CHAPTER – 3
PLAN AND PROCEDURE

3.0 INTRODUCTION:

The methodology of the study endears an overview of all the considerations of the research works that is to be executed and at this stage the crucial decisions for the accomplishment of objectives of the study are taken. Research methods are of utmost importance in a research process. They describe the various steps of the plan of attack to be adopted in solving the research problem, such as the manner in which the problem is formulated, the definition of terms, the choice of subjects for investigation, the validation of data-gathering tools, collection of data, analysis and interpretation of data and the process of inferences and generalizations (Koul, 1996).

According to Kothari C.R (1996), Research Methodology is a way to systematically solve the research problem. It is a science that deals with the various steps that are generally adopted by a researcher in studying his research problem along with the logic behind them. The truth is that, successful completion of a research work without proper planning becomes not only difficult, but will become impossible. The planning includes the measures which are to be adopted for collecting the relevant data, the sample to be taken, what controls are to be employed, and which would be pertinent data that would be analyzed. The details regarding the methods adopted, tools and techniques used, sample selected, procedure adopted and statistical techniques employed are given in this chapter.

The chapter is divided into eight major areas:

1. Research Method
2. Research Design
3. Variables
4. Population and the Sample
5. Tools Used
6. Description of The Tools
7. Procedure for Data Collection
8. Statistical Techniques Used
9. Statistical Methods Adopted

3.1 RESEARCH METHOD

The selection of a method and the specific design within that method appropriate to the research problem will depend upon the nature of the problem and upon the kind of data.

In order to measure the effectiveness of the multimedia approach and traditional method on the retention and academic achievement of the science student’s at the secondary school level, the experimental method was found to be the best method to conduct the research due to the following reasons:

• The experimental method provides a logical, systematic way to answer the question, “if this is done under carefully controlled conditions, what will happen?’

• The experimental method is the only method of research that can truly test hypotheses concerning cause-and-effect relationships. It represents the most valid approach to the solution of educational problems, both practical and theoretical, and to the advancement of education as a science.

• Experimentation or experimental research differs from descriptive studies in which the researcher has some degree of control over the variables involved and the conditions under which the variables are observed. Experimental method provides much control and therefore establishes a systematic and logical association between manipulated factors and observed effect.

• Campbell and Stanley (1963) are of the opinion that "the experiment is the only means of settling disputes regarding educational practice, the only way of verifying educational improvements, and the only way of establishing a cumulative tradition in which improvements can be introduced without the danger of a faddish discard of old wisdom in favour of inferior novelties."

For assessing the opinion of students regarding the effectiveness of the two methods i.e. multimedia and traditional, with respect to academic achievement, retention and overall teaching and learning, survey method was adopted. Survey
research is a method for collecting and analyzing data obtained from a large number of respondents representing a specific population. “Survey is concerned with conditions or relationships that exists, practices that prevails, beliefs and point of view or attitude that are held, process that are going on, effects that are being felt—or trend that are developing” (Best and Khan 1999). The various dimensions included under this are;

1. Opinion of students regarding the impact of multimedia approach on the Quality of Learning.

2. Opinion of students about the impact of multimedia approach on the Quality of Teaching.

3. Opinion of the students about the New Instructional Settings/Materials.

4. Opinion of students about the impact of multimedia approach on learners with respect to the Socialization.

5. Opinion of students about the Change in Teacher’s Role/ Attitude due to the use of multimedia approach.

6. Opinion towards Development of Students Abilities by using multimedia approach.


8. Opinion of the students regarding the Effect on Educational System.

9. Opinion of students about the Change in Student’s Role/ Attitude due to the use of multimedia approach.

10. General/Other opinion of students towards multimedia approach.

3.2 RESEARCH DESIGN

An experimental design to the researcher is what a blueprint is to an architect. It provides the researcher an opportunity for comparisons required by the hypotheses of the experiment and enables him to make a meaningful interpretation of the results of the study with the help of statistical analysis of the data.

The design found to be most useful for the purpose of this study was “The
pre-test-post test Equivalent Groups Design.” In this design, subjects are randomly assigned to experimental and control groups. Following is the symbolic representation of the design:-

\[
\begin{align*}
 R &\quad E &\quad = &\quad O1 &\quad T &\quad O2 \\
 R &\quad C &\quad = &\quad O3 &\quad O4
\end{align*}
\]

Where:

\[
\begin{align*}
 R &= \text{Randomly selected} \\
 E &= \text{Experimental group} \\
 C &= \text{Control group} \\
 O &= \text{Observation or measurement} \\
 T &= \text{The experimental treatment to which a group is exposed i.e. Independent variable.}
\end{align*}
\]

This design is one of the most effective in minimizing the threats to experimental validity. At the conclusion of the experimental period, the difference between the mean scores of the experimental and control groups as subjected to a test of statistical significance i.e. a t-test and an analysis of variance- ANOVA (Farooq, 2001).

