functions of achievement test, but in present study, the researcher was interested in knowing the state of attainment in science of students at that time,
because she was interested in finding out relation of achievement of students to that of their learning styles and attitude towards learning science.

The details of preparation of achievement tests by the researcher are given below.

**Preparation of achievement tests:-**

First of all the researcher referred material related to construction of a good achievement test, and found out steps involved in constructing an achievement test. Those steps are:

(i) Preparation of design
(ii) Preparation of a blueprint
(iii) Designing of questions
(iv) Editing the question paper
(v) Preparation of the scoring key and marking scheme
(vi) Item wise analysis of the paper.

The researcher followed the above-mentioned steps of construction of achievement test.

At the stage of preparation of a design for Achievement test on science - I, and science - II the researcher discussed with the teachers who were teaching science subject to 9th standard students, the second term syllabus. She found variation in the topics for second term
syllabus from school to school. But she found logic in selection of topics. In science - I first three chapters are of chemistry and fourth to ninth are of physics, and tenth chapter is of biology. So most of the schools had selected topics numbered third, seventh, eighth, ninth and tenth for second term syllabus, so as to cover all the three sciences. Even though there was variation, the researcher decided and set the achievement test on science - I on chapter number third, seventh, eighth, ninth and tenth.

Before setting of achievement tests the researcher discussed with school teachers, teaching science to 9th standard’s students, she had heard about new circular of Maharashtra State Secondary and Higher Secondary Board, Pune, about change in marking scheme of science. So she tried to get the circular, and after getting it she went through it. (The circular is attached in appendix ‘A’) Then she decided and framed achievement test for science - I and science - II of forty marks each. Before June the pattern of marks distribution was as follows.

Science - I written evaluation .................. 60 marks
Science - II written evaluation .................. 60 marks
Practical of both Science - I and Science - II... 30 marks
Total marks........................................ 150 marks
Total mark granted for science at 9th standard level was 150 and distribution of 150 was 60 + 60 + 30. But according to circular published on 18th of June 2005, from June 2005 onwards the subject science is of 100 marks only but there is no change in syllabus and the distribution of marks is as follows.

Science - I written evaluation ................. 40 marks
Science - II written evaluation ................. 40 marks
Practical of both Science - I and Science - II... 20 marks
Total marks....................................... 100 marks

Before the actual process of preparation of achievement test the researcher studied the format of question paper given in the circular which also included chapter wise, question wise and objective wise distribution of marks. Considering the instruction given in circular the researcher was ready to prepare achievement tests.

**Preparation of achievement test on science -I :-**

According to circular of Maharashtra State Secondary and Higher Secondary Board, Pune Marks provided for topics of science - I are given on the next page.
Table: 3.1 Topic wise distribution of marks for Science part-I

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>Topics</th>
<th>Marks</th>
<th>Marks with option</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Properties of Matter</td>
<td>03</td>
<td>05</td>
</tr>
<tr>
<td>2</td>
<td>Structure of Atom</td>
<td>05</td>
<td>08</td>
</tr>
<tr>
<td>3</td>
<td>Mass of an Atom</td>
<td>04</td>
<td>06</td>
</tr>
<tr>
<td>4</td>
<td>Motion</td>
<td>05</td>
<td>07</td>
</tr>
<tr>
<td>5</td>
<td>Equations of Motion</td>
<td>04</td>
<td>06</td>
</tr>
<tr>
<td>6</td>
<td>Force</td>
<td>04</td>
<td>06</td>
</tr>
<tr>
<td>7</td>
<td>Classification of Forces</td>
<td>03</td>
<td>05</td>
</tr>
<tr>
<td>8</td>
<td>Work and Energy</td>
<td>04</td>
<td>06</td>
</tr>
<tr>
<td>9</td>
<td>Heat</td>
<td>05</td>
<td>08</td>
</tr>
<tr>
<td>10</td>
<td>World of Work</td>
<td>03</td>
<td>03</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>40</td>
<td>60</td>
</tr>
</tbody>
</table>

Here 40 marks are allotted for ten topics, but the researcher had to prepare achievement test on five topics only, that is 3rd, and 8th to 10th only. The marks allotted to these five topics were 19 only. One mark was added to the topic ‘Heat’ (because it contains more concepts as compared to other topics) and it came 20, and in marks with options one mark was added to the topic ‘Heat’ and one mark to ‘World of work’ making it 30. She doubled the marks of all the topics. The table of topic wise mark distribution framed by the
researcher for science – I, and used it for preparation of achievement test was as shown below.

**Table: 3.2 Topic wise distribution of marks of second term syllabus of science - I**

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>Topic no. in text book</th>
<th>Topics</th>
<th>Marks</th>
<th>Marks with options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>Mass of an Atom</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>Classification of Forces</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>Work and Energy</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>9</td>
<td>Heat</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
<td>World of Work</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td>40</td>
<td>60</td>
</tr>
</tbody>
</table>

Selection of topics and topic wise mark distribution for preparation of achievement was completed.

For blue print content wise, question type wise and objective wise marks distribution is necessary, so it was done.
Table: 3.3  Content-wise distribution of marks

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>Content</th>
<th>Marks</th>
<th>Marks with options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mass of an Atom</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>2</td>
<td>Classification of Forces</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>Work and Energy</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>Heat</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>5</td>
<td>World of Work</td>
<td>6</td>
<td>08</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>40</td>
<td>60</td>
</tr>
</tbody>
</table>

Table: 3.4  Question type-wise distribution of marks

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>Type of question</th>
<th>Marks</th>
<th>Marks with options</th>
<th>% of marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Objective</td>
<td>08</td>
<td>08</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>Short answer</td>
<td>20</td>
<td>30</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>Essay</td>
<td>12</td>
<td>22</td>
<td>30</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>40</td>
<td>60</td>
<td>100</td>
</tr>
</tbody>
</table>

