CHAPTER III

PLAN AND PROCEDURE
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page No</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Introduction</td>
<td>80</td>
</tr>
<tr>
<td>3.2</td>
<td>Statement of the problem</td>
<td>80</td>
</tr>
<tr>
<td>3.3</td>
<td>Experimental research</td>
<td>82</td>
</tr>
<tr>
<td>3.4</td>
<td>Research design</td>
<td>83</td>
</tr>
<tr>
<td>3.5</td>
<td>Main objective of the study</td>
<td>84</td>
</tr>
<tr>
<td>3.6</td>
<td>Variables of the study</td>
<td>85</td>
</tr>
<tr>
<td>3.6.1</td>
<td>Independent variables</td>
<td>85</td>
</tr>
<tr>
<td>3.6.2</td>
<td>Demographic variables</td>
<td>86</td>
</tr>
<tr>
<td>3.6.3</td>
<td>Dependent variables</td>
<td>86</td>
</tr>
<tr>
<td>3.7</td>
<td>Hypotheses formulated</td>
<td>86</td>
</tr>
<tr>
<td>3.8</td>
<td>Methods used in the study</td>
<td>88</td>
</tr>
<tr>
<td>3.8.1</td>
<td>Method-I Control group</td>
<td>89</td>
</tr>
<tr>
<td>3.8.2</td>
<td>Method-II Experimental groups</td>
<td>89</td>
</tr>
<tr>
<td>3.8.2.1</td>
<td>Group I – Programmed Learning Method (PLM)</td>
<td>89</td>
</tr>
<tr>
<td>3.8.2.2</td>
<td>Group II – Computer Assisted Instruction (CAI)</td>
<td>89</td>
</tr>
<tr>
<td>3.8.2.3</td>
<td>Group III – Multimedia Package (MMP)</td>
<td>89</td>
</tr>
<tr>
<td>3.9</td>
<td>Tools and techniques used for the study</td>
<td>90</td>
</tr>
<tr>
<td>3.10</td>
<td>Changing paradigms of teaching Cell Biology</td>
<td>90</td>
</tr>
<tr>
<td>3.11</td>
<td>Principles of learning</td>
<td>91</td>
</tr>
<tr>
<td>3.12</td>
<td>Application of PLM</td>
<td>92</td>
</tr>
<tr>
<td>3.12.1</td>
<td>Structure of programmed Learning Method (PLM)</td>
<td>92</td>
</tr>
<tr>
<td>3.12.2</td>
<td>Validation of PLM</td>
<td>96</td>
</tr>
<tr>
<td>3.13</td>
<td>Application of CAI Package</td>
<td>96</td>
</tr>
<tr>
<td>3.13.1</td>
<td>Structure of Computer Assisted Instruction (CAI)</td>
<td>97</td>
</tr>
<tr>
<td>3.13.1.1</td>
<td>Structure of Volume I</td>
<td>98</td>
</tr>
<tr>
<td>3.13.1.2</td>
<td>Structure of Volume II</td>
<td>100</td>
</tr>
<tr>
<td>3.13.1.3</td>
<td>Structure of Volume III</td>
<td>102</td>
</tr>
<tr>
<td>3.13.2</td>
<td>System requirements for CAI</td>
<td>103</td>
</tr>
</tbody>
</table>
CHAPTER – III
PLAN AND PROCEDURE

3.1. INTRODUCTION

This chapter explains the plan and procedure of the study. The main method for the present investigation is an experimental method. Based on the analysis of the methods of teaching and on the outcomes of the experimental studies, the PLM (Programmed Learning Method), CAI (Computer Assisted Instruction) and MMP (Multimedia Package) were developed. The method adopted for the study, the experimental design, procedure and the statistical techniques employed for the analysis of data are described under appropriate sections.

Scientific inquiry stands for a systematic and investigative performance ability which incorporates unrestrained inductive thinking capabilities after a person has acquired a broad and critical knowledge of the particular area after thorough formal learning process. All these views indicate the need for a science and technology training which provides knowledge, skills, attitudes and values.

As the goal of education begins to change the new social and educational needs, teaching strategies must also change and so, consequently, do strategies for integrating technology into teaching and learning. Education should emphasize more general capabilities for learning to learn that will help future citizens to cope with inevitable changes (Bindu 2007).

3.2. STATEMENT OF THE PROBLEM

The statement of the problem is “EFFECTIVENESS OF MULTIMEDIA STRATEGIES IN LEARNING BOTANY AT HIGHER SECONDARY LEVEL”.

80
Operational definitions of the key terms

**Effectiveness**

Effectiveness means making a striking impression in the task. In the present study the positive effect in the achievement tests using the intervention strategies especially in learning Botany.

**Multimedia strategies**

Multimedia strategies mean multiple strategies are used by the researcher in this study to find out the effectiveness of the particular strategy in learning Botany. The strategies adopted for this study are conventional teaching, programmed learning method, computer assisted instruction and multimedia package. Conventional teaching method is the classroom teaching method followed in the educational system of Tamilnadu, India.

i) **Programmed Learning method**

In the past decades, the learning theory given by B.F.Skinner was followed. But now it was replaced by computers. To fill the gap between the conventional teaching and computer related Computer Assisted Instruction, the researcher included Programmed learning method in this study. The unit “Cell Biology and Genetics” is taken and it was prepared like skinner’s linear programming method, as a paper and pen technique in the form of a booklet.

ii) **Computer Assisted Instruction**

The same unit “Cell Biology and Genetics” was prepared by using computer. Text is given as frame wise along with picture and some multiple choice questions gives interactivity to the learner.

iii) **Multimedia package**

Multimedia is a combination of several mediums like text, graphic, sound, video and animation. Vanaja and Rajasekar (2006), in their study explains, “Interactive multimedia encourage students to seek information, apply knowledge and re-attempt tasks (based on feedback...
given), behaviours that are associated with higher order learning". Multimedia has been proved that in schools it is effective for constructive knowledge actively, work in groups or individual and use multi senses at a time.

The researcher has developed multimedia package method in the same unit “Cell Biology and Genetics” of subject Botany. The multimedia provides much interactivity, animations, more pictures, sounds and videos and others to each and every part of the concepts. At the end of each part of the concept, it contains multiple choice questions to check the students' understanding level then and there.

Through multimedia the learner is exposed to a variety of information which helps in a clearer understanding of a subject. The learner can make use of the information contained in the package with different volumes from basic to advance.

**Higher secondary level**

Higher secondary level refers to any school curriculum recognized by the government of Tamilnadu, India imparting instruction to students at the XI and XII levels. Higher secondary school curriculum was started by the government of Tamilnadu in the year 1978 and subsequently restructured in every three years.

**3.3. EXPERIMENTAL RESEARCH**

The researcher had chosen experimental method for her study. The research process is related to classroom learning and teaching experiences and the learner's achievement in learning is measured.

According to the view of Johnson and Christensen (2007), experimental research provides a systematic and logical method for answering the question done under carefully controlled conditions. Experimenters manipulate certain stimuli, treatments, or environmental conditions and observe how the condition or behavior of the subject is affected or changed. Experimenter must be aware of other factors that
could influence the outcome and remove or control them so that they can establish a logical association between manipulated factors and observed effects.

According to Campbell and Stanley (1963), “the experiment is the only means for setting disputes regarding educational practice, in which improvements can be introduced without the danger of a faddish discard of old wisdom in favour of inferior novelties”

3.4. RESEARCH DESIGN

The researcher followed quasi experimental study with parallel – group design and the sampling is convenient sampling.

1. Objectives
To develop a PLM, CAI and Multimedia Package and to validate the PLM, CAI and Multimedia package in “Cell Biology and Genetics” and to compare it.

2. Variables under Study
   a) Values of Independent variables - PLM, CAI and Multimedia package.
   b) Dependent variables - Achievement test.
   c) Demographic variables - Type of schools, gender and area.