In this design the groups are randomly selected from the total available group. One of the groups was treated as experimental group. Pre-test was conducted. This design has an advantage of the pre-test, which affords an opportunity to check on the initial equivalence of the groups. Many other factors jeopardizing internal and external validity are easy to control.

Although there are three groups in the present study (one control and two experimental groups), at a time comparisons are made between two groups only. The groups are compared in the following pattern to compare the performance of each group in achievement and retention tests.

1. Experimental Group-I and Control Group
2. Experimental Group-II and Control Group
3. Experimental Group-I and Experimental Group-II
Population of 186 students of class IX

Population was categorized into three categories of Low, Average and High Intelligence groups on the basis of their intelligence score in the Non Verbal Intelligence Test (Raven’s Standard Progressive Matrices Test)

Sample of 90 students was randomly selected. The students were distributed into 3

- Control Group (30 students)
- Experimental Group-II (30 students)
- Experimental Group-I (30 students)

Each group has equal number of students from the low, average and high intelligence categories. Each group has 6 students of low intelligence, 18 students from average intelligence and 6 students of high intelligence level.

Pre Achievement Test

Control Group taught with the Traditional Method of Instruction

Experimental Group-I taught with the Multimedia Approach (Multimedia Package-I)

Post Achievement Test administered to all the three groups

Delayed Post Achievement Test administered to all the three groups

Administration of Opinionnaire

Figure 3.1: Flow chart showing the steps involved in the conduct of the study
3.3 VARIABLES IN THE EXPERIMENT

Something that can change in value and can be measured is a variable. It can be an aspect of an experimental situation or a characteristic that changes in different individuals. For an experimental study there are independent variables and dependant variables.

“Variables are the characteristics or conditions that are manipulated, controlled or observed by the experimenter” (Singh 1997).

In the present study, the prepared multimedia packages were to be tested for their effectiveness experimentally in comparison with the traditional method for teaching science at secondary school level. Hence the variables used in the present study are:

3.2.1 Independent Variables

The variable, which is manipulated by the experimenter or the variable, which is suspected of being the cause in the experiment is called independent variable.

In the present study, the independent variables are the multimedia approach and traditional method. In this experiment study the teaching method is the independent variable. The two methods selected by the investigator in this study i.e. multimedia approach (MMA) and traditional method (TM) are the independent variables. The control group is subjected to the traditional method (TM) i.e. the conventional text book approach (also known as chalk and talk method) while the other groups, i.e. the experimental groups are taught by the multimedia approach (MMA). In the present study the following three levels of the instructional strategy are selected namely,

i. Multimedia Package-I administered to Experimental group-I in which the students were taught with the help of Computer Assisted PowerPoint Presentations (Appendix I (a) to I (m)), a Comprehensive Supplementary Booklet (Appendix - II) and hands on experience on computers.

ii. Multimedia Package-II administered to Experimental group-II in which the students were taught with the help of Interactive Multimedia Instructional
Software (Appendix - III), Computer Assisted PowerPoint Presentations (Appendix I(a) to I(m)) and the Comprehensive Supplementary Booklet (Appendix - II). In addition they utilized computer based technology resources; including internet access and e-mail in the form of hands on experience.

iii. Traditional Method which contains prescribed text book only. The control group was taught with this method with the help of the chalk and talk only. The students of this group were given chance and time for interaction, questioning and what else is being practiced in our schools but without using any component of the multimedia based technology.

3.2.2 Dependent Variables

The dependant variable is the condition or characteristic that appears, disappears or changes as the experimenter introduces, removes or changes independent variable. The dependant variable is measured before and after the manipulation of the independent variable.

The dependent variable considered for the present study are academic achievement and retention of the students with respect to the teaching approach adopted.

The first dependant variable used in this study is the academic achievement. It is measured by administering an achievement test after introducing the three strategies in the three different groups. The achievement of students in control and experimental groups (in total and objective-wise) are taken into account. The delayed post scores (total and objective-wise) are also considered to compare the retention of the three groups. To measure retention, the retention test was administered about three weeks after administering the post achievement test.

3.4 POPULATION AND THE SAMPLE

Out of the different English medium Secondary schools of the Sonepat District of Haryana, one school namely Ramjas Senior Secondary School was purposively selected keeping in view of the availability of the sufficient infrastructural facilities mainly a well equipped computer laboratory and other audio
visual aids like LCD projector and a power backup system. Out of the total 186 students of IX class, 90 students were selected for the sample on the basis of their performance in a non-verbal intelligence test (Raven’s Standard Progressive Matrices Test). The criterion to select the sample subjects was based on varying intelligence level of the students i.e. Higher Intelligence Level, Average Intelligence Level and Low Intelligence Level. This test was administered to the students for the two reasons. Firstly, this helped in the formation of equated groups, as intellectual capacity of a student is a major contributor towards student learning and it would be a strong mediator if not controlled. Secondly, to form groups on the basis of the varying level of intelligence so that the objective to compare the relative effectiveness of the different instructional strategies in terms of academic achievement and retention of the students could be studied.