Table: 3.5  Objectives-wise distribution of marks

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>Objectives</th>
<th>Marks</th>
<th>Marks with options</th>
<th>% of marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Knowledge</td>
<td>12</td>
<td>16</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>Comprehension</td>
<td>14</td>
<td>22</td>
<td>35</td>
</tr>
<tr>
<td>3</td>
<td>Application</td>
<td>10</td>
<td>16</td>
<td>25</td>
</tr>
<tr>
<td>4</td>
<td>Skill</td>
<td>04</td>
<td>06</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>40</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>Unit No. &amp; name (Content)</td>
<td>Type of question</td>
<td>Knowledge</td>
<td>Comprehension</td>
<td>Objective Application</td>
</tr>
<tr>
<td>---------------------------</td>
<td>------------------</td>
<td>-----------</td>
<td>---------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>1- Mass of an Atom</td>
<td>Objective</td>
<td>1(2)</td>
<td></td>
<td>1(2),1(2)</td>
</tr>
<tr>
<td></td>
<td>Short answer</td>
<td>1(2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Essay</td>
<td></td>
<td>1(4)</td>
<td></td>
</tr>
<tr>
<td>2- Classification of Forces</td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Short answer</td>
<td>1(2)</td>
<td></td>
<td>1(2),1(2)</td>
</tr>
<tr>
<td></td>
<td>Essay</td>
<td></td>
<td>1(4)</td>
<td></td>
</tr>
<tr>
<td>3- Work and Energy</td>
<td>Objective</td>
<td>1(2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Short answer</td>
<td>1(2)</td>
<td>1(2)</td>
<td>1(2)</td>
</tr>
<tr>
<td></td>
<td>Essay</td>
<td></td>
<td>1(4)</td>
<td></td>
</tr>
</tbody>
</table>
Table 3.6 continued-

<table>
<thead>
<tr>
<th>Unit No. &amp; name (Content)</th>
<th>Type of question</th>
<th>Knowledge</th>
<th>Comprehension</th>
<th>Objective Application</th>
<th>Skill</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>4- Heat</td>
<td>Objective</td>
<td>1(2)</td>
<td></td>
<td>1(2),1(2)</td>
<td>1(2),1(2),1(2)</td>
<td>12 / 18</td>
</tr>
<tr>
<td></td>
<td>Short answer</td>
<td>1(2)</td>
<td>1(4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Essay</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5- World of Work</td>
<td>Objective</td>
<td>1(2)</td>
<td></td>
<td>1(2)</td>
<td></td>
<td>6 / 08</td>
</tr>
<tr>
<td></td>
<td>Short answer</td>
<td></td>
<td>1(4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Essay</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Marks</td>
<td></td>
<td>12 / 16</td>
<td>14 / 22</td>
<td>10 / 16</td>
<td>4 / 6</td>
<td>40 / 60</td>
</tr>
</tbody>
</table>

- Number out of bracket shows number of questions whereas numbers in the bracket shows marks of questions.
- Though the blue print was prepared for 60 marks, it included the marks of optional questions also (shown in pink colour). But the students had to solve the paper for 40 marks only (shown in blue colour).
According to blueprint the researcher prepared the Achievement test - I on Science - I, and got checked by experts. One teacher educator, who was teaching science content and method at a college of education and two school teachers, teaching science subject to 9th standard checked the achievement test. The researcher followed some valid suggestions of experts and finalized the test to use for measuring achievement in science of 9th standard students.

Content validity was established with the help of subject teachers. Reliability coefficient of the test was estimated by test-retest method. The reliability coefficient and index of reliability was as under.

**Table No. 3.7 Reliability of Achievement test 1**

<table>
<thead>
<tr>
<th>Achievement Test 1</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability Coefficient</td>
<td>0.865</td>
</tr>
<tr>
<td>Index of reliability</td>
<td>0.93</td>
</tr>
</tbody>
</table>

The final copy of achievement test - I, which was used to test achievement in science of 9th standard students, is attached in appendix ‘B’. To attain objectivity in assessing answer sheets, the researcher prepared scoring key of achievement Test - I, is also attached in appendix ‘B’.
Preparation of achievement test on science - II

Same criteria as used for selection of topics for achievement test on science-I, were used for achievement test on science - II, and decided to prepare and set the achievement test on chapter number third, eighth, ninth, tenth, eleventh and twelfth. Here in science - II, first three chapters are of chemistry and from fourth to twelfth are of biology. So chapter third of chemistry was included in the second term syllabus.

In science part - II there are twelve topics, out of which six topics are for second term, topic number third, eighth, ninth, tenth, eleventh and twelfth, are the six topics included in second term syllabus. Marks allotted to these topics by Maharashtra State Secondary and Higher Secondary Board, Pune. are shown below.

Table: 3.8 Topic wise distribution of marks for science part- II

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>Topics</th>
<th>Marks</th>
<th>Marks with option</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Formation of Compound</td>
<td>04</td>
<td>05</td>
</tr>
<tr>
<td>2</td>
<td>Chemical Reaction and Products</td>
<td>04</td>
<td>07</td>
</tr>
<tr>
<td>3</td>
<td>Types of Chemical Reaction</td>
<td>04</td>
<td>05</td>
</tr>
<tr>
<td>4</td>
<td>Classification of Plants</td>
<td>04</td>
<td>07</td>
</tr>
<tr>
<td>5</td>
<td>Classification of Animals</td>
<td>04</td>
<td>07</td>
</tr>
<tr>
<td>6</td>
<td>Habitat of Organisms</td>
<td>02</td>
<td>02</td>
</tr>
<tr>
<td>7</td>
<td>Adaptation</td>
<td>02</td>
<td>02</td>
</tr>
<tr>
<td>8</td>
<td>Organization of Organisms</td>
<td>04</td>
<td>07</td>
</tr>
<tr>
<td>9</td>
<td>Life Processes - I</td>
<td>04</td>
<td>07</td>
</tr>
<tr>
<td>10</td>
<td>Life Processes - II</td>
<td>04</td>
<td>07</td>
</tr>
<tr>
<td>11</td>
<td>Human Body</td>
<td>02</td>
<td>02</td>
</tr>
<tr>
<td>12</td>
<td>Increase in Food Yield</td>
<td>02</td>
<td>02</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>40</td>
<td>60</td>
</tr>
</tbody>
</table>
Total marks of topic number third, eighth, ninth, tenth, eleventh and twelfth are 20. So there was no need to make any change in it, only researcher had to double it so as to make 40 marks achievement test.

Table showing marks used for achievement test is shown below.

Table: 3.9 Topic-wise distribution of marks for second term syllabus of science part-II

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>Topic no. in textbook</th>
<th>Topics</th>
<th>Marks</th>
<th>Marks with options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>Types of Chemical Reaction</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td>Organization of Organisms</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>3</td>
<td>9</td>
<td>Life Processes - I</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>Life Processes - II</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>5</td>
<td>11</td>
<td>Human Body</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>12</td>
<td>Increase in Food Yield</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>40</td>
<td>60</td>
</tr>
</tbody>
</table>

Selection of topics and topic wise mark distribution for preparation of achievement was completed, and the researcher was in the stage of preparation of blue print.