3. Sample selected for
   a) Validation of PLM
      30 XII standard students (Individual tryout)
      40 XII standard students (Group tryout)
b) Validation of CAI 30 XII standard students (Pre.
   Validation)
60 XII standard students
(Experimentation)
c) Validation of MM Package 35 XII standard students (Pre.
   Validation)
60 XII standard students
(Experimentation)

4. Tool (Multimedia Opinion Schedule)
a) Reliability of MMOS 60 XI and XII Botany teachers
b) Validity of MMOS Professors in Universities
   and Media Technology experts.

5. Achievement test
a) Validation of Achievement test 40 XI and XII botany Teachers
b) Reliability of Achievement test 60 XII standard students

6. Tools used PLM, CAI, MM package on
   'Botany', MMOS for Teachers,
   Achievement test for the
   students.

7. Statistical Techniques used Mean, S.D, 't' –test, 'F' –test,
   and ANOVA.

8. Variables measured Pre test score, Post test score,

3.5. MAIN OBJECTIVE OF THE STUDY

The main objective of the study is to find out the effectiveness of
conventional teaching, PLM, CAI and Multimedia package as learning
methods.
3.6. VARIABLES OF THE STUDY

The word variable means the facts which brings about a change or may be the result of that change. The main definitions of variables are,

Kerlinger.F.N (1986)  "Variables are a property that takes on different values".

Garrett.H.E. (1981)  "Variables are attributes or qualities which exhibit differences in magnitudes and which vary along some dimensions".

A hypothesis suggests that an antecedent condition called independent variable causes another condition, event or effect in the dependent variable to occur. Some researchers apply different names to these factors, such as

⇒ cause and effect,
⇒ stimulus and response,
⇒ antecedent and consequent,
⇒ experimental variable and behavioral variable, and
⇒ treatment and effect.

The researcher has used the treatment and effect relationship for the present study.

3.6.1. INDEPENDENT VARIABLES

In an educational research an independent variable may be a particular teaching method, a type of teaching material, a reward, a period of exposure to a particular condition, or an attribute such as sex or level of intelligence (Best and Kahn 2007).

The values of the independent variables of the present study are PLM, CAI and MMP. The impact of multimedia package learning
method over the other methods on higher secondary student’s achievement has to be studied. The method of instruction or teaching method in the form of multimedia package has been manipulated to study the effectiveness.

3.6.2. DEMOGRAPHIC VARIABLES

Type of schools, gender and locality are the demographic variables in the study. Government and government aided schools come under one category named government aided schools; the other category is matriculation schools named as private schools. So government aided and private schools are the two types of variable among the demographic variable, type of schools. Boys and girls are in the category of gender, whereas the locality is urban and rural.

3.6.3. DEPENDENT VARIABLES

Dependent variables are the conditions that appear, disappear or change as the experimenter introduces, removes or changes independent variables.

The dependent variable may be a test score, the number of errors, or speed in performing a task. Thus the dependent variables are the measured changes in pupil performance attributable to the influence of the independent variables (Best and Kahn 2007).

The study focuses on enhancing student’s performance by using different methods of instruction and the effectiveness of learning botany. The effectiveness is measured in terms of achievement test taken as the dependent variable.

3.7. HYPOTHESES FORMULATED

PLM, CAI and Multimedia packages are developed, on the selected concepts of higher secondary syllabus. All the strategies are tested for its effectiveness as a new method for learning botany over the other methods. It is also compared with the conventional group of learning.
The hypotheses of the study are,

i) There is a significant difference between their pre and achievement scores of students who learnt Botany through
   a) Conventional teaching.
   b) Programmed Learning Method (PLM).
   c) Computer Assisted Instruction (CAI).
   d) Multimedia package (MMP).

ii) There is a significant difference between and among the groups of various strategies
   a) Conventional teaching.
   b) Programmed Learning Method (PLM).
   c) Computer Assisted Instruction (CAI).
   d) Multimedia package (MMP).

iii) There is no significant difference in the post test of conventional teaching methods between
    a) Government aided and private school students
    b) Boys and girl students
    c) Rural and urban area students

iv) There is no significant difference in the post test between the students who studied Botany through PLM among
    a) Government aided and private schools
    b) Boys and girls
    c) Rural and urban area
v) There is no significant difference in the post test between the students who studied Botany through CAI among
   a) Government aided and private schools
   b) Boys and girls
   c) Rural and urban area

vi) There is no significant difference in the post test between the students who studied Botany through MMP among
   a) Government aided and private schools
   b) Boys and girls
   c) Rural and urban area

3.8. METHODS USED IN THE STUDY

Control and experimental are the groups in the study. For the control group conventional teaching method, whereas for the experimental groups self learning packages are the teaching methods followed in this study. Conventional teaching for the control group and for experimental groups the methods of PLM, CAI and MMP are used for the study.

i) Details of Self Learning Packages

Details of Self Learning Packages

FIG. 1.2
3.8.1. METHOD I: CONTROL GROUP

In conventional teaching, there is no difference in all types of school such as government-urban, government-aided, matriculation rural and urban. Here, government and government-aided in the rural areas are not taken for this study because of the unavailability of English medium students. The method of teaching was chalk and talk method, clearing the doubts with illustrated examples and using minimum requirements of low cost technology. Repeated drill and assignments are the regular pattern of works given to this group.

3.8.2. METHOD-II: EXPERIMENTAL GROUPS

Three experimental groups present in the study are, programmed learning method, Computer assisted instruction and multimedia package.

3.8.2.1. GROUP I-PROGRAMMED LEARNING METHOD (PLM)

Experimental method-I (PLM) is used as a treatment method for government, government aided in urban area, private matriculation in rural and urban groups. The method of teaching was printed book matter in a programmed learning format. The answers followed by a response.

3.8.2.2. GROUP II-COMPUTER ASSISTED INSTRUCTION (CAI)

The experimental method-II (computer assisted instruction) was the method adopted for the experimental group-II. Chapters are divided into simple concepts and given easily with the help of computer. Text is given by using computers a frame wise with pictures and objective type questions.

3.8.2.3. GROUP III- MULTIMEDIA PACKAGE (MMP)

Experimental Method-III (Multimedia Package) has been used as a method for government and government aided urban, private matriculation schools in rural and urban area. Using computers the developed CAI is improved as MMP. Repeated drill option, learner’s
own pace of instruction and video, and animations make the learner understand the content easily.

### 3.9. TOOLS AND TECHNIQUES USED FOR THE STUDY

Software is used to enhance the teaching and learning process in all subject areas. Computer tools act as "cognitive enhancers" to broaden the capabilities of the student (Dede 1987).

A good number of tools are found necessary for the collection of data required to test the hypothesis. The details regarding all these tools and techniques employed for the study are presented below.

a) **Methods or techniques used in this study are,**
   
i) Conventional teaching
   
ii) PLM
   
iii) CAI
   
iv) MMP

b) **Tools for the study**
   
Tools used in the study are:-
   
i) Multimedia opinion schedule (MMOS)
   
(For teachers)
   
ii) Achievement test (For students)

The tools are prepared by using higher secondary school level syllabus. The researcher has taken the units of "cell biology and genetics" in the subject Botany and the book was published by Tamilnadu textbook corporation, Government of Tamilnadu, India.

### 3.10. CHANGING PARADIGMS OF TEACHING CELL BIOLOGY

Cytology or cell biology, in Greek terms ‘kytos’ means hollow vessel or cell, ‘logous’ means to discourse. Cell biology is a biological science which deals with the study of cells from morphological,
biochemical, physiological, developmental, genetical, pathological and evolutionary point of views. The branch of biology which deals with the facts and laws of heredity and inherited variations is known as genetics (Kochhar 1989).

According to UNESCO group (1971), science actually implies the knowledge of this world and the way of gaining that knowledge. Scientific method implies asking appropriate questions, seeking relevant answers, setting out the evidence in a clear way and drawing conclusions from this (Abraham 2006).