Out of the total 186 students those who were given the intelligence test, the different categories of intelligence i.e. High, Average and Low had 30, 116 and 44 students respectively. Further out of these 30, 116 and 44 students of high, average and low intellectual ability, 18 (high intelligence), 54 (average intelligence) and 18 (low intelligence) students respectively were selected randomly, thus making the total sample of 90 students. These 90 students were equally distributed among the three groups i.e. two experimental groups and one control group. Thus, each group had total 30 students. The sample of 30 students in each of the three groups had students of three categories of high intelligence group (6 students in each group), average intelligence group (18 students in each group) and low intelligence group (6 students in each group) as given in the table 3.1 below.

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of Students</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low Intelligence</td>
<td>Average Intelligence</td>
</tr>
<tr>
<td>Experimental Group-I</td>
<td>6</td>
<td>18</td>
</tr>
<tr>
<td>Experimental Group-II</td>
<td>6</td>
<td>18</td>
</tr>
<tr>
<td>Control Group</td>
<td>6</td>
<td>18</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>54</td>
</tr>
</tbody>
</table>
3.5 **TOOLS USED**

Keeping in view of the objectives of the study, the following tools and materials were developed and used:

3.5.1 Raven’s Standard Progressive Matrices Test (1938)

3.5.2 Self developed Multimedia Instructional Packages (MMIPs) were used. The experimental group-I was taught with Multimedia Package-I whereas the experimental group-II was taught with Multimedia Package-II.

3.5.3 Achievement tests.

3.5.3.1 A self constructed Pre Achievement Test was used.

3.5.3.2 A self constructed Post Achievement Test

3.5.3.3 A self constructed Retention Test was used.

3.5.4 A self-developed Opinionnaire was used.

3.6 **DESCRIPTION OF THE TOOLS**

The details regarding the preparation of tools and techniques employed for the present study are outlined below.

3.6.1 **Raven’s Standard Progressive Matrices Test:**

**Description:** Standard Progressive Matrices (Sets A, B, C, D and E) prepared by J.C. Raven in 1938 was used to measure intelligence of the students. Raven’s Progressive Matrices Sets A, B, C, D and E is a non verbal group of intelligence. This test consists of 60 items divided into 5 sets of 12 each. In each item, the portion of a figure is removed and a number of alternatives are given from which the correct answer has to be chosen. The subject has to choose the correct answer and put an ‘X’ mark in the box provided against each problem in the answer sheet separately given to them. This test is intended for people above 11 years of age. This test has retest reliability varying with age from 0.83 to 0.93. (See Appendix-IV)

3.6.2 **Self Developed Multimedia Instructional Packages:**

The Experimental groups- I and II were taught using multimedia approach with the help of multimedia instructional packages. The experimental
group-I was taught with Multimedia Package-I whereas the experimental group-II was taught with Multimedia Package-II.

1. **Development and Description of Multimedia Package-I**: The Multimedia Package administered to Experimental group-I included the following:

   a. **Computer Assisted PowerPoint Presentations**: PowerPoint which is a Microsoft Office Suite program is used to make presentation slideshows, combining text and images to create captivating and motivating presentations. Keeping in mind the subtopics of the unit “The fundamental Unit of Life”, six PowerPoint presentations were made. Content and graphics presenting to the section covering each subunit were composed in sequential slides. During this various principles such as from simple to complex, from concrete to abstract, from known to unknown etc. were used. Aesthetic quality of the slides was also taken care of.

   In order to make the presentations effective the presentation were edited and formatted. The text portions were animated and supplemented with audio using custom animation and sound effects facility of the PowerPoint XP Version as per the need of the presentation. All the slides were ordered sequentially and numbered as well as given in Appendix-I(a) to I(m).

   b. **Comprehensive Supplementary Booklet**: An instructional booklet in the form of module was also developed for the learners to achieve a set of objectives. The booklet was prepared by following the scientific procedures like analysis phase, formative phase, pre validation phase and assembling phase. Following steps were involved in the preparation of the comprehensive booklet:

   i. The unit “Fundamental Unit of Life” was selected which was further broken down into several manageable subunits.

   ii. Instructional Objectives in the form of outcomes of learning were formulated.

   iii. The prepared booklet contained the title, subtitles, the content as per each subtopic, coloured labeled diagrams and definitions; check your memory after each subunit; practice online, differences between the various concepts in tabular form, quick recall and summary.

   iv. Formative assessment including the various assessment techniques like
individual worksheet based upon flow chart, fill in the blanks, crossword, diagram based, match the following, multiple choice questions, true or false, science quiz and difference based were used.

All the formative assessment was supplemented with the answer key at the end of each assessment. In summative assessment in the form of Post Test was administered separately.

The hardcopy of the Comprehensive Booklet developed by the researcher, used for both the experimental group-I and II is given as Appendix - II.

c. **Hands on Experience:** In addition they utilized computer based technology and online resources including internet access and e-mail.