For blue print content-wise, question type-wise and objective-wise distribution of marks had to be done, hence it was done accordingly which is presented on the next page.
Table: 3.10  
Content-wise distribution of marks

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>Content</th>
<th>Marks</th>
<th>Marks with options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Types of Chemical Reaction</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>Organization of Organisms</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>3</td>
<td>Life Processes – I</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>4</td>
<td>Life Processes - II</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>5</td>
<td>Human Body</td>
<td>4</td>
<td>04</td>
</tr>
<tr>
<td>6</td>
<td>Increase in Food Yield</td>
<td>4</td>
<td>04</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>40</strong></td>
<td><strong>60</strong></td>
</tr>
</tbody>
</table>

Table: 3.11  
Question type-wise distribution of marks

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>Type of question</th>
<th>Marks</th>
<th>Marks with options</th>
<th>% of marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Objective</td>
<td>08</td>
<td>08</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>Short answer</td>
<td>20</td>
<td>32</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>Essay</td>
<td>12</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>40</strong></td>
<td><strong>60</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Table: 3.12  
Objectives-wise distribution of marks

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>Objectives</th>
<th>Marks</th>
<th>Marks with options</th>
<th>% of marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Knowledge</td>
<td>12</td>
<td>16</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>Comprehension</td>
<td>14</td>
<td>22</td>
<td>35</td>
</tr>
<tr>
<td>3</td>
<td>Application</td>
<td>10</td>
<td>16</td>
<td>25</td>
</tr>
<tr>
<td>4</td>
<td>Skill</td>
<td>04</td>
<td>06</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>40</strong></td>
<td><strong>60</strong></td>
<td><strong>100</strong></td>
</tr>
<tr>
<td>Unit No. &amp; name (Content)</td>
<td>Type of question</td>
<td>Knowledge</td>
<td>Comprehension</td>
<td>Objective Application</td>
</tr>
<tr>
<td>--------------------------</td>
<td>------------------</td>
<td>-----------</td>
<td>---------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>1 - Types of Chemical Reaction</td>
<td>Objective</td>
<td>1(2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Short answer</td>
<td>1(2)</td>
<td>1(2), 1(2)</td>
<td>1(2)</td>
</tr>
<tr>
<td></td>
<td>Essay</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 - Organization of Organisms</td>
<td>Objective</td>
<td>1(2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Short answer</td>
<td>1(2)</td>
<td></td>
<td>1(2), 1(2)</td>
</tr>
<tr>
<td></td>
<td>Essay</td>
<td></td>
<td></td>
<td>1(4)</td>
</tr>
<tr>
<td>3 - Life Processes - I</td>
<td>Objective</td>
<td>1(2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Short answer</td>
<td>1(2)</td>
<td></td>
<td>1(2), 1(2)</td>
</tr>
<tr>
<td></td>
<td>Essay</td>
<td></td>
<td></td>
<td>1(4)</td>
</tr>
<tr>
<td>4 - Life Processes - II</td>
<td>Objective</td>
<td>1(2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Short answer</td>
<td>1(2)</td>
<td></td>
<td>1(2)</td>
</tr>
<tr>
<td></td>
<td>Essay</td>
<td></td>
<td></td>
<td>1(4)</td>
</tr>
</tbody>
</table>
Table 3.13 continued-

<table>
<thead>
<tr>
<th>Unit No. &amp; name (Content)</th>
<th>Type of question</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Knowledge</td>
</tr>
<tr>
<td>5 - Human Body</td>
<td>Objective</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Short answer</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Essay</td>
<td></td>
</tr>
<tr>
<td>6 - Increase in Food Yield</td>
<td>Objective</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Short answer</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Essay</td>
<td></td>
</tr>
</tbody>
</table>

- Number out of bracket shows number of questions whereas numbers in the bracket shows marks of questions.
- Though the blue print was prepared for 60 marks, it included the marks of optional questions also (shown in pink colour). But the students had to solve the paper for 40 marks only (shown in blue colour).
According to blueprint the researcher prepared the Achievement test - II on Science - II, and got checked by experts. One teacher educator, teaching science content and method at college of education and two school teachers, teaching science subject to 9th standard checked the achievement test. The researcher followed some valid suggestions of experts and finalized the test to use for measuring achievement in science of 9th standard students.

Content validity was established with the help of subject teachers in schools. Reliability coefficient of the test was estimated by test-retest method. The reliability coefficient and index of reliability was as under.

**Table No. 3.14 Reliability of Achievement test 2**

<table>
<thead>
<tr>
<th>Achievement Test 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability Coefficient</td>
<td>0.84</td>
</tr>
<tr>
<td>Index of reliability</td>
<td>0.92</td>
</tr>
</tbody>
</table>

The final copy of achievement test - II, which was used to test achievement in science of 9th standard students, is attached in appendix ‘C’. To attain objectivity in assessing answer sheets, the researcher prepared scoring key of achievement Test - II, is also attached in appendix ‘C’.
3.3.2 Attitude Scale:

Attitude is most common term in social science. Some of the scholars who had worked on attitude described it as a central problem in social psychology.

According to Thurstone an attitude is “the degree of positive or negative affect associated with some psychological object.”

To obtain a better understanding of the findings of research it is essential for a researcher to go through the ways in which they have been studied, so, in order to know the methods of assessment the researcher, went through the various ways of assessment of attitudes and found that, the methods of assessment of attitudes vary from the sociological surveys to psychological one. In social surveys the central tendency of group is discovered but no information about individual members is furnished. But the psychological surveys aim at assessing with considerable accuracy the relative attitudes of the individuals in the group.

A problem may occur in assessing an attitude is that assessment may cause change in the attitude. Even the change does not occur at remarkable level, the process of assessment is likely to result in a modification of the original attitude. The realization of this fact has affected some of the methods and techniques developed for attitude assessment. Those methods are described in the next pages in short.
• **The Method of Direct Observation of Behavior:**

Most of the time, an attitude is accompanied by a tendency to act in a particular way in given circumstances. Sometimes it is possible to know the attitude of an individual from his behavior. Sometimes observation of some selected individuals could be done in an artificial experimental situation, but it is cumbersome and time consuming.

Sometimes the research worker is interested in knowing attitudes of large number of individuals, and it becomes impossible for the researcher to observe the behavior of all those.

There is no guarantee that the behavior observed in any specific condition or in experimental condition is exactly similar to that of real life.

There is no necessarily one-to-one relationship between overt behavior and attitudes so the way of knowing attitudes through observation of behavior is not satisfactory.

• **The Method of verbal expression:**

This method includes more than one way. Some methods under verbal expression are discussed here.

(i) **Direct Questioning:**

Sometimes a single question can elicit all the information required about the attitude, and it seems logical to ask an individual, how he/she feels about any psychological object.

The disadvantage of this method is that sometimes some individuals may be reluctant in answering the question about attitudes openly. This method is helpful only when the
(ii) The method of assessing the expressed opinions:

The method of assessing the expressed opinions of the subject could also be helpful in judging attitudes of individuals, because opinion is often defined as the verbal expression of attitudes. But this method is also not that much reliable without safeguards. Because people like to give opinion which will show them in favorable light, and those opinions may not be true.