Early attempts at computer assisted instruction was based on reducing the time and place with the added advantage of individual processing by the student. A highly effective model of inquiry based learning was the BSCS (Biological Science Curriculum Study) of the 1960's (Malhotra 2007).

The study of biology especially botany starts from school level to adulthood. The present study focuses the basic concept of cell biology and genetics with technology.

3.11. PRINCIPLES OF LEARNING

In order to create educational media which are effective teaching instruments, educational technologists should follow a general learning theory upon which they can model their innovation. The core problem in a science of instruction is the process by which the individual student learns. Students do not learn merely by looking at or reading the content, they themselves learn. The learner is exposed to interact with the material or stimuli; he must interact with that material in some active fashion.

Learning with computers is capable of stimulating active involvement which aids learning. Various instructional materials differ primarily in the degree of sensory experience they are able to provide. The more the student employs, the better will be the learning experience.
The three types of learning methods are prepared that enhance learning botany in an interesting way. One is programmed learning method, second is computer assisted instruction and the third one is multimedia package.

3.12. APPLICATION OF PLM

In the present scenario computer occupies a major role in the environment of learning. So computer packages were developed by the researcher to find out the effectiveness of the strategies in learning when it is compared with conventional teaching. There is a jump between conventional teaching method and computer technology based packages. In our educational system, before the advent of technology, the technique of programmed learning was introduced by Skinner. In the present study, to substantiate the gap between conventional method of teaching and computer package based teaching, programmed learning method has been adopted as one package for a group of learner. Cell biology and genetics chapter has been divided into sub topics. Each subtopic is clearly defined or explained along needed examples are given a simple way. The learner has to read the explanation and understand the concept. A simple objective question has been asked from the above concept and the learner must answer the question. The answer is given in the left side of the next frame or a page after. Immediate feedback is given for the answers in the right side, with the feedback learner moves to the next concept. The researcher has used in this research for PLM as paper pen technique.

3.12.1. STRUCTURE OF PROGRAMMED LEARNING METHOD (PLM)

Programmed leaning method has emerged out of the experimental research on operant conditioning which was formulated by B.F. Skinner. Programmed learning involves instruction with carefully specified goals and skillfully arranged learning experiences which are self instructional and self corrective. Skinner (1954), programmed
learning is the first application of laboratory technique utilized in the study of the learning process to the practical problems of education. According to Leith (1966), a programme is a sequence of small steps of instructional material called frames, most of which require a response to be made by completing a blank space in a sentence. Such a sequence is intended to be worked at the learner’s own pace as individualized self instruction.

A large number of small easy to take steps make a programme. A student can proceed from knowing very little about a topic to the mastery of the subject by going through a programme. The linear type of programme is originated by Skinner and his associates. This type of programming is directly related to his theory of operant conditioning and is based on the assumption that human behaviour can be shaped or conditioned gradually, step by step with suitable reinforcement for each desired response. Here questions are asked directly and the learner is required to think and write down his answer. A constructed response is the term used to refer to the answers.

According to Sharma & Sharma in Encyclopedia of Education (2009), properly employed programmed instruction can free the teacher from much routinized work.

The learner begins from the initial frame and ends at the terminal frame following the ordered sequence. In this type of programme every student must go through each and every frame in a straight line fashion, hence it is called a linear programme. But each student has the liberty to complete the programme at his/her own pace and ability. Subject matter is broken down into very small steps and each step is presented in proper sequence. In the succeeding frames, the active responses of the learner are reinforced instantly. In some frames cues or prompt are provided to aid in getting correct response and to reduce errors.
There are twenty five frames based on the concept cell biology and genetics has been developed by the researcher (Varma and Agarwal 1988).

The frames of the PLM are,

i) Cytology

ii) Cell theory

iii) Cytogenetics

iv) Eukaryotic cells

v) Structure of a chromosome

vi) Type of chromosomes

vii) Autosomes and sex chromosomes

viii) Special types of chromosomes

ix) Gene and Genome

x) Linkage

xi) gene mapping

xii) Recombination of chromosomes

xiii) Mutation

xiv) Addition and Substitution Mutation

xv) Chromosomal aberration – Deletion and Duplication

xvi) Inversion and Translocation

xvii) Numerical chromosomal aberrations

xviii) DNA as a genetic material

xix) Heredity role of DNA transformation

xx) Structure of DNA

xxi) Erwin Chargaff’s law or base pair law

xxii) Replication of DNA
xxiii) Types of RNA

xxiv) DNA and RNA

Each frame contains a concept. Learner after mastering the concept must answer the question given at the bottom. Answer of the question is given in the next frame followed by a response. Learner's answer is instantly checked against the correct answer which appears in the next frame. So the learner verifies the answer then and there. Sometimes if the answer is not known also can move to the next frame. Sample frames are given below.

**CELL BIOLOGY AND GENETICS**

<table>
<thead>
<tr>
<th>Replication</th>
<th>V.Good</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Structure of DNA</strong></td>
<td></td>
</tr>
<tr>
<td>DNA is a double stranded polynucleotide. Each nucleotide is made up of pentose sugar, a phosphate group and a nitrogenous base. Four kinds of nucleotides are Adenine, Guanine, Thymine and Cytosine. Adenine and guanine are the Purines. Cytosine and thymine are the Pyrimidines. Adenine and guanine are the _______ .</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Purines</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Erwin Chargaff’s law or base pair law:</strong></td>
<td></td>
</tr>
<tr>
<td>1. Adenine always pair with thymine and guanine pairs with cytosine.</td>
<td></td>
</tr>
<tr>
<td>2. Total no of purine nucleotides is always equal to the total no of pyrimidine nucleotides.</td>
<td></td>
</tr>
<tr>
<td>3. The proportion of adenine is equal to thymine and also guanine is equal to cytosine. Erwin Chargaff’s law is otherwise known as _______ law.</td>
<td></td>
</tr>
</tbody>
</table>

| base pair | Good |

95
3.12.2. VALIDATION OF PLM

i) Individual try-out

ii) Group try-out

i) Individual Try-out

Developed PLM has been given to thirty individual XII Std students for individual try-out. Here, the researcher sits face to face with the randomly selected individuals. This gives an opportunity to the researcher to study the reactions of the learner in respect to the stimulus and response part of the frames. Thirty numbers of individuals are to be tried out for the quality of the draft frames and the degree of refinements the researcher needs. After each individual try-out, the programme gets refined. Thus after the completion of more number of individual try-outs, the material becomes better refined.

ii) Group try-out

After the feedback of the individual tryout, the programmed learning material (PLM) is given to forty XII STD higher secondary students in the printed format for group try out. Sufficient time will be given for the students to read and answer the questions. The time taken to complete the material was noted down. The reaction of the students during the group tryout will be noted down by the researcher, so that, it may be considered for further refinement. Based on the feedback and suggestions given by the students along with their science teachers, modifications such as removing and increasing the content, corrections of the biological terms were made by the researcher and used in this research as a PLM method. Thus the validity and reliability was established for PLM in the study.

3.13. APPLICATION OF CAI PACKAGE

The researcher has chosen the topic of cell biology and genetics in this chapter. CAI package contains three volumes. The chapter cell biology and genetics has been taught in a traditional conventional
teaching format were converted into a developed PLM. Then the
developed PLM was/is modified into a CAI package in an elaborate
way. The learning package of CAI is user friendly.

The users "open" the volume by moving the cursor, to the arrow
in the index page and click the mouse. Inside the volume it opens with
subtopics. The user "opens" the subtopics by the same procedure to
make it open as frame of the subtopic is displayed. When the frame is
displayed, by using the cursor to the bottom of the right-hand corner and
clicking the mouse, the user can go to the next page of the frame. Pages
of the frames are turned by activating the triangular shaped buttons at
the bottom of the right-hand corner facing east and west. All the
volumes are written in simple sentences with an easy understanding.
Based on the needs of the learner, the content is arranged in the form of
simple to complex.