2. **Development and Description of Multimedia Package-II:** The Multimedia Package-II administered to Experimental group-II included all the components of multimedia package-I. Additionally it also included a major component in the form of Self Developed Interactive Multimedia Instructional Software. The developed software is termed as **e-Biology**.

a. **Interactive Multimedia Instructional Software:** The production of the Interactive Instructional Software involved a series of six different phases.

**Fig. 3.2: Flowchart showing Differences Phases of the Production of Multimedia software**

![Flowchart showing differences phases of multimedia software](image)

The six phases are categorized into the following three categories:
Fig. 3.3: Flowchart showing different categories of the production of Multimedia software

**Description of Each Phase:** The different phases are described as following:

**Analysis Phase:** During the Analysis Phase, the investigator interacted with the students and teachers of the different schools in order to find out their needs with reference to the biology portion of the science subject for class IX. It was decided that the unit entitled “Fundamental Unit of Life” which lays a foundation for the biology of both secondary and senior secondary classes must be taught through multimedia approach. For this step, scoping details were written in three columns, namely objectives, content and treatment.

**Design Phase:** The Design Phase is the second phase in multimedia production. The Design Phase refers to the planning of the design of the multimedia program to be developed. The two popular tools which were used in the Design Phase were namely the Flow Chart and Storyboard. Flow Charts helped to lay out the flow of a multimedia program. Storyboards are rough sketches of everything that are included in a multimedia program. A Storyboard for the program on the unit “Fundamental Unit of Life” based on the Flow Chart. In the Storyboard, the content of the program according to the various subunits, navigational system to be used and the layout of the program were considered, finalized and produced. The storyboard lays out how the multimedia elements are to be put in a multimedia program. In this step the following fundamental design aspects were finalized, with the help of computer personnel.
Table: 3.2 Different Aspects and Elements Involved in the Framework of the Multimedia Software

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Aspect of the Framework of the Multimedia Software</th>
<th>Element Involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Method of Instruction</td>
<td>Presentation</td>
</tr>
<tr>
<td>2.</td>
<td>Style of Navigation</td>
<td>Non-Linear</td>
</tr>
<tr>
<td>3.</td>
<td>Components of Multimedia used</td>
<td>Text, Audio, Video, Sound, Animation and Graphics</td>
</tr>
<tr>
<td>4.</td>
<td>Nature of Interactivity</td>
<td>Buttons, Stepper, Tool Tips, Drag and Drop</td>
</tr>
</tbody>
</table>

**Implementation Phase:** This is the phase where the multimedia program is produced. The Implementation Phase refers to the process of converting the design plan into a multimedia program. In the Implementation Phase, we used Action Script 3.0 as the authoring tool to integrate the multimedia elements. A prototype by incorporating all the ideas was finally converted to software. The computer experts helped in finalizing graphics and software details considering storyboard, budget and time in hand. The following software’s were used for the production of the multimedia software used in the present study.

- Corel Draw X5 and Adobe Photoshop CS4—for image and graphics creation.
- Adobe Flash CS4—for clip/movie/animation production.
- Action Script AS 3.0—for animation, programming and effects.
- .NET 4.0—run time environment
- Windows based C#—for audio creation.

**Testing Phase:** Checklist to test the multimedia program was used in the series as the next step. Errors in the programme can be easily identified and removed by this method. The Testing Phase began after the Implementation Phase. The purpose of testing was to ensure that the program runs correctly without errors. In the Checklist the aspects focused were content, interface and navigation. The content refers to the goals of the program, text, graphics, audio, video, animation, language used and how informative the program is.
For the interface, CASPER principles were used for the items in the multimedia program. They are Contrast, Alignment, Simplicity, Proximity, Emphasis and Repetition. For Navigation, the navigation aids and consistency were tested. The multimedia program was tested to make sure that the multimedia software was error-free. For this two types of testing’s was done. The Alpha testing was done at the development site. Software was tested for performance by running the software and carefully observing the execution speed and audio/video playback and also for content. The feedback suggested by the researcher was incorporated by the software experts for further rectifications and modifications. Then, a group of randomly
selected users from different schools tested the revised product at their computers. This type of testing is known as Beta testing. The difficulties were noted and modified accordingly. The software was then modified from the observations made by the investigator, and the comments of the students, science teachers, educationists and colleagues. After that, the final release of the product was made ready for the target users.

**Evaluation Phase:** In the Evaluation Phase, selected users were given an Evaluation Form to tryout the program and give feedback. The Evaluation Phase focused on overall presentation and effectiveness of the multimedia in terms of the good user interface (GUI) characteristics like consistency, clarity, context, navigation and flexibility of the multimedia program.

**Publishing Phase:** The Publishing Phase is the last phase in a multimedia production. Generally, we have two options of mediums used in delivering multimedia contents i.e. either through web pages or through compact disc. The present developed interactive multimedia instructional software was delivered through CD ROMs.