(iii) The Interview Technique:

In this method the subject is encouraged to talk about him/her and their views, and assessment of their attitudes is made on the basis of what they say. If the subject is literate he/she may be asked to write a paragraph or so on the topic, and from the analysis of that attitudes can be found out. Here the literary skill of the writer affects the matter and sometimes the written matter may not match with the facial expression, voice and gesture shown during interview.

(iv) The Projective Technique:

In this method the subject is faced with an ambiguous picture as in Murray’s Thematic Apperception Test and asked to talk or write about it. After analyzing the responses by references to norms one can find out attitude of an individual.

This method has an advantage that the subject can not realize the purpose of the test and also does not realize the
significance of his/her saying/writing, but some intelligent subjects may spot the true purpose of it and refuse to co-operate.

After the appreciation of the need for more objective means of assessing attitudes, the method of assessing attitude through attitude scale was developed.

- **Attitude Scale:**

This method enables inferences to be made based on individuals’ responses to a series of sentences or adjectives is called scaling technique and the tools developed are called scales.

An attitude scale usually consists of a set of statements with which agreement or disagreement could be expressed. The resulting scores distribute the test population along the attitude range. The usefulness of this method depends on the skill of the construction of the scale, which includes the skill of statement writing, selecting and combining.

Merits of attitude scale:

- Attitude scale is a quick and convenient measure of attitudes.
- It can be used with large group.

Limitations of attitude scale:

- Respondents may not react in true sense to a short statement of a printed form in the absence of real-life situation.
• Though it provides for anonymous response, it is possible that one may answer accordingly to what one should feel rather than what one really feels.

There are no fixed rules available in attitude measurement to be applied slavishly in every instance. The measurement procedure depends upon researcher’s theoretical assumptions about the nature of attitude which he/she wanted to measure.

In present study the researcher wanted to measure attitude towards learning science of 709 students, so it was not possible to measure attitude of those students objectively within such short period without using attitude scale. Hence, the researcher decided to use attitude scale for her work, but because of unavailability of any ready made attitude scale which could measure attitude towards learning science, she decided to prepare scale of her own.

After the decision was taken of preparation of attitude scale to measure attitude towards learning science, she started reading literature about the attitude scale. The details about attitude scale are presented below.

Attitude scale is the list of sentences or adjectives which is given to the subjects and they are asked to respond to each sentence or adjective according to their own feelings. The most frequently used scales are Thurstone Scales, Likert Scales, Guttman Scales and Semantic Differential.

(i) **Likert Scale:**

Likert Scale consists of a series of statements, all of which are related to a person’s attitude towards a single object. Two types of statements appear on Likert scale.
The first type of statements whose endorsement indicates a positive or favourable attitude towards the object under consideration (called as favourable statements).

The second type includes statements whose endorsement indicates a negative or unfavourable attitude toward the object (called as unfavourable statements).

Approximately equal numbers of favourable and unfavourable statements are included on a Likert scale.

Over the years some modifications have been made by developers and users of Likert scales, those are as follows.

(a) Modification of the response options-
Original Likert scale included five responses options ranging from ‘strongly agree to strongly disagree’. In the use of odd number of options the respondent tends to choose the ‘not sure’ option to avoid making real choice. With an even number of options the respondent is forced to choose between favorable and unfavorable responses to the attitude object.

The use of a larger number of response options reflects the attempt to increase the internal consistency of the scale by increasing total number of response opportunities given to the respondents.

(b) Modification of the statement format-
In addition to the modification in the number of response options, modification of the statement format has also been made. Incomplete statement rather than complete statements have been used and accordingly appropriate modification in the response
options also has been made. Here the response options suggest different degrees of attitude.

The response to each statement is significantly related to the entire set of statements. Statements not possessing this characteristic are eliminated. Hence during item writing stage more statements of favourable and unfavourable types are needed to be written.

Merits of Likert scale:

- Likert scale is easy, takes less time to construct, can be carried out without the panel of judges.

- It shows adaptability to wide variety of attitude objects, situations, settings etc.

- It shows ability to assess both directions and intensity of attitude.

- These are very flexible and they have a common scale (strongly agree and strongly disagree) for the responses, which allows a common comparison across items.

Limitations of Likert scale:

- In Likert scale different response patterns can produce the same total scores, hence not as sensitive as Guttman and Thurstone scales.

- This scale is somewhat inexact and fails to measure opinion with desired precision.

- There is no basis to believe five positions on the scale are equally spaced.
(ii) **Guttman scale:**

Guttman scale includes a set of statements which all relate to a person's attitude toward a single object. The respondent is directed to indicate whether they agree with or disagree with each statement. Each respondent's score is simply the number of statements agreed. This total score provides information about the particular statements that were agreed or not.

**Characteristics of Guttman scale:**

(a) The statements included on such a scale represent increasingly positive feeling with respect of the attitude towards object. This differentiates Guttman scale from Likert scale.

(b) The endorsement of any statement implies the endorsement of each less positive statement. Because of this, such scale is referred to as cumulative scale. This characteristic differentiates Guttman scale from Likert scale.

Unlike Likert and Thurstone scale, judges are not used to examine the appropriateness of the statements to be included on Guttman scale. Rather two empirical criteria are used for it. The first is the coefficient of reproducibility and the second is the coefficient of scalability. To compute these two, tentative Guttman scale is to be administered to a fairly large sample. The responses are submitted to Guttman scale analysis.
Merits:

- It is possible to determine entire pattern of responses to the statements from a single total score.
- The cumulative nature of Guttman scales makes it feasible to access change in attitude.

Demerits:

- This scale is difficult to construct.
- Statements of this scale may appear to be cumulative in nature, but the results of the Guttman scale analysis may fail to support this appearance. If either the coefficient of reproducibility or the coefficient of scalability is too low, the assumptions underlying Guttman scales are not met.

(iii) Semantic Differential:

It is a method for measuring aspects of the learning of the meaning of various concepts. It is widely used as an attitude measurement technique.

It consists of a set of seven point bipolar scales and a set of concept. Each concept is rated on each scale. In a typical format the concept is printed at the top and all the scales below. For a concept on a scale, on the extreme ends, closely related; in the middle, slightly related or neutral to the bipolar adjectives are arranged. It is simple but creates lot of data in an hour. e.g. 30 concepts, 12 scales, 50 students \((30 \times 12 \times 50 = 18000)\) data points will be collected. Hence data reduction is required, which needs to be done by grouping into categories.
Some people have criticized this scale, that it is attractive for its simplicity and its versatility but is not without controversy, the controversy is:

(a) One group has directed itself to a set of scaling assumptions fundamental to the semantic differential methodology. Bipolarity of semantic differential scales and the integrity of the midpoint fall into this category.

