Chapter – III
Development & Description of Tools
CHAPTER – III
DEVELOPMENT AND DESCRIPTION OF TOOLS

The chapter presents development of instructional materials viz. Multimedia Presentations (MMP) and Computer Assisted Instruction (CAI) for imparting instruction to students in the selected topics of Biology and development of achievement test for measuring the achievement of students.

3.1 SELECTION OF TOPICS

Following topics were chosen by the investigator for preparing instructional material:

1. Discovery of the Cell and The Cell Theory
2. Cell -Diversity and Types
3. Cell Membrane& Diffusion Process
4. Osmosis, Exocytosis and Endocytosis
5. Cell Structure: Cytoplasm and Nucleus
7. Cell Structure: Lysosomes and Mitochondria
9. Plant Tissues : Meristematic and Simple Permanent
10. Plant Tissues : Complex Permanent
11. Plant Tissue Systems
12. Animal Tissue : Epithelial
13. Animal Tissues: Connective

3.2. APPROACH TO MMP AND CAI

Computer-based instructional technologies, used as educational strategies to deliver the classroom curriculum, continue to increase in popularity.

Multimedia presentations (MMP) is found to be an effective method of imparting instructions in Biology as integrated use of multiple media elements such as
audio, video, graphics, text, animation etc. enables the teacher to help students understand the subject matter in depth.

Computer Assisted Instruction (CAI), a self-instructional teaching strategy also makes use of a combination of text, graphics, sound and video while presenting material. Interactive nature of the program captures the students’ attention, arouse their interest and enhance their learning to increase their scores. The principles of programmed learning are being applied to computer assisted instruction (CAI) which is a self-paced instruction format where each student works his or her way through the course material, which is broken down into small steps. The computer can be used to present learning material and help students learn through a variety of techniques such as quizzes, simulations, explorations, and tests. Computer assisted instruction is effective in improving knowledge and skill acquisition because of the availability of immediate feedback (Pridemore & Klein, 1995).

3.2.1 Relevance of MMP and CAI

Major technological innovations have brought a key paradigm shift in the way people learn. Consequently, a major change has been necessitated in the way educational materials are designed, developed, and delivered to those who wish to learn (Wiley, 2000). Pure text, speech and chalk board used in conventional methods of teaching are not enough to meet the needs of contemporary learners. Incorporating computer based multimedia material in teaching has great potential in meeting the objectives of teaching-learning process. A multimedia presentation allows the educators to present more information, more examples, illustrations, and problems for students to solve than the conventional instructional method. The dynamic processes of Biology can be explained better by making use of sound, colour, movement and three dimensional graphics and animations. Multimedia presentations provide novel learning environments to develop conceptual understanding of biological topics resulting in better performance of students.

Computer-assisted instruction (CAI) is an interactive instructional method that uses a computer to present material, track learning, and direct the user to additional material which meets the different needs of students especially with diverse ethnic backgrounds and also of students with special needs. The automatic
interaction and immediate feedback provided by the computer during CAI enables students to learn at their own pace and progress on an individual basis.

3.2.2 Preparation of MMPs and CAIs

The main steps in preparation of MMPs and CAI are as follows:

3.2.2.1 Identification of Need

An increased efficiency of the delivery of instructional material also makes students learn more efficiently. Taking advantage of integrating technology in classroom teaching, a teacher can create a learning environment which can meet the individual needs of the students and facilitate them in having deeper insights of the concepts.

Figure 3.1: Format showing different steps involved in the development of Instructional Material (MMP & CAI) (Meyer, 1984).
3.2.2.2 Selection of Topics

The topics mentioned at 3.1 were taken to prepare MMPs.

3.2.2.3 Identification of Instructional Objectives

"...an instructor will function in a fog of their own making until they know just what they want their students to be able to do at the end of instruction." - R. F. Mager (1962.)

A learning objective is a statement that specifies in behavioural (measurable) terms what a learner will be able to do as a result of instruction. It describes the intended outcome of the instruction rather than a description or summary of the content. It is but one of several steps that should be followed when developing instruction (Morrison, 2004).

Instructional objectives are written for the student and they state what the student is expected to do following instruction. Objectives are specific, observable, and measurable learning outcomes (Waller, 2008).

Educators have used instructional, or behavioural, objectives by following different techniques of writing objectives put forward by many educationists like Gronlund (1970), Mager, (1975) and Popham and Baker (1970).

Investigator has followed Gronlund’s approach by writing general and specific objectives for the selected 14 topics of Biology that are given in table 3.1
<table>
<thead>
<tr>
<th>Sr.No.</th>
<th>Topics</th>
<th>General Objectives</th>
<th>Specific Objectives</th>
</tr>
</thead>
</table>
| 1.    | Discovery of the Cell & The Cell Theory | ➢ Know how cells were discovered.  
➢ Understand the concept of the cell theory. | • Define cell.  
• Name the scientist who discovered cells.  
• Name the scientist who discovered nucleus.  
• Name the scientists who propounded and expanded the cell theory.  
• Enlist major points of the cell theory. |
| 2.    | Cell – Diversity & Types      | ➢ Understand about diversity of cells.  
➢ Know about the types of cells. | • Define unicellular organisms.  
• Name a unicellular organism that keeps on changing its shape.  
• Identify the type of a cell on the basis of its microscopic structure.  
• Define an organelle. |
➢ Understand the process of diffusion across cell membrane. | • Identify the chemical substances that form the framework of plasma membrane.  
• Mention the role of plasma membrane that it plays due to its property of selective permeability.  
• Name the process by which oxygen molecules (O₂) move from the lungs into the bloodstream. |
| 4.    | Osmosis, Exocytosis & Endocytosis | ➢ Understand the process of osmosis, exocytosis and endocytosis. | • Describe the movement of water through a semi permeable membrane stretched across a chamber filled with water on its one side and salt solution on the other.  
• Define hypotonic, isotonic and hypertonic solutions.  
• Mention the function of exocytosis in cells.  
• Name the process referred to as ‘cell eating’. |
Understand the functions of cytoplasm and nucleus. |
|  |  | • Mention the combined name given to the nucleus and cytoplasm of a cell.  
• Match various parts of nucleus to their structure and functions. |
Understand the functions of ribosomes, endoplasmic reticulum and Golgi apparatus. |
|  |  | • Describe what will happen if all the ribosomes of a cell are destroyed.  
• Name the cell organelle that carries out the process of packaging and exporting proteins.  
• Name the organelle that forms the supporting skeletal framework of the cell. |
Understand the functions of lysosomes & mitochondria. |
|  |  | • Name the organelles that are popularly called suicidal bags.  
• Identify mitochondrion from its structure given in the diagram.  
• Explain why mitochondria are called ‘Powerhouses’ of the cell. |
|  |  | • Name pigment containing organelles found in autotrophs that collect light energy.  
• List major differences between animal Cell and plant Cell. |
| 9. | Plant Tissues – Meristematic & Simple Permanent | ➢ Know the characteristic features of meristematic & simple permanent tissues found in plants. | • Define meristematic tissue.  
• Name