The softcopy of the Interactive Multimedia Instructional Software e-Biology developed by the researcher, used for the experimental group-II is given as Appendix - III

**3.6.3 Achievement Tests**

The researcher constructed both the pre-test and the post-test, after a thorough review of the techniques of test construction. An achievement test in Science on the unit “The Fundamental Unit of Life” for class IX was prepared by the investigator himself as there was no standard test available on the unit selected. The details of the various steps undertaken are as following:

a. **Preparation of the Test Items and Draft Test:** It was decided to have long answer type, short answer type I, short answer type II, very short answer type and multiple choice items in the achievement test. After the investigator was satisfied with the item prepared, it was shown to expert teacher educators to
verify the suitability of the items for the target group. Modifications were made accordingly.

b. **Try Out:** A try out was carried out in the form of small group testing. The small group testing of the achievement test was executed on 10 students of class IX from two different schools other than the sample school who had already studied the related chapter. Enough time was given to the students to complete the test. The average time used was noted and the scoring was done according to the weightage of marks given to each type of question. The students also high-lightened their observations during an interview taken soon after test administration. Specific difficulties faced by the students were noted and discussed with them. The test was improved by removing the difficulties faced by these students.

c. **Item Analysis:** The test was item analysed by estimating the index of discrimination and discriminating power. Items having difficulty index between 0.25 and 0.75 and discriminating power above 0.25 were selected for the final test.

d. **Preparation of the Final Achievement Test:** After carrying out the additions, deletions and modifications of the items final achievement test had 50 items with a maximum score of 100. The test items were prepared based on a blue print, by giving due weightage to the content, objectives and difficulty level which were fixed in concurrence with a number of general science and biology teachers who are handling the subjects in different schools. Instructions were printed on the first page of the final drafted version of the achievement test. Time limit was also fixed to 3 hours. Separate answer sheets were given to the students for answering.

e. **Weightage to the Content:** The weightage to different sub-units in the content of the achievement test are given in table 3.3
Table 3.3 Weightage to the Content in the Achievement Test in Biology for Standard IX

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Content</th>
<th>Marks (Theory)</th>
<th>Marks (MCQ)</th>
<th>Total Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Cell- Basic Unit of Life</td>
<td>10</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>2.</td>
<td>Prokaryotic and Eukaryotic Cells</td>
<td>10</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>3.</td>
<td>Multicellular Organisms</td>
<td>16</td>
<td>3</td>
<td>19</td>
</tr>
<tr>
<td>4.</td>
<td>Cell Membrane and Cell Wall</td>
<td>16</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>5.</td>
<td>Cell Organelles</td>
<td>28</td>
<td>9</td>
<td>37</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>80</td>
<td>20</td>
<td>100</td>
</tr>
</tbody>
</table>

f. Weightage to the Instructional Objectives: the weightage to different instructional objectives in the achievement test is given in table 3.4

Table 3.4 Weightage to the Instructional Objectives in the Achievement Test in Biology for Standard IX

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Objective</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Knowledge</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>2.</td>
<td>Understanding</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>3.</td>
<td>Application</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>4.</td>
<td>Creativity</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

g. Weightage to Difficulty Level of Questions: the weightage according to difficulty level of the questions is given in table 3.5

Table 3.5 Weightage to Difficulty Level of Questions in the Achievement Test in Biology for Standard IX

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Difficulty level of questions</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Easy</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>2.</td>
<td>Average</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>3.</td>
<td>Difficult</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
h. **Weightage to the Form of Questions:** the weightage according to the different types of the questions is given in table 3.6

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Type of questions</th>
<th>Marks for each question</th>
<th>Number of questions</th>
<th>Total Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Very Short Answer Type (VSA)</td>
<td>1 Mark</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>2.</td>
<td>Short Answer Type-1 (SA-1)</td>
<td>2 Marks</td>
<td>6</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>3.</td>
<td>Short Answer Type-2 (SA-2)</td>
<td>3 Marks</td>
<td>12</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td>4.</td>
<td>Long Answer Type (LA)</td>
<td>5 Marks</td>
<td>5</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>5.</td>
<td>Multiple Choice Questions (MCQ)</td>
<td>1 Mark</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
<td>50</td>
<td>100</td>
</tr>
</tbody>
</table>

i. **Time Distribution to the Different Forms of Questions:** The time distribution according to the different types of the questions is given in table 3.7

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Type of questions</th>
<th>Time for each question (in minutes)</th>
<th>No. of questions</th>
<th>Total time taken (in minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Very Short Answer Type (VSA)</td>
<td>1 minute</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>2.</td>
<td>Short Answer Type-1 (SA-1)</td>
<td>4 minutes</td>
<td>6</td>
<td>24</td>
</tr>
<tr>
<td>3.</td>
<td>Short Answer Type-2 (SA-2)</td>
<td>6 minutes</td>
<td>12</td>
<td>72</td>
</tr>
<tr>
<td>4.</td>
<td>Long Answer Type (LA)</td>
<td>10 minutes</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>5.</td>
<td>Multiple Choice Questions (MCQ)</td>
<td>1 minutes</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>For the Revision</td>
<td></td>
<td>--</td>
<td>--</td>
<td>7</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td>50</td>
<td>180</td>
</tr>
</tbody>
</table>
j. Blue Print: A blueprint was prepared by giving due weightage to the objectives, content and form of questions as shown in table 3.8