(b) The second group deals with the interpretation of semantic differential data in terms of EPA (evaluation, potency and activity). This criticism includes concept-scale interaction and concept-domain differences.

(c) The third group relates to the choice of the analytic model to transform semantic differential data into the EPA structure.

(iv) Thurstone Scale:

In Thurstone scale 20 or more than 20 statements are written expressing various views towards a group. These statements are submitted to panel of fifty or more judges. Each one asked to arrange them in eleven groups ranging from one extreme to another in position. This sorting yields composite position for each item. If too much disagreement upon some item occurs then it is discarded. Each item then is given a median scale value between one to eleven by panel. Such a list is given to the subjects and they are asked to express their agreement. Median value of the statements which they have checked establishes their score or quantifies their opinion.
Merits:

- Scale is prepared after numerous comparisons, so it is more popular.
- Difference between the scale values is equal in any two adjacent statements.

Limitations:

- It takes too much time to construct the scale.
- It is not easy to construct.
- It is difficult to get so many judges and their co-operation.

The researcher studied all the methods through which one can measure the attitudes and use attitude scale to measure attitude towards learning science. As no ready made scale was available to measure attitude towards learning science she had to prepare her own attitude scale to measure attitude towards learning science of 9th standard students. For that she had to decide which method of attitude scale preparation was to be followed.

She decided to adopt Likert’s method of preparation of attitude scales. As Likert scale is easy, takes less time to construct, shows ability to assess both directions and intensity of attitude, is very flexible and has a common scale (strongly agree to strongly disagree) for the responses, which allows a common comparison across items. And unlike Thurstone scale it does not require panel of judges. These all characteristics of Likert scale are instrumental for preparation of new scale, so the researcher studied the steps followed in development of Likert scale.
Likert attitude scale can be developed if a series of eight steps are followed by the researcher. These steps are described below.

**Steps in development of Likert type attitude scale**

(i) Statements must be written that are favourable or unfavourable with respect to the attitude object.

(ii) Judges are called to examine the statements that have been written. The judges should be selected from the population for whom the scale is designed. They are asked to examine each statement and classify it either as favourable, unfavourable or neither.

(iii) Any statement not classified as favourable or unfavourable by the vast majority of the judges is eliminated.

(iv) The remaining statements are placed on a piece of paper in a random order. Appropriate directions and response options are added. The directions typically indicate that the respondent should indicate how they feel about each statement by marking ‘SA’ if they strongly agree, ‘A’ if they agree, ‘NA’ if they are not sure of their feelings, ‘D’ if they disagree, and ‘SD’ if they strongly disagree. The directions may also indicate the purpose of the scale and suggest that there are not right or wrong answers. At this point an initial version of a Likert scale has been prepared.

(v) The initial version of the Likert scale is administered in the sample of the population for whom the scale is intended in order to gather meaningful, reliable data on statements individually and collectively.
(vi) The correlation between the responses made to each statement and the total scale scores is computed.

(vii) A statement having correlation with the total score not statistically significant is eliminated. The fact that each statement must be correlated with the total scale score if it is to be included on the final form of the scale is referred to as Likert’s criteria.

(viii) Modification in the Likert scale falls into categories-(a) modification of response option, here instead of odd number of option to even number of options, and (b) modification of the statement format, here instead of full statement, first half part of the statement is given and options are provided to complete the sentence. Those response options suggest different degrees of attitude, as do the traditional response options. However modified options are more appropriate given in the nature of the incomplete statement.

Steps followed in development of attitude towards learning science scale:

(i) The researcher prepared in all 168 Statements out of which 84 statements were favourable and 84 statements were unfavourable statements with attitude towards learning science.

(ii) The list of 168 Statements including favourable and unfavourable with attitude towards learning science, was submitted to the five Judges. All the five judges were Ph.D. in Education. Four of them were working in P.G.
Department of Education and the remaining one was working in college of education. Out of those five, four were Ph. D. guide and all had experience in preparing such scales. The judges were requested to examine each statement and classify it either as favorable, unfavorable or neither. The judges examined all the statements, marked them favourable or unfavourable according to the content of the statement.

(iii) Statements those were not classified as favourable or unfavourable by the judges were eliminated. Thus 72 statements (36 positive and 36 negative) remained which could be incorporated in the attitude towards learning science scale.

(iv) The remaining statements were placed on a piece of paper in a random order. Appropriate directions and response options were added. Instructions were added as-

- Feel free to record your responses.
- Record your responses for each statement.
- For each statement, put ✓ mark in the appropriate column.

(v) The initial version of the attitude towards learning science scale was administered to a sample which was selected for determination of the reliability of the tools prepared.

(vii) Item-total correlation of each statement was found out.

(viii) The significance of the correlation value was determined referring to table ‘25’\(^{\text{(10)}}\) in the Garrett’s book.
(ix) The researcher decided to consider 0.05 level for selecting statements for final version of attitude towards learning science scale. Items having item total correlation above the figure shown in table were selected for final version of attitude towards learning science scale. Statements having correlation with the total score not statistically significant were eliminated.

(x) In the final version of attitude towards learning science total 30 statements were retained, of which 16 statements were favourable in nature and 14 statements were unfavourable. The content validity was established with the help of five subject experts and reliability coefficient by test-retest and split half (odd-even) was found out to check stability and internal consistency respectively. Details are given below.

Table No. 3.15 Reliability of attitude scale

<table>
<thead>
<tr>
<th></th>
<th>Test-retest method</th>
<th>Split half (odd-even) method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability coefficient</td>
<td>0.673</td>
<td>0.80</td>
</tr>
<tr>
<td>Index of Reliability</td>
<td>0.82</td>
<td>0.89</td>
</tr>
</tbody>
</table>

Now the tool was ready to use on selected sample. The final version of attitude towards learning science scale is attached in appendix ‘D’.
The researcher prepared first two tools of her own, but she borrowed the third tool, that is learning style inventory from HayGroup.

3.3.3 Learning style inventory:

There are many learning style inventories available in the market to test the learning styles of the students. But the researcher decided to use the Kolb’s learning style inventory version 3.1, to find out learning styles of 9th std. students.

If one wants to use this inventory for research purpose, one has to follow proper procedure. The researcher followed the procedure. She filled research application form and emailed it to havtrg@haygroup.com along with CV and proposal. The HayGroup tested the proposal against their criteria for acceptance of research proposal, and accepted the proposal. But the researcher had to sign conditional use agreement and fax it to them so as to get the inventory at no cost, so she signed it and sent it to them. The HayGroup approved the researcher’s request regarding the use of learning style inventory and provided it. The copies of correspondence between the researcher and HayGroup are attached in the appendix ‘E’. The details of the learning style inventory are given here.