3.13.1. STRUCTURE OF COMPUTER ASSISTED
INSTRUCTION (CAI)

The chapters are divided into many meaningful lessons,
according to the context of botany subject in the form of volumes. The
chapter is divided into a number of sub concepts. Some of the sub
concepts are further divided into small concepts. Each small concept is
arranged by the researcher in the form of frames. Every frame is added
with necessary and suitable pictures. Navigated test button with
questions and three multiple answers are given in the frames. The index
page of the package appears as,

"Cell biology and genetics"
   I. Volume I
   II. Volume II
   III. Volume III
3.13.1.1. STRUCTURE OF VOLUME I

Volume - I consists of number of sub-topics of cell biology and they are given in an orderly form. The main subtopics in volume - I are,

**Volume I**

**Index**

I. Introduction / Historic view  
II. Cell theory  
III. Cytology with other biological science  
IV. Cell types and cell organelles  
V. Cytoplasmic organelles  
VI. Nucleus

When the learner’s cursor is over the labels of the topic, that particular topic’s label is highlighted with molecules are in a running position. Each topic is opened by a left click; it opens with the main text frame. Buttons related to the frame or Volume lies in the right side of the frame. At the bottom of the frame there is a two triangular shaped buttons facing east and west. If the text is learnt by the learner, the learner can make a click on the button to move to the next page of the frame.

The learners can master the sub-topic easily. If the learner immediately wants to check the mastery level of the subtopic, the test button helps. After the test, if the learner feels that obtained score is not satisfactory, he/she can take the same sub-topic again without any hesitation.

The same procedure can be adopted to the next subtopic which is chosen by the learner. It starts from the subtopic, “Introduction and Historical view” and continues up to the subtopic “Nucleus”. After all the concepts are learnt in Volume -I, then the learner can go to the next volume that is Volume II which is also a continuation of the same topic “cell biology and genetics".
Structure of DNA

DNA and RNA are identified in the nucleus. DNA is a macromolecular substance with double stranded polynucleotide. Each nucleotide is made up of pentose sugar, a phosphate group and a nitrogenous base. Four kinds of nucleotides are adenine nucleotide, guanine nucleotide, thymine nucleotide and cytosine nucleotide. Hence nucleotides are building blocks of DNA. There are two grooves found in DNA molecule namely major and minor groups.

Types of RNA

Transfer RNA:

Transfer RNA is also known as soluble RNA (sRNA). The most important function is to act as a carrier of amino acid to the site of protein synthesis.

Structure: The tRNA has a clover leaf like structure. It has four loops namely anticodon loop, D loop, TVC and amino acid acceptor arm. The acceptor arm carries an amino acid. tRNAs in addition to these four arms an extra arm called variable arm.
3.13.1.2. STRUCTURE OF VOLUME II

Volume II consists of a number of subtopics of genetics and they are again subdivided into many subheadings. Based on the textual concept the sub-topics are arranged in the following manner.

Volume II

Index

I. Chromosome

II. Gene

III. Linkage

IV. Crossing Over

V. Mutation

VI. Chromosomal aberrations

VII. Numerical chromosomal aberration

VIII. DNA

IX. RNA

Subtopics and the other subheadings are,

I. Chromosome
   i) Structure of chromosome
   ii) Types of chromosome
   iii) Autosomes and Sex chromosomes
   iv) Unusual / Abnormal chromosomes
   v) Special types of chromosomes

II. Gene

III. Linkage
   i) Mechanism of Linkage —Coupling
   ii) Mechanism of Linkage — repulsion
IV. Crossing over
   i) Significance of crossing over
   ii) Gene mapping
   iii) Recombination of chromosome

V. Mutation

VI. Chromosomal aberrations

VII. Numerical chromosomal aberrations

VIII. DNA
   i) Transformation of DNA
   ii) Structure of DNA
   iii) Replication of DNA

IX. RNA
   i) Structure of RNA
   ii) Types of RNA

In Volume-II also the labels of the topic is highlighted like molecules in a running position. Volume-II has subtopics and subheadings. Each sub-topic is arranged in a sequential manner. Each sub-topic has few sub headings and few sub-topics have direct explanation frames. If the learner selects one sub topic, from that all the sub headings can be learnt by the learner.

Each and every subheading can be mastered by the learner and every individual. The learner can take up a test separately. If the learner in a particular test cannot perform well, and the learner has doubt over the content the learner can choose that particular subheading again. After clearing the doubts, the learner proceeds to the next subheading in the particular sub topic. It makes the learner to mastery over the level of the concept thoroughly. Then the learner proceeds to the next
subheading. When the subheadings are learnt by the learner the learner can choose the next subtopic.

While learning the concept, it is like formative evaluation, the learner themselves evaluate her or him to check the mastery level of the concepts. This gives self confident and creates interest to the learner. In the second volume the learning starts from the sub topic “Chromosome” to the subtopic “RNA”. All the subtopics and subheadings are covered in the unit cell biology and genetics in Volume-I and II.

3.13.1.3. STRUCTURE OF VOLUME III

Volume III has some topics given to the learner’s choice to evaluate by themselves.

i) FAQ’s

ii) MCQ’s

i) FAQs – frequently Asked Questions

Questions are asked at the back of the text book which follow the State Government of Tamilnadu and also from public examination question papers conducted every year by the Government under the department of education. All the questions are given with answers for the learner’s reference. Necessary diagrams related to the questions also given along with answers. Each page of the question bears the button with home picture and is used to move on to the index page of Volume-III.

ii) MCQ’s – Multiple Choice Questions

In volume-I multiple choice questions are given to each and every sub topic. In volume-II each and every sub headings from the sub topic is given with multiple choice questions. In volume-III, both multiple choice questions of volume I and II are combined and given continuously to the learner to take a test. There are one hundred and sixty three MCQ’s in volume-III to check the mastery level of the
learner by themselves. This enhances learning and increases their memory and retention level of the concept.

Each page of the frame contains one question with three multiple answer options. The same procedure was followed in volume -III as it was followed in volume-I and II. In volume-III, test page has a top arrow button facing north side, which is used to move on to the index page. But in Volume-III each MCQ's is added its score at the end, out of one hundred and sixty three, the learner can check the individual scores. This makes the learner score more marks in their achievement test. The score is not recorded in the package; so that the learner feels free in using the package again and again for the MCQ's to revise the needed concept well.

3.13.2. SYSTEM REQUIREMENTS FOR CAI

i) Software

Adobe Flash CS5 is used for developing the Multimedia package. Flash player is used for running the project hence it should be installed in the user computer.

ii) Hardware

System with Pentium IV or above processors, 512Mb of RAM and a color display The folder contains .swf file which can be played using flash player 8.0 or above.

iii) Flash Shockwave file

The folder contains .swf file which can be played used flash player 8.0 or above.

3.13.3. DETAILS OF THE FOLDER-CAI PACKAGE

i). Copy the folder “Botany-CAI” in your computer.

ii). Locate the file “Start’ and double-click to run.

A complete package of information stored in the system is presented sequentially. It is displayed on the computer screen.
3.13.4. VALIDATION OF CAI PACKAGE

After the development of the CAI package, it is given to the subject experts, computer professionals. The package is given to a small group of thirty XII standard higher secondary school students for pre-validation. The average time taken to complete the package has been noted and it has taken ninety minutes. Students are asked to give suggestions for improvement of the CAI package. They say about the lengthy texts of few pages, ambiguity of certain questions and terms of the biological concepts. Appropriate modifications such as removing and increasing the page, corrections of the biological terms are made based on the suggestions given by the students and other experts. After the refinements the package is now ready for experimentation.