Table 3.8 Blue Print of the Achievement Test in Biology for Standard IX

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Objectives</th>
<th>KNOWLEDGE</th>
<th>UNDERSTANDING</th>
<th>APPLICATION</th>
<th>CREATIVITY</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Form of questions</td>
<td>VSA</td>
<td>SA-I</td>
<td>SA-II</td>
<td>LA</td>
<td>MCQ</td>
</tr>
<tr>
<td>1.</td>
<td>Cell- Basic Unit of Life</td>
<td>1(2)</td>
<td>2(1)</td>
<td>1(2)</td>
<td>1(3)</td>
<td>1(3)</td>
</tr>
<tr>
<td>2.</td>
<td>Prokaryotic and Eukaryotic Cells</td>
<td>2(1)</td>
<td>1(3)</td>
<td>1(3)</td>
<td>1(5)</td>
<td>2(1)</td>
</tr>
<tr>
<td>3.</td>
<td>Multicellular Organisms</td>
<td>3(2)</td>
<td>1(3)</td>
<td>1(2)</td>
<td>1(5)</td>
<td>3(1)</td>
</tr>
<tr>
<td>4.</td>
<td>Cell Membrane and Cell Wall</td>
<td>2(1)</td>
<td>1(3)</td>
<td>1(5)</td>
<td>1(3)</td>
<td>1(3)</td>
</tr>
<tr>
<td>5.</td>
<td>Cell Organelles</td>
<td>4(1)</td>
<td>1(1)</td>
<td>2(2)</td>
<td>5(1)</td>
<td>2(3)</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>4(1)</td>
<td>2(2)</td>
<td>3(1)</td>
<td>5(1)</td>
<td>4(1)</td>
</tr>
<tr>
<td>% OF MARKS</td>
<td></td>
<td>25</td>
<td>35</td>
<td>25</td>
<td>15</td>
<td>100</td>
</tr>
</tbody>
</table>

- The number inside the brackets denote the marks of each question and the number outside the bracket denote the number of questions

k. Reliability and Validity of the Achievement Test: Split half method was followed to find the reliability of the test. It was found to be 0.78, which showed a high substantial reliability of the tool. The face validity and content validity of the test was assured while preparing the blue print and giving adequate weightage to content and objectives. The draft of the achievement test was submitted to the adviser for his feedback and critical review. Also opinion of the experts in this field was taken into consideration while preparing the test and necessary modifications were made accordingly.
3.6.3.1 Pre Achievement Test: A pre-test in a module can be used to diagnose weakness and to help a student to decide whether he or she is ready to study the module. The pre-test determines the student’s level of skills or knowledge before studying the module. Also using the results from the tests given before and after the experimentation, an attempt can be made to establish whether any significant change in behaviour has occurred in relation to the objectives of the module. The pre achievement test was prepared by the investigator himself which included all the points as mentioned in 3.4.2 (a to k) is given in Appendix V(a) . The answer key showing the correct responses for the pre achievement test is given in Appendix V(b)

3.6.3.2 Post Achievement Test: This instrument was developed to measure the achievement of students of all three groups on the topics taught to them during the study. This test was of the form of pre-test having the same questions and having same weightage to the content, marks, objectives, difficulty level, types of question and time distribution. The only difference was the sequencing of the question in the post-test. The sequencing of the questions was purposively changed as per the table of random numbers as Appendix VI (a) Changing the sequence of the questions reduced the sensitization to the instrument. The answer key showing the correct responses for the post achievement test is given in Appendix VI (b)

3.6.3.3 Delayed Post Achievement Test: It is also known as retention test. The delayed post test was developed for the purpose of measuring the retention of the topic taught to the students of all the groups. This test was form of post test. A table of random numbers was used to randomize the sequence of the questions of the post-test as Appendix VII (a). Changing the sequence of the questions and time interval (after three weeks from post-test) between administration of the post test and retention test reduced the sensitization to the instrument. The answer key showing the correct responses for the pre
achievement test is given in Appendix VII (b)

3.6.4 Opinionnaire: In order to study and measure the opinion of students towards the effect of multimedia approach and traditional method on retention and academic achievement of science students an opinionnaire was prepared.