• **Purpose of learning style inventory:**

There are two purposes behind the creation of learning style inventory. The first purpose is to serve as an educational tool to increase individual’s understanding about the process of learning from experience. Increase in awareness of learning process helps (i) in increasing capacity for meta-cognitive control of their
learning process, (ii) in enabling them in choosing and monitoring the best approach which suits them in different learning situations. To fulfill this purpose, a self scoring and interpretation book, along with scoring and profiling instructions is available with the inventory.

The second purpose is to provide research tool for investigation of experiential learning theory and investigation of characteristics of individual learning styles. Data collected through this research tool was helpful for advancement of experiential learning.

- **History of learning style inventory:**

  **The learning style inventory version 1 (Kolb 1971)**

  (LSI 1):-

  Since 1971 five version of learning style inventory has been established. First of all the learning style inventory was developed in 1969, as a part of MIT curriculum development project. In 1971 Kolb, Rubin and McIntyre wrote a first textbook based on experiential learning. At the same time the term ‘learning style’ was coined to describe individual differences in the way people learn. The final version of learning style inventory was of nine items, and six scored items on each scale. Reliability and validity for the learning style inventory version 1 was established. Validity for it was established in a number of fields including education. More than 350 research studies with the use of learning style inventory version 1 were published. The weaknesses of learning style inventory version 1 were low consistency reliability and test-retest reliability. After 1971 it was revised in 1985.
The learning style inventory version 2 (Kolb 1985)

(LSI 2):-

Due to the low reliability coefficients the learning style inventory version 1 was revised into the learning style inventory version 2 in 1985. Because of the additions of six new items internal reliability increased and there became 12 scored items on each scale. More than 630 studies were published before the publication of version 2a, in which learning style inventory version 2 was used as a tool. Independent studies showed high internal reliability whereas test-retest reliability was low.

The learning style inventory version 2a (Kolb 1993)

(LSI 2a):-

Reliability study of randomized version of learning style inventory 2 by Veres, Sims and Locklear was published in 1991. That study showed small decrease in the internal reliability but increase in test-retest reliability with the random scoring format. To study that format in 1993 Kolb published a research version of the random format inventory 2a.

Kolb learning style inventory version 3 (Kolb 1999)

(LSI 3):-

The version 3 which is published in 1999, had adopted randomized format. In this version a color coded scoring sheet was used to simplify scoring and a revised self scoring and interpretation booklet was prepared and some new application information was added in that. Till the creation of norms for the
randomized version, the LSI 3 continued to use the LSI 2 normative reference group.

**Kolb learning style inventory version 3.1 (Kolb 2005)**

(KLSI 3.1):-  

Learning style inventory version 3 modified into learning style inventory version 3.1 in 2005 by Kolb according to the standards of educational and psychological testing developed by the American Research Association, The American Psychological Association and the National Council on Measurement in education (1999). New norms based on diverse and representative sample of 6977 LSI users were established. This is the only change, rest of the things like, items, scoring, interpreting booklet remain same as version 3.

To understand the value of the learning inventory, it is very important to have a basic understanding of the experiential learning model.

The experiential learning theory framed by Kolb in 1984 is mainly based on the work of prominent twentieth century scholars namely John Dewey, Jean Piaget, Kurt Lewin, William James, Carl Rogers, Carl Jung and Paulo Freire. These scholars gave central role to the experiences in their theories of human learning and development. In experiential learning theory, experience is considered as the source of learning and development.

According to Kolb the process in experiential learning model (see figure number 2.1) ideally (and not always) represents a learning cycle or spiral in which the learner touches all the four bases of cycle while learning experientially. The four bases are
experiencing, reflecting, thinking and acting. Kolb believes that
concrete experiences lead to observations and reflections. These
observations and reflections are then assimilated into abstract
concepts. Abstract concepts produce new implications for action,
which can be actively tested and enable to create new
experiences. Kolb further argue that the learning cycle can begin
at any one of the four points.

Kolb through his experiential learning theory want to say
that learning is a process of creating knowledge through grasping
and transforming of experiences. His model provides a
framework for identifying students' learning style preferences.

Greatest limitation of the Inventory\(^{(11)}\) is pointed out by
Kolb himself. “The results are based solely on the way learners
rate themselves. It does not rate learning style preferences through
standards or behavior, as some other personal style inventories do,
and it only gives relative strengths within the individual learner,
not in relation to others.”

In spite of these limitations the researcher used the Kolb’s
learning style inventory in present research for the following
reasons.

i) Kolb's model not only offers a way to understand
individual learner's different learning styles, but also gives
an explanation of a cycle of experiential learning that
applies to all.

ii) This inventory is designed to understand the way one learns
best in any life situations.
iii) This inventory acts as educational tool to increase individual’s understanding about the process of learning from experience.

iv) Though there is limitation, Kolb has helped in moving educational thought from the locus of the instructor back to the learner.

v) Besides these reasons one and important reason was, the availability of inventory.

- **Format of learning style inventory:**

  The learning style inventory is designed in such a way that it measures the degree to which individual shows different learning styles.

  The inventory is very brief. There were only nine items in the first version of learning style inventory and twelve items in subsequent versions. Due to its straightforward nature it is useful for research purpose as well as for discussing the learning process of individuals and providing feedback to them. Inventory is useful for teenagers and adults and not for younger children.

- **The forced choice format of learning style inventory:**

  The forced choice format of the learning style inventory is suggested by experiential learning theory and the purpose of the inventory. The experiential learning theory describes two dialectically related modes of grasping experiences and two dialectically related modes of transforming experiences. Concrete Experience (CE) and Abstract Conceptualization (AC) are the two dialectic modes of grasping experiences. And Reflective Observation (RO) and Active Experimentation (AE) are the two
dialectic modes of transforming experiences. These all four modes are conceived as interdependent. As AC - CE and RO - AE are dialectically related, if one chooses one pole it automatically rejects the other. Because of this the experiential learning theory postulates that learning in life situations needs the ability for resolution of conflicts among interdependent learning modes. According to experiential learning theory learning style is not a fixed but dynamic state. As individual change their learning preferences in resolving conflicts among learning modes the learning style changes.

The basic purpose of the learning style inventory is to provide information to the individual about his/her preferred learning approaches.

- **Types of scores on learning style inventory:**
  After implementation of learning style inventory six types of scores are obtained. The four primary scores show emphasis of the person on the four learning orientations and the remaining two are the scores which show individual's preference for abstractness over concreteness (that is the score on AC minus the score on CE), and action over reflection (that is the score on AE minus the score on RO).