Sixty XII standard higher secondary students are taken for experimentation and instructions are given regarding the CAI package along with their school science teachers. In the first day the researcher explained about the package and its navigation. Then the students are allowed to use the package. The second and third day, Students go through the package with the help of the computer and asked to give frame wise suggestions over the package along with their science teachers. Based on their feed back and suggestions given by the students along with their science teachers, the necessary refinements and modifications have been done. Thus the validity and reliability of the CAI package has been established for this study.

3.14. APPLICATION OF MULTIMEDIA PACKAGE

Cell biology and genetics are taught in a traditional conventional teaching format and they are converted into a developed PLM. Then the developed PLM has been modified into a CAI package. The chapters in CAI are divided into many meaningful lessons, according to the context of botany subject in the form of volumes. Later the CAI package has been developed with all the features of multimedia components along
with audio, video, animation and pictures. In addition to that related facts, explanation of the cytological terms and scientists with their discoveries regarding cell biology and genetics are included in to multimedia presentation. This makes the learner feel the package user friendly.

3.14.1. INTERACTIVE MULTIMEDIA LEARNING PACKAGE

The chapter's cell biology and genetics was converted into a multimedia format. Each chapter has been divided into subtopics. In volume I and II, each subtopic is further subdivided into number of subheadings depending upon the level of the content. Both subheadings and subtopics have a number of frames. Each subheading contains fields of text, voice, pictures, animations, video and buttons that invoke action. Text is typed. Drawings and photographs are digitized and placed in an appropriate format for display within the explanatory part. Also colour images are displayed within the frame. Animations are created and presented, sounds are digitized and utilized, and other data may be presented.

All the buttons in the learning package are user friendly. Navigation is made easy through animated buttons. When the learner moves the cursor over the button, the colour of the button appears bright. Depending upon where the buttons are in the package, it differs. With the help of these buttons the learner can experience much interactive ness.

3.14.2. STRUCTURE OF MULTIMEDIA PACKAGE

Computer mediated learning includes multimedia to provide interactivity with built-in questions and answers by frequent pauses provided by the teacher and by way of group discussion mode of teaching which will create meaningful learning. Multimedia is "woven
combinations of text, graphic, art, sound, animation, and video elements" (Vaughan 1998).

Multimedia package starts with the welcome screen displays videos used inside the project with animated cell structure and titles that are to be explained inside. Animated cell structure and titles are with music in the welcome screen and extend up to 26 seconds before entering into the main page of the learning package. At the end, it displays the topic cell biology and genetics. Welcome screen stimulates the sensory organs of the learner with motivation and create readiness to learn the content. Multimedia package can be skipped without the welcome screen. The skip button is optional for the learner.

After the welcome screen of the learning package, the index page of the package appears as,

"Cell biology and genetics"

I. Volume I

II. Volume II

III. Volume III

The package contains three volumes. The first volume teaches cell biology, the second volume teaches the aspects of genetics and the third volume contains terminologies, Biological scientists and their inventions, frequently asked questions (FAQ's) and Multiple choice questions (MCQ's).

3.14.2.1. STRUCTURE OF VOLUME I

Volume - I consists of a number of subtopics of cell biology and they are given in an orderly form. The main subtopics in volume - I are:-

Volume I

Index

i. Introduction / Historic view

ii. Cell theory

106
iii. Cytology with other biological science
iv. Cell types and cell organelles
v. Cytoplasmic organelles
vi. Nucleus

When the learner’s cursor is over the labels of the topic, that particular topic’s label is highlighted with molecules in a running position. Each topic is opened by a left click; it opens with the main text frame. Buttons related to the frame or Volume lies in the right side of the frame. At the bottom of the frame there is a two triangular shaped buttons facing east and west. The text is visible to the learner to read along with a number of pictures or animations and they are arranged like slides. The text can hear clearly through the audio.

If the text is learnt by the learner, the learner can make a click on the button to move to the next page of the frame. The learner can have the options to click the facts button, to know the related facts, to click the test button to take a test. Likewise he can make use of picture and video buttons to understand the related picture or videos to enhance the learning better.

The learners can master over the subtopics easily. If the learner immediately wants to check the mastery level of the subtopic, the test button helps. After the test, the learner feels that obtained score is not satisfactory; the learner can take the same subtopic again without any hesitation.

After mastering the concept in the particular frame, the learner can select the next page of the concept using the option bottom. When the concept of all the frames is mastered by the learner, the learner can take up a test by selecting the test button option. A screen is displayed with questions related to the concept mastered by the learner. A multiple choice question is given with three options bearing small round button,
all the buttons appear bright. If the learner, once selects any option of the answer the buttons are faded. Then the frame displays the answer selected by the learner. The frame displays the answer selected by the learner at the bottom side, whether the selected answer is correct or wrong and the score also. If the selected answer is wrong then the score is 0. If the selected answer is right then the score is 1.

The same procedure can be adopted to the next subtopic which is chosen by the learner. It starts from the subtopic, “Introduction and Historical view” and continues up to the subtopic “Nucleus”. After all the concepts are learnt in Volume I, then the learner can go to the next volume that is Volume II which is also a continuation of the same cell biology and genetics.

3.14.2.2. STRUCTURE OF VOLUME II

Volume II consists of a number of subtopic of genetics and they are again subdivided into many subheadings. Based on the textual concept the subtopics of volume II are arranged in a following manner.

<table>
<thead>
<tr>
<th>Volume II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Index</td>
</tr>
<tr>
<td>I. Chromosome</td>
</tr>
<tr>
<td>II. Gene</td>
</tr>
<tr>
<td>III. Linkage</td>
</tr>
<tr>
<td>IV. Crossing Over</td>
</tr>
<tr>
<td>V. Mutation</td>
</tr>
<tr>
<td>VI. Chromosomal aberrations</td>
</tr>
<tr>
<td>VII. Numerical chromosomal aberration</td>
</tr>
<tr>
<td>VIII. DNA</td>
</tr>
<tr>
<td>IX. RNA</td>
</tr>
</tbody>
</table>

Subtopics and the other subheadings in the subtopics are,

I. Chromosome
   i) Structure of chromosome
ii) Types of chromosome
iii) Autosomes and Sex chromosomes
iv) Unusual / Abnormal chromosomes
v) Special types of chromosomes

II. Gene
III. Linkage
   i) Mechanism of Linkage – Coupling
   ii) Mechanism of Linkage – repulsion

IV. Crossing over
   i) Significance of crossing over
   ii) Gene mapping
   iii) Recombination of chromosome

V. Mutation

VI. Chromosomal aberrations

VII. Numerical chromosomal aberrations

VIII. DNA
   i. Transformation of DNA
   ii. Structure of DNA
   iii. Replication of DNA

IX. RNA
   i) Structure of RNA
   ii) Types of RNA

In Volume-II also the labels of the topic are highlighted like molecules in a running position. Volume-II has subtopics and subheadings. Each subtopic is arranged in a sequential manner. Each subtopic has a few subheadings and the sub topic has direct explanation frames. If the learner selects one subtopic, from that all the subheadings can be learnt by the learner. Each subheading bears the necessary buttons like home, picture, video, fact, Web and test depends on the necessity of the content of the frame.
Each and every subheading can be mastered by the learner and for every individual subheadings, the learner can take up a test separately. If the learner in a particular test cannot perform well, and the learner has doubt over the content the learner can choose that particular subheading again. After clearing the doubts, the learner proceeds to the next subheading in the particular subtopic. It makes the learner have master over the level of the concept thoroughly. Then the learner proceeds to the next subheading. When the subheadings are learnt by the learner, he/she can choose the next subtopic.

While learning the concept, it is like formative evaluation, the learner evaluates her or him to check the mastery level of the concepts. This gives confidence and creates interest to the learner.

In the second volume the learning starts from the sub topic “Chromosome” to the subtopic “RNA”. All the subtopics and subheadings are covered in the unit cell biology and genetics in Volume-I and II.