Development and Description of Opinionnaire: The related literature and the steps involved in the production of the multimedia software was the source for the items. By going through the literature on multimedia, the investigator designed 60 statements containing positive and negative statements for the construction of opinionnaire in the rough draft. For screening the statements the criteria suggested by Edward (1957), Kilpatrick (1948) and Likert (1932) were applied. The opinionnaire was typed out and presented to a group of experts in the field for their critical comments. The tool was modified in the light of their comments and suggestions. In the light of criticism and comments of the experts, some statements were modified and about 15 statements were deleted. Thus, the final draft of the opinionnaire consists of 46 statements and is classified under the following eleven categories:

Table 3.9: Framework of the Opinionnaire

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>Category</th>
<th>No. of positive statements</th>
<th>No. of negative statements</th>
<th>Total no. of statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Quality of learning</td>
<td>4</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>Quality of teaching</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>New instructional settings/materials</td>
<td>5</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>Socialization</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>Change in teacher’s role/attitude</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>Development of student’s abilities</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Evaluation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>------------------------------------------------</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>8</td>
<td>Effect of multimedia approach on education system</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>Change in student’s role/attitude</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>10</td>
<td>Others</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>11</td>
<td>Overall effectiveness</td>
<td>Statement no. 45 was constructed to rate the developed multimedia software on the basis of the outstanding, excellent, average, fair and poor rating scale.</td>
<td>Statement no. 46 was constructed to welcome suggestion(s) from the students for improving this multimedia software further. It was an open ended statement.</td>
<td></td>
</tr>
</tbody>
</table>

In each category an equal number of positive and negative statements as far as possible were arranged at random. The statements were arranged on a five point scale with the response strongly agree, agree, undecided, disagree and strongly disagree. The final draft of the Opinionnaire used in the present study is given as Appendix VIII. For scoring, numerical values were assigned to the five categories of the response as indicated below:

**Table 3.10: Numerical Value assigned to the Opinionnaire Statements**

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive or Favourable</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Negative or unfavourable</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

### 3.7 PROCEDURE FOR DATA COLLECTION

Towards the starting of the academic year in the schools the principals of the various schools were contacted personally and prior permission was sought for administration of the tools. After getting the consent and approval of the school authorities. The finalized tools i.e. achievement tests, opinionnaire and retention test were administered on the sample. Necessary instructions were given to the students
to respond to the items in the tools. The filled achievement tests, opinionnaire and retention tests were collected back on the same day itself.

Following major steps were used in the data collection:

- Administration of the non-verbal intelligence test (Raven’s Standard Progressive Matrices Test).
- Administration of the pre-test to all the three groups.
- Conducting classes for control group with the help of the traditional method i.e. the conventional textbook approach commonly known as ‘chalk and talk’ method.
- Conducting classes for the experimental group-I with the help of the multimedia approach based multimedia package-I.
- Conducting classes for the experimental group-II with the help of the multimedia approach based multimedia package-II
- Administration of the post-test to all the three groups after experimental treatment.
- Administration of the retention test after three weeks for all the three groups.
- Administration of the opinionnaire to the experimental group-II for eliciting the opinion regarding the effectiveness of the self developed interactive multimedia instructional software.

**Administration of the Non Verbal Intelligence Test:** a standardized non verbal group test of intelligence i.e. Raven’s Progressive Matrices Sets A, B, C, D and E was administered to all the 186 students. The mean and standard deviation of intelligence test scores of the 90 students were calculated. Students who scored more than (M + S.D) were categorized into high intelligence group and who scored below (M – S.D.) was categorized into low intelligence group. The remaining students formed the average intelligence group. Out of the three categorized 90 students were randomly selected such that each group had 6 students (high intelligence), 18 students (average intelligence) and 6 students (low intelligence) thus comprising a
total of 30 students in both the experimental groups and control group.

Administration of the Pre-Test: a pre achievement test comprising 50 questions were administered to all the three groups i.e. Experimental Groups-I and II and the Control Group before the conduct of the experiment. The achievement scores of the three groups were tabulated in total and objective wise and are given as Appendix IX (a) and XI(a), XI(b), XI(c), XI(d). The total and objective wise scores of the pre test were given the necessary statistical treatments for the analysis and interpretation of the data.

Conducting Classes for Control Group: the control group was taught the same topic i.e. ‘Fundamental Unit of Life’ with the help of the traditional method. The researcher himself taught the control group. The instructions were provided through lecturing technique focusing attention to the conventional textbook material and to some extent to the problem solving. During treatment to this group “chalk and talk” remained the most frequently used approach. Students were asked to solve the exercises given at the end of the unit by themselves. Homework was also given and checked on daily basis and informal feedback was given. Teacher was more active throughout the treatment and students were passive listeners.

Conducting Classes for Experimental Group-I: The experimental group-I was also taught the same topic i.e. ‘Fundamental Unit of Life’ with the help of Multimedia Package-I which included Computer Assisted PowerPoint Presentations, a Comprehensive Booklet and Hands on experience on computers. The students were taught through the PowerPoint Presentations projected on a wall mounted screen with the help of a Sony LCD Projector connected with a computer in a computer lab. All the presentations related to the day wise topics as given in Appendix X were preloaded in the individual computers. The students were taught for a period of 40 minutes duration every day. The 40 minutes teaching was divided into two phases of 30 minutes and 10 minutes respectively.