- **Cut points for learning style types:**
  To determine one's learning style type one has to mark AC-CE score on vertical dimension of the grid and AE-RO score on the horizontal dimension. The cut point for AC-CE scale on the grid is +7; and the cut point for AE-RO scale on the grid is +6.
If the raw score of AC-CE is \( \leq 7 \) and AE-RO is \( \geq 7 \) it denotes accommodating learning style.

If the raw score of AC-CE is \( \geq 8 \) and AE-RO is \( \geq 7 \) it denotes converging learning style.

If the raw score of AC-CE\( \leq 7 \) is and AE-RO is \( \leq 6 \) it denotes diverging learning style.

If the raw score of AC-CE is \( \geq 8 \) and AE-RO is \( \leq 6 \) it denotes assimilating learning style.

- **Reliability of learning style inventory:**

  The internal consistency reliability of 3.1 version is high. The average of Alpha coefficient of three repeated administrations is 0.70.

  Kappa coefficients show high test-retest reliability that means very few students changes their learning style classification time to time.

- **Validity of learning style inventory:**

  The structure of KLSI 3.1 was studied for internal validity by using correlation and factor analysis. Similar results were obtained from the studies of correlation and factor analysis, and data were found consistent with previous versions. External validity was decided on the basis of researches done in various fields like; demographics and educational specializations. Concurrent validity was also found out.

  The researcher decided to collect data by using the above mentioned three tools.
3.4 **Data collection**

One tool for data collection was achievement test, the two achievement tests were based on the second term syllabus, because of that the researcher decided to collect the data at the end of second term. The researcher decided to collect the data by conducting two achievement tests, one attitude towards learning science scale and learning style inventory by Kolb on 9th standard students. She planned the dates for data collection from March 2006 to May 2006.

3.5 **Need for classification of data**

The information gathered from data collection through various tools is in the scattered form. Proper and logical sequencing of the information and presentation therefore becomes necessary. This needs classification of data. To fulfill this need the researcher planned for classification and tabulation of data.

Classification of data: even though the data was large the researcher decided to carry out the classification of data by herself.

3.6 **Analysis of data**

When knowledge is unanalyzed it doesn’t give clear and right picture, therefore, before going to the conclusion on the basis of collected data it is essential to analyze the data and use statistical operations. It is the most skilled task of all the stages of the research. Analysis of data means studying the organized material in order to discover inherent facts. The analysis strategy has to be decided before the data collection. In this data analysis step
complicated procedural language is re-organized to draw inferences.

According to Good, Barr and Scates\(^{(12)}\) "Analysis is a process which enters into research in one form or other from very beginning. It may be fair to say that research consists in general of two large steps, the gathering of data and analysis of data."

Data analysis can be done by two methods, one is quantitative analysis and the other is qualitative analysis. In quantitative analysis the information gathered is transformed into numbers and presented in the forms of tables and charts.

Though the qualitative analysis provides some special insight towards sample and could give some additional inferences about sample, in present study it was not possible to analyze data by qualitative way and it was not intention of it either.

### 3.7 Statistics Used for Data Analysis

In any research data is to be collected, but only data collection is not sufficient, it should be analyzed. In quantitative research generally statistics is applied, to come to the conclusion.

According to Best and Kahn\(^{(13)}\) "Statistics is a body of mathematical techniques or processes for gathering, organizing, analyzing and interpreting numerical data. Because research yields such quantitative data, statistics is a basic tool of measurement, evaluation and research."

Statistical data describe group behavior or group characteristics and help to make generalizations.
In educational research it is too much difficult to study on entire population, but one can learn nearly as much about the population by studying sample of that population. However, any selected sample is likely to be different in some respect from the entire population because of sampling errors.

According to Walter R. Borg (14) “one of the main purposes of statistics is to help us estimate the probable size of those sampling errors. The advantage of studying random sample of the population is that our statistical procedures are usually based upon the assumptions that we have a random sample. Thus if we have a random sample we can accurately estimate the probable size of our sampling errors.”

According to Tyrus Hillway (15) “the aim of statistical description is to present an accurate and useful picture of the data” that is why it is necessary to apply statistics in research.

In research two types of data are recognized to which statistics is to be applied, one is parametric data and the other is non-parametric data.

Parametric data are measured data; parametric statistical tests assume that the data are normally or nearly normally distributed.

Non parametric data are counted or ranked data and the non parametric tests do not rest upon normal distribution of population.

Two main types of statistical approaches are there, those are Descriptive and Inferential.
Descriptive statistical analysis limits generalization to the particular group of individuals observed by researcher. No conclusions are extended beyond the observed group, and any similarity to those outside the group can't be assumed. The data describe the concerned group only. Descriptive analysis provides valuable information about the nature of the particular group of individuals observed.

In descriptive statistics several measures are available to describe and analyze the data. These measures are listed below.

- Measures of central tendency
- Measures of spread and dispersion
- Measures of relative position
- Measure of relationship

It always involves the process of sampling. The small group selected from large group is called as ‘sample’ and the large group as ‘population’. The purpose of inferential statistics is to draw conclusions about the populations on the basis of observations of the sample. But when a number of randomly selected sample means are computed the chance variation are inevitable, and is called as ‘sampling error’. Inferential statistics can overcome this chance variation and help the researcher to make generalizations or inferences about populations from the observations of sample. The degree to which a sample statistics represents its parameter is an index of the significance of the computed sample statistics.
There are many statistical measures available; it depends on the nature of data available and the hypothesis to be tested, which measure is to be applied. In present study it was though pertinent to apply inferential statistics. Inferential statistics further divided into two: parametric statistics and non-parametric statistics.

As the researcher was interested in finding out the difference between girls and boys on different learning styles it was necessary to test significance of the difference between two percentages. Besides this she also wanted to find out the difference between achievement in science and difference between attitude towards learning science of boys and girls on various styles and opposite styles, hence, it was very necessary to test significance of the difference between two means. So it was appropriate to find out critical ratio for knowing significance of the difference between means and percentage.

As a part of present study the researcher had to see whether there is some relation between achievement in science and attitude towards learning science of 9th standard students. Data was to be collected from ten schools, obviously N would be large, and so it was pertinent to find out correlation by product-moment method, as this method saves time and computational labour. In accrual procedure the researcher decided to find correlation on computer, and then find its significance.

The steps through which the researcher proceeded, and the formulae used, are described in detail in next pages.
3.7.1 The significance of the difference between percentages:

The researcher intended to see distribution of girls and boys on learning styles, and find out if there was any significant difference between the number of girls and boys on learning styles. So it was pertinent to test significance of the difference between two percentages.

Two different methods, depending upon correlated and uncorrelated percentages are there, for getting SE of difference in percentages. The researcher decided to chose the method for uncorrelated percentages. Details are given below.