By clicking the picture button and video button makes the learner to clear the doubts regarding the pictures and concepts. In picture button based on the concept, number of pictures are downloaded from the net or scanned from the textbook for clear viewing and clear understanding of the parts minutely. Pictures with parts are kept in a separate folder. This Pictures folder contains various pictures under relevant headings are also only an option button. The main usage of the button is to clarify the doubts regarding diagrams and their labeling. The pictures are with colours and help the learner to retain in their memory about the shapes and labeling of the diagrams for a longer time.

In video button, some concepts which cannot be given live by the researcher or the author of the textbook or the compact disc courseware materials can be given through video. From the source of internet it is downloaded. Downloaded concepts are kept in a flash file and it is
linked with the main frame. The learner if needed, can access these video clips by using the video button. It also gives elaborate views related to the concept. Facts button makes the learner know more about the concept.

Web button is used, if the learner needs to search through web and can use this option or else it is only an option button.

3.14.2.3. STRUCTURE OF VOLUME III

Volume III has some topics given to the learner’s choice for ease understanding and it helps the learners to evaluate by themselves.

i) Terminology

ii) Who is who?

iii) FAQ’s

iv) MCQ’s

i) Terminology

Terminology defines or explains the terms related to the unit cell biology and genetics alone to make the learner understand clearly and meaningfully. The learner uses this terminology part as it was like a dictionary to the unit cell biology and genetics alone. Ninety five terms with their meanings are given as reference to the learner. All the terms and explanations are given in a web page. Web page is linked with Volume-III.

ii) Who’s who?

Few chronological representations of certain cytological investigations of 19th century are kept open in a web page. This is also linked with Volume-III. Name of the person, year of their investigation and their cytological contributions are arranged chronologically to know more about cytology and genetics. Fifty one numbers of ‘who discovered’ has been given regarding the chapter cytology and genetics.
iii) FAQ’s – Frequently Asked Questions

Questions asked at the back of the text book followed by State Government of Tamilnadu and also from public examination question papers conducted every year by the Government under the department of education. All the questions are given with answers for the learner’s reference. Necessary diagrams related to the questions are also given along with answers. Each page of the question bears the button with home picture and it is used to move on to the index page of Volume-III.

iv) MCQ’s – Multiple Choice Questions

In volume-I multiple choice questions are given in each and every subtopic. In volume-II each and every subheadings from the sub topic are given with multiple choice questions. In volume-III, both multiple choice questions of volume I and II are combined and given continuously to the learner to take a test. There are one hundred and sixty three MCQ’s in volume-III to check the mastery level of the learner by themselves. This enhances learning, increases their memory and retention level of the concept.

Each page of the frame, contains one question with three multiple answer options. The same procedure was followed in volume -III as it was followed in volume-I and II. In volume-III, test page has a top arrow button facing north side, which is used to move on to the Index page. But in Volume-III each MCQ’s is added its score, at the end out of one hundred and sixty three, the learner can check the individual scores. This makes the learner to achieve more marks in their achievement test. The score is not recorded in the package, so that the learner feels free in using the package again and again for the MCQ’s to revise the needed concept well.
Mutation

Addition of one or more nucleotides into a gene results in addition mutation.
Facts

Chromatin:
Viscous, gelatinous substance contains DNA, RNA, basic proteins called histones and non histone proteins.

Nucleosomes:
Chromatin is formed by a series of repeating units called nucleosomes.

Centromere:
It has specific DNA sequence. It is associated with a structure called kinetochore.

Kinetochore:
It is a proteinaceous part and plays an important role in mitosis and meiosis.

CELL BIOLOGY

Nucleus Pictures

- Nucleus
  - Nucleus 01
  - Nucleus 02
  - Nucleus 03
  - Nucleus 04
  - Nucleus 05
  - Nucleus 06
  - Nucleus 07

Chromatin: Viscous, gelatinous substance contains DNA, RNA, basic proteins called histones and non histone proteins.

Nucleosomes: Chromatin is formed by a series of repeating units called nucleosomes.

Centromere: It has specific DNA sequence. It is associated with a structure called kinetochore.

Kinetochore: It is a proteinaceous part and plays an important role in mitosis and meiosis.
Test - Structure of DNA

4. James Watson and Francis Crick proposed double helix _______ model.

- RNA
- mRNA
- DNA

Selected Answer: DNA
Result: Correct
Score: 1
3.14.3. SYSTEM REQUIREMENTS FOR MULTIMEDIA PACKAGE

i) Software
Adobe Flash CS5 is used for developing the Multimedia package. Flash player is used for running the project hence it should be installed in the user computer.

ii) Hardware
Multimedia systems that could play audio and video with Pentium IV or above processors, 512Mb of RAM and a color display monitor. The folder contains .swf file which can be played using flash player 8.0 or above.

iii) Flash source files
The folder contains flash source files in .fla format which the project has been developed.

iv) Flash Shockwave file
The folder contains .swf file which can be played used flash player 8.0 or above.

v) XML files
The folder contains .xml files used by flash files for displaying the tree structures.

vi) HTML files
The folder contains .html files which are linked from flash files for displaying “Who’s who and Terminologies”.

3.14.4. MAIN COMPONENTS OF THE MULTIMEDIA PACKAGE

i) Audio files
All the audio files are merged with the flash files.
ii) **Video files**
   i) The Videos are downloaded from web for educational purpose.

iii) **Picture files**
   i) The folder contains pictures in JPG, GIF and PNG format which have been used in the project.
   
   ii) The pictures are downloaded from web, and some are scanned from text books which are used only for the presentation.
   
   iii) The picture files location should not be changed as they are used by XML and Flash documents.

### 3.14.5. DETAILS OF THE FOLDER-MULTIMEDIA PACKAGE

i). Copy the folder “Botany-Multimedia” in your computer.

ii). Locate the file “Start” and double-click to run.

A complete package of information stored in the system is presented sequentially with a welcome screen consists of all the sub headings and animations of cell biology and genetics.

### 3.14.6. VALIDATION OF MULTIMEDIA PACKAGE

The developed Multimedia Package was given to a group of thirty five XII standard higher secondary students for Pre validation. Students were asked to observe the content along with their science teachers and if so, give necessary changes and suggestions to improve the multimedia package. Clarity of some pictures, extra textual concepts has been modified based on the suggestions given by the students. Parts of the diagrams are modified based on the biology teacher’s suggestions. After the modifications are over, the package is ready for further experimentation.
Sixty XII standard students are selected and allowed to watch the package along with their science teachers. It takes three days to complete the process. With the help of the students’ suggestions some of the frames and pictures are modified and deleted. Parts of the diagrams are also modified based on the suggestions given by them with the idea of the teachers. So initially there were ninety seven frames, and it has been reduced into seventy four frames finally.

3.15. CONSTRUCTION OF TOOLS

The researcher constructed two tools for the study. One is multimedia opinion schedule for the teachers and the other one is achievement test for the students.

3.15.1. MULTIMEDIA OPINION SCHEDULE FOR TEACHERS

Teachers having their undergraduate degree or post graduate degree in botany or zoology with education, working in government aided and private matriculation schools handle science subjects.

Schedule is the name given to a lot of questions to which responses are obtained from the respondent by the researcher in a face to face contact. A schedule is administrated personally to a respondent or a group of respondents.

The researcher and Nachimuthu (2009) have developed a tool named Multimedia Opinion Schedule (MMOS). For the schedule, eight dimensions have been selected viz; basic presentation; diagram colour; concept continuity; information relevancy; audio synchronization; logical syntax; image arrangement and content delivery.
3.15.1.1. PILOT STUDY

In order to ascertain the feasibility of the proposed research and also the adequacy of the proposed tool for this research, a pilot study had been undertaken. It has been done with the help of multimedia opinion schedule (MMOS) for forty higher secondary school teachers. Finally all the suggestions given by the teachers are made by the researcher.