During the 30 minutes teaching the teacher (researcher) showed the ppt to all the students for the scheduled topic of the day. Active discussions, skill of questioning, explanation, demonstration were part of the most frequently used approach. The multimedia presentation included text, graphics and images as major
component whereas audio and video as a minor component. The comprehensive booklet was also given to all the students.

During the remaining 10 minutes students were allowed to go through the slides on the computer on individual basis as a part of the self study and note down any difficulty or discuss any point which the find fit for the discussion. Handouts of the ppt. as given in Appendix I(a) to I (m) were supplied on the daily basis before the class teaching to the experimental group-I for their ready reference and to note down the points while discussion of the content takes place.

Students were given the formative assessments as per the planned schedule after each subunit. Immediate feedback was also given to the students of this group during the teaching and the assessment.

**Conducting Classes for Experimental Group-II:** Similarly the experimental group-II was also taught the same topic i.e. ‘Fundamental Unit of Life’ with the help of Multimedia Package-II which included **Self Developed Interactive Multimedia Instructional Software: e-Biology**, Computer Assisted PowerPoint Presentations, comprehensive booklet and hands on experience on computers. The self developed interactive instructional software was preloaded on the individual computers. For every lesson, the teacher introduced the topic for 15 minutes with the help of the PowerPoint presentations delivered via the same setup as provided to the experimental group-I. Thereafter, the researcher invited the students to go through the interactive multimedia software for the remaining 25 minutes. The comprehensive booklet was also provided to the students as ready reference. The teacher (researcher) facilitated the students if they came across some specific difficulty of content and accent. The whole unit was delivered according to the day wise schedule of the topics as given in Appendix X. Researcher remained in the laboratory for the whole time during the treatment. The role of the teacher (researcher) was more of a guide who performed the following:

- Kept a record of student’s progress on daily basis.
- Kept the student busy in purposeful activities by advising them to follow the instructions strictly.
- Observed the behaviour of each student in the laboratory and kept record of his interest, sense of responsibility and attitude towards learning through multimedia approach based interactive instructional software.

- Maintain discipline in the laboratory during treatment sessions.

- Helped students if they had any problem with the usage of the software.

In addition to the experimental group-I the experimental group-II was also provided with internet facility. The students of the experimental group-II got the opportunity to explore the internet facility for further enrichment of their knowledge by updating of the content of the ‘Fundamental Unit of Life’ online. The students were motivated to seek any clarification or query through the email. The researcher responded to their emails immediately. Handouts of the ppt. were supplied on the daily basis after the class teaching to the experimental group-II. Students were given the formative assessments as per the planned schedule after each subunit.

**Administration of the Post-Test:** The post-test was given to all the three groups on the very next day following the two weeks teaching to the students of all the three groups seated in a big hall. The total and objective-wise scores of the three groups in the achievement test as given in Appendix IX (b) and XI(a), XI(b), XI(c), XI(d) were tabulated for further comparisons and statistical analysis. Separate answer sheets were provided to the students.

**Administration of the Retention Test:** Three week subsequent to the post-test, delayed post-test was administered to all the three groups to measure the student retention of the topics taught to them during the treatment. This test was form of the post-test with the sequence of the questions changed randomly as given in Appendix XII The procedure and the conditions of the administration of the delayed post test were similar to the post-test. The total and objective-wise scores of the three groups in the achievement test as given in Appendix IX (c), and XI(a), XI(b), XI(c), XI(d) were tabulated for further comparisons and statistical analysis.

### 3.8 STATISTICAL TECHNIQUES USED

The main objective of the study is to assess the effectiveness of the multimedia approach and traditional method on academic achievement and
retention. For this the scores obtained through all the tools were consolidated and analyzed statistically. The mean and standard deviations of items in the achievement test and retention test were used. The opinionnaire was analyzed with the percentage score. The 't' test and ANOVA were used for comparison. The percentage of positive responses for all the items in the opinionnaire was calculated.

In order to test the performance regarding the use of multimedia approach, paired 't' test was done using the pre-test, post test scores. Analysis of Covariance was applied for overcoming the slight difference in the pre-test scores. The pre-test scores and post test scores of the two experimental groups and the control group (total and objective wise scores) were compared using the statistical technique of Analysis of Covariance.

Comparison of performance of students in experimental group-I and control group was done in terms of pre test, post test and retention test scores. Similarly performance of students in experimental group-II and control group was done. Likewise the comparison of performance of experimental group-I and experimental group-II was also carried out.

Comparison of effectiveness of multimedia package-I and multimedia package-II with traditional method for secondary school science students using ANCOVA with regard to total achievement and retention scores was also carried out.

Multimedia packages and performance of the students according to the objective wise achievement and retention was also compared. A similar comparison among the three groups at varying level of intelligence was also carried out to find out effectiveness of the developed packages for the students of differential intellectual abilities.

Lastly the opinionnaire was analyzed with the percentage score. The percentage of positive responses for all the items in the opinionnaire was calculated.