- **The SE of the difference of when the percentages are uncorrelated:**

The formula given by Garrett, H. E. (16) for significance of the difference between two uncorrelated percentages is:

$$
\sigma_{D_{un}} = \sqrt{\frac{\sigma^2 p_1 + \sigma^2 p_2}{N_1 N_2}}
$$

Where, $\sigma_{D_{un}}$ = significance of the difference between percentages

$P = \text{the percentage occurrence of the behaviour}$

$Q = (1-P)$

$N_1 = \text{size of the first sample}$

$N_2 = \text{size of the second sample}$
To put the values in the formula, it was necessary to find out those values, so the researcher followed the steps as -

(i) Finding out \( P \) by using formula given by Garrett, H. E.\(^{17}\)

\[
P = \frac{N_1 P_1 + N_2 P_2}{N_1 + N_2}
\]

For this formula \( N_1, N_2, \) and \( P_1, P_2 \) are essential, so-

(ii) Noting down \( N_1, \) and \( N_2. \)

(iii) Noting down \( P_1, \) and \( P_2, \) and estimate \( P \) by using values of \( N_1, N_2, \) and \( P_1, P_2. \)

(iv) Finding out value of \( Q \) by using equation, \( Q = (1-P). \)

(v) Putting all the values \( P, Q, N_1, \) and \( N_2 \) in the formula of \( \sigma_{D\%} \) to get \( \sigma_{D\%}. \)

(vi) Finding out the difference between two percentages, \( P_1 - P_2. \)

(vii) Putting the values of \( P_1 - P_2 \) and \( \sigma_{P_1-P_2} \) into the formula for \( CR \) as given by Garrett, H. E.\(^{18}\)

\[
CR = \frac{(P_1 - P_2) \cdot 0}{\sigma_{P_1-P_2}}
\]

(viii) Finding out df by using equation, \( df = (N-2). \)

(ix) Using table \( D^{(19)} \) for getting value of expected \( CR \) to be significant at 0.01 level.

(x) Comparing the expected \( CR \) with obtained \( CR \) for deciding the significance of the two uncorrelated percentages.
3.7.2 The significance of the difference between means:

After the implementation and assessment of the decided tools the researcher got data of achievement in science of boys and girls in the form of marks.

The means may have subjected to sampling fluctuations or 'errors of sampling', and therefore, the difference between two means of two samples will also be subjected to sampling errors. So there is a need to know the standard error of the difference between the two sample means.

In order to test the significance of an obtained difference, one must first have a SE of the difference.

There are two methods of finding significance of difference between means, (i) method used for deciding SE of the difference when means are uncorrelated, and (ii) method of deciding SE of the difference when means are correlated. Here method for deciding SE of the difference for uncorrelated means was used. Steps in this method are described in detail in next pages.
The SE of the difference (\(\sigma_D\)) when means are uncorrelated and samples are large:

The formula of SE of the difference of large means given by Garrett, H. E. \(^{(20)}\) was decided to be used.

\[
\sigma_D = \sqrt{\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}}
\]

Where, \(\sigma_D\) = the SE of the difference between the two sample means

\(\sigma_1\) = the standard deviation of the first sample

\(\sigma_2\) = the standard deviation of the second sample

\(N_1\) = size of the first sample

\(N_2\) = size of the second sample

The steps of proceeding through are given below.

(i) Noting down \(N_1\) and \(N_2\), which is number of girls and boys respectively.

(ii) Calculating the standard deviation of the samples, \(\sigma_1\) and \(\sigma_2\).

Here the researcher decided to calculate \(\sigma_1\) and \(\sigma_2\) through computer.

(iii) Finding out the SE of the difference between the two sample means, \(\sigma_D\).

Finding out the obtained D, that is difference between two means, the formula given by Garrett, H. E. \(^{(21)}\) is as given on the next page:
\[ D = M_1 - M_2 \]

(iv) Calculating the means of achievement in science of girls and boys separately, \( M_1 \) and \( M_2 \).

(v) Finding out difference between two means, \( D \).

Is the obtained mean difference of \( D \), in view of its SE, large enough? To answer this question one has to compute a critical ratio, that is CR. By using the formula given by Garrett, H. E. (22) as-

\[ CR = \frac{D}{\sigma_D} \]

(vi) Calculating the CR.

Then it was time to decide the significance of difference between two means with the help of obtained CR, and the value expected to be significant at 0.01 level. But to find out the value expected to be significant at 0.01 level ‘df’ (degrees of freedom) was necessary. Here in the present study the hypotheses presumed were null hypotheses, and the tests were two-tailed, so it was necessary to subtract 2 from \( N \), that is

\[ df = (N-2). \]

(vii) Calculating the df.

(viii) Entering the df in table ‘D’ and finding out the value of expected CR to be significant at 0.01 level.

(xi) Deciding the significance of difference between means of two samples with the help of obtained CR, and the value expected to be significant at 0.01 level.
3.7.3 The significance of the coefficient of correlation:

In present research the researcher was interested in finding if there is any relationship, especially positive relation, between achievements of 9th std. students in science and their attitude towards learning science. So she decided to find out correlation between those two.

According to Van Dalen(23) "The degree of relationship between the paired scores is called the correlation."

To measure the relationship between two variables, the most widely used measure is the product-moment correlation coefficient ‘r’. This may be thought of essentially as that ratio which expresses the extent to which changes in one variable dependent upon changes in a second variable. The product-moment correlation is index of relationship that can take value from -1.00 to +1.00.

As the researcher wanted to test the obtained ‘r’ against the hypothesis, she decided to proceed for its significance.

In present study the researcher decided to calculate the ‘r’ with the help of computer. Then enter table '25, with degrees of freedom and search for the expected ‘r’ to be significant at 0.01 level. Compare the obtained ‘r’ with the expected ‘r’ and decide the significance.

All these stages mentioned earlier were implemented and reported in the next chapter.
In this chapter the research plan has been discussed.

The following flow chart depicts the planning.

**Figure 3.1 Flow chart showing plan of research**

1. To define objectives of the study
2. To decide information needed for the study
3. To decide population
4. To decide method of sampling
5. To prepare / import required tools
6. To implement the tools on small group to find out reliability of tools
7. To implement the tools on selected sample
8. To collect data
9. To tabulate, analyze and interpret data
10. To draw conclusions

Actual data collection and analysis is presented in chapter 4.
3.8 References


(11) Limitation of the inventory in http://iteslj.org/Articles/Kelly-Experiential/


(17) Ibid.(P. 235)

(18) Ibid.(P. 236)

(19) Ibid.(P. 461)

(20) Ibid.(P. 214)

(21) Ibid.(P. 215)

(22) Ibid.