3.15.1.2. DIFFICULTY LEVEL AND DISCRIMINATIVE INDEX

The Item analysis was found out through the difficulty level and discriminative index of the pilot study.

i) Difficulty level

To determine the item difficulty the difficulty value is calculated by using the following formula suggested by Ebel (1972).

\[
\text{Difficulty Index (DI)} = \frac{U + L}{2N}
\]

Where

- \(U\) = the number of correct responses in the upper group
- \(L\) = number of correct responses in the lower group
- \(N\) = the number of subjects in either group

Then all the total scores are arranged in the order of size and put into the highest score on the top. Then the top 27% and the bottom 27% are selected. The difficulty value was calculated by dividing the number of right answers by total number of examinees.
ii) **Discriminating Power**

The discriminating power of an item analysis is its power to discriminate between the upper and lower groups. The difference between the correct responses in the two groups will be an indication of how far it can discriminate between the two groups. To determine the item discrimination, discriminating power was calculated by using the formula,

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

Where

- \( U = \) the number of correct responses in the upper group
- \( L = \) number of correct responses in the lower group
- \( N = \) the number of subjects in either group

If the difficulty value is higher, the item is said to be easier and the difficulty value is lower, the item is said to be harder. So the mid values from 0.4 to 0.6 are selected for final study. An item should satisfy both the difficulty level and discriminative index. Among the seventy three items, extreme items were dropped and the items with mid value are improved and finally fifty five items in eight dimensions were selected for final use of the MMOS tool. The following table furnished the details about multimedia opinion schedule by item analysis.
TABLE 3.1
DIMENSIONS IN THE MULTIMEDIA OPINION SCHEDULE

<table>
<thead>
<tr>
<th>S.No</th>
<th>Dimensions</th>
<th>Items in Pre tool</th>
<th>Eliminated items</th>
<th>Total Items (Final tool)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Basic presentation</td>
<td>11</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>2.</td>
<td>Diagram colour</td>
<td>9</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>3.</td>
<td>Concept continuity</td>
<td>9</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>4.</td>
<td>Information relevancy</td>
<td>10</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>5.</td>
<td>Audio synchronization</td>
<td>7</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>6.</td>
<td>Logical syntax</td>
<td>6</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>7.</td>
<td>Image arrangement</td>
<td>11</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>8.</td>
<td>Content delivery</td>
<td>10</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>73</td>
<td>18</td>
<td>55</td>
</tr>
</tbody>
</table>

The final part of multimedia opinion schedule (fifty five items) has been administered for sixty higher secondary school teachers in Salem District of Tamilnadu State, in India.

3.15.1.3. RELIABILITY OF THE MMOS

Reliability refers to the consistency with which a test measures, whatever it measures, depending on the nature and purpose of the test.

In this study the reliability has been computed using Cronbach’s Alpha method and the results for each dimension of the schedule are given in Table.4.
TABLE 3.2
RELIABILITY OF MULTIMEDIA OPINION SCHEDULE

<table>
<thead>
<tr>
<th>S.No</th>
<th>Dimensions</th>
<th>Total no of items (55)</th>
<th>Reliability Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Basic Presentation</td>
<td>8</td>
<td>0.7833</td>
</tr>
<tr>
<td>2.</td>
<td>Diagram Colour</td>
<td>6</td>
<td>0.8545</td>
</tr>
<tr>
<td>3.</td>
<td>Concept Continuity</td>
<td>6</td>
<td>0.8081</td>
</tr>
<tr>
<td>4.</td>
<td>Relevant Information</td>
<td>8</td>
<td>0.8674</td>
</tr>
<tr>
<td>5.</td>
<td>Audio Synchronization</td>
<td>6</td>
<td>0.8934</td>
</tr>
<tr>
<td>6.</td>
<td>Logical Syntax</td>
<td>5</td>
<td>0.7871</td>
</tr>
<tr>
<td>7.</td>
<td>Image Arrangement</td>
<td>8</td>
<td>0.7968</td>
</tr>
<tr>
<td>8.</td>
<td>Content Delivery</td>
<td>8</td>
<td>0.8431</td>
</tr>
</tbody>
</table>

In multimedia opinion schedule, the reliability for each dimension is calculated. Basic presentation dimension has eight items and the reliability value is 0.7833. The part that focuses on diagram colour contains six items and the reliability value is 0.8545. The dimension, concept continuity also contains six items and its reliability value is 0.8081. Likewise the dimension relevant information consists of eight items and the reliability value is 0.8674. There are six items under audio synchronization and its reliability value is 0.8934. The dimension of logical syntax contains five items and its reliability value is 0.7871. The dimension of image arrangement consists of eight items; the value of reliability is 0.7968. The area focusing on the content delivery consists of eight items, and its reliability value is 0.8431. The value is quite significant and implies that the tool adopted is reliable.
3.15.1.4. VALIDITY OF THE MMOS

In addition to reliability another essential property of the measuring instrument is its validity. A measuring instrument is said to be valid if the measurements made by it are accurate and comparable with those made by a standard instrument. Validity depends upon the accuracy with which it is measured.

Content validity is essentially applied only to test of proficiency and of educational achievement. It is estimated by evaluating the relevance of the test items, in relation to instructional and actual subject matter studied, individually and as a whole. This form of validity is based upon judgement of severals subject experts and test specialist by careful analyses of instructional objectives, and the actual subject matter studied. This analysis is rational as well as judgemental and therefore, the content validity is sometimes also named as rational or logical validity (Koul 2004).

The items are validated by jury technique. A result is internally valid if an appropriate methodology has been followed in order to yield that result. The experts’ opinion of different University staff was obtained before finalising the design of the tools. Multimedia technology experts and experienced professors in different universities also were requested to analyse the tool. Their opinions indicated that the tool had content validity.

3.15.2. ACHIEVEMENT TEST FOR THE STUDENTS

To determine the extent to which the objectives have been attained by the learner through a test. An achievement test depicts present proficiency and also represents what a person has learned. An implicit assumption in selecting an achievement test is that the examinees have been directly exposed to the concepts needed; the universe of content is defined specifically (Kanakaraj 2005).
Realizing the major objective of the present study it was decided to have separate tool to measure the achievement level of the students. The researcher constructed the self made achievement test to measure the achievement level of the learners through PLM, CAI and Multimedia treatments for both control and experimental groups. Hundred and twelve objective type question items covering the package on “Cell biology and Genetics” are structured for this purpose.

3.15.2.1. VALIDITY OF THE ACHIEVEMENT TEST

The Constructed achievement test question paper was given by the researcher to forty XI and XII standard teachers for validation. Questions selected in the test are related to the concept in the study. After their validation is over, all the changes in the achievement test question paper are consolidated and made by the researcher. Except four questions, all the questions are in the test has validity. At the beginning it was one hundred and twelve questions, the subheadings like “cell type and cell components” has six and it was reduced to four questions, “nucleus” contains six questions and reduced into four questions. After refinement the no of questions in the subheadings are reduced and finally it was 108 questions.

3.15.2.2. RELIABILITY OF THE ACHIEVEMENT TEST

The Achievement test was given over two sets of thirty students each. The doubt raised by the students was clarified then and there and the filled in answer scripts were collected. These students were selected in such a way that they were not part of either in the control or experimental groups. Based on the exercise, the item scores 21% to 79% was selected for final use. Thus the item carries that 20% and below and 80% percent and above was removed. Finally eight items was removed from the pilot study test. Among the thirty items in true or false, five items has been removed. Finally twenty five items are in true or false. As the twenty three items in complete the sentence, three items were
removed, so finally twenty items are in complete the sentence. Initially the achievement test question paper consists of one hundred and eight items and finally eight items were removed. The final form of the achievement test consists of hundred items. The following table describes the types of questions in achievement test.

TABLE 3.3
TYPES OF QUESTIONS IN ACHIEVEMENT TEST

<table>
<thead>
<tr>
<th>S.No</th>
<th>Contents of Achievement test</th>
<th>Pilot study test</th>
<th>Total No of items Eliminated</th>
<th>Final test</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Choose the correct answer</td>
<td>25</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>2.</td>
<td>Write True or False</td>
<td>30</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>3.</td>
<td>Complete the sentence</td>
<td>23</td>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>4.</td>
<td>Match the following</td>
<td>20</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>5.</td>
<td>Select the exact option</td>
<td>10</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>108</strong></td>
<td><strong>8</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

The final test form which is used for achievement test consists of five sections and the first section is with alternate choice questions which consists of twenty five numbers, second section has twenty five true or false type, third one complete the sentence, fourth section, twenty match the following type and the last one select the exact option type consists of ten questions and in total there are hundred questions. Each question carries equally one mark. The following table gives details about the achievement test.
TABLE 3.4
BLUE PRINT OF ACHIEVEMENT TEST

<table>
<thead>
<tr>
<th>S.No</th>
<th>Components</th>
<th>No of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction</td>
<td>04</td>
</tr>
<tr>
<td>2</td>
<td>Cell theory</td>
<td>04</td>
</tr>
<tr>
<td>3</td>
<td>Cytology with other subjects</td>
<td>04</td>
</tr>
<tr>
<td>4</td>
<td>Cell type and cell components</td>
<td>04</td>
</tr>
<tr>
<td>5</td>
<td>Cytoplasmic organelles</td>
<td>07</td>
</tr>
<tr>
<td>6</td>
<td>Nucleus</td>
<td>04</td>
</tr>
<tr>
<td>7</td>
<td>Chromosome</td>
<td>13</td>
</tr>
<tr>
<td>8</td>
<td>Gene</td>
<td>07</td>
</tr>
<tr>
<td>9</td>
<td>Linkage</td>
<td>05</td>
</tr>
<tr>
<td>10</td>
<td>Crossing over</td>
<td>05</td>
</tr>
<tr>
<td>11</td>
<td>Mutation</td>
<td>10</td>
</tr>
<tr>
<td>12</td>
<td>Chromosomal aberrations</td>
<td>04</td>
</tr>
<tr>
<td>13</td>
<td>Numerical chromosomal aberrations</td>
<td>10</td>
</tr>
<tr>
<td>14</td>
<td>DNA</td>
<td>12</td>
</tr>
<tr>
<td>15</td>
<td>RNA</td>
<td>07</td>
</tr>
<tr>
<td></td>
<td>Total components = Total scores</td>
<td>100</td>
</tr>
</tbody>
</table>

The same question paper was used for both pre and post tests to evaluate the students' learning level. Cronbach (1963) has defined evaluation as: "the collection and use of information to make decisions about an educational program. The program may be a set of instructional materials distributed nationally, the instructional activities of a single school, or the educational experiences of a single pupil..."
improvement: deciding what instructional materials and methods are satisfactory and where change is needed" teachers for validation.

3.16. SAMPLING

Sampling is a process of selecting a subset of randomized number of members of the population for a study and collecting data about their attributes.

When sample is required to be selected from a population, it is necessary to decide which method should be applied. Depending upon the nature of data and the purpose of enquiry different methods of sampling can be used. Judgement sampling, Random sampling, Multi-stage sampling and quota sampling are the various sampling methods. Among the methods purposive sampling method is selected and used for this study by the research due to its suitability. Purposive sampling is otherwise known as deliberate sampling or judgement sampling.

3.16.1. PURPOSESIVE SAMPLING

In purposive sampling, the choice of the sample items depends exclusively on the discretion of the researcher. The researcher exercises her judgement in the choice and includes those items in the sample which she thinks are most typical of the universe with regard to the characteristics under investigation (Gupta 1994).

The researcher followed purposive sampling technique. The sample included two forty XII-standard students from Government, Government aided, and matriculation higher secondary schools in Salem district of Tamilnadu state, in India. The schools included for pilot study, validation and experimentation were not included in the study. The following table contains sample details.
TABLE 3.5
SAMPLE FOR THE STUDY

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Type of School</th>
<th>Female</th>
<th>Male</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Government</td>
<td>20</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>2.</td>
<td>Government aided</td>
<td>20</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>3.</td>
<td>Matriculation(private)</td>
<td>80</td>
<td>80</td>
<td>160</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>120</td>
<td>120</td>
<td>240</td>
</tr>
</tbody>
</table>

The state of Tamilnadu has uniform pattern of education at higher secondary level with English and Tamil as medium of instruction. Salem educational district has Government and Government aided English medium schools and also matriculation schools in urban areas. Since the rural schools have low strength in Government and Government aided schools with regard to pure science group, the researcher has gone in for the choice of samples only from urban group. The researcher has chosen samples from matriculation schools both in urban and rural areas.

3.16.2. SAMPLE FOR THE STUDY

TABLE 3.6
DETAILS OF THE SAMPLE FOR THE STUDY

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Type of School</th>
<th>Locale</th>
<th>Control Group</th>
<th>Experimental Group</th>
<th>Grand Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Boys</td>
<td>Girls</td>
<td>Total</td>
</tr>
<tr>
<td>1.</td>
<td>Government</td>
<td>Urban</td>
<td>5</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>2.</td>
<td>Government aided</td>
<td>Urban</td>
<td>5</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>3.</td>
<td>Matriculation</td>
<td>Rural</td>
<td>10</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Urban</td>
<td>10</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>30</td>
<td>30</td>
<td>60</td>
</tr>
</tbody>
</table>
The total samples selected are two hundred and forty. In urban area the Government higher secondary school, has the total strength of forty in each class. Among the forty students ten samples are taken for the control group. The control group consists of five boys and five girls respectively. The other thirty samples are for the experimental groups. In this experimental group half of them are boys and the other half of them are girls. In each experimental group there are five boys and five girls respectively for the study.

Likewise in urban area in government aided higher secondary school, the total strength of a class is forty four. Among the strength only forty samples are taken for the study. In the government aided school, ten samples consist of five boys and five girls are taken by the researcher for the control group. Thirty samples are taken for the experimental groups consist of boys and girls. In each experimental group there are five boys and five girls respectively for the study.

In rural area, the total strength of the matriculation higher secondary school is one hundred and forty nine. Due to the non availability of the computers only eighty samples are selected randomly for the study among the total strength. Totally eighty samples are taken, twenty for the control group and sixty for the experimental group. Among the samples ten boys and ten girls constitute the control group. In each experimental group there are ten boys and ten girls, and altogether the sample size is sixty.

Likewise in matriculation higher secondary school, the strength of the school is eighty-four in urban area. Only Eighty samples are selected for the study and the remaining is not selected due to long absentees. Twenty samples of boys and girls equally constitute the control group. Remaining sixty samples are in the experimental groups. These samples are divided equally as ten males and ten females for each
experimental group. So for the three experimental groups the total sample is sixty.

After selecting samples for the study, the researcher personally visited the schools and a good rapport has been established before administering the software. The purpose of the study has been explained, it is emphasised that the data are confidential and the students are directed not to leave any frame without touching it. No time limit to respond to the software has been fixed. The researcher has collected their achievement score.

3.17. DATA COLLECTION BY ADMINISTERING THE ACHIEVEMENT TEST

Data are collected from the samples included two forty XII-standard students from Government, Government aided and Matriculation higher secondary schools in Salem District of Tamilnadu, India. Data's were collected by administering the achievement test before the treatment as pre test and after the treatment as post test for both control and experimental groups.

3.18. STATISTICAL TECHNIQUES USED IN THIS STUDY

To study the effects of PLM, CAI, and Multimedia package with reference to gender, type of school and location of the school, mean and standard deviation have been calculated. Based on mean and standard deviation, 't'-test and F-test have been worked out. Whenever two groups are involved in a variable, t'-test has been used to know the significant differences between these groups. When more than two groups are involved in a variable, F-test has been worked out to know the significant differences among these groups. Test for mean score analysis (ANOVA) is used to compare mean scores of more than two groups. If differences exist among the means, post hoc range tests can determine which means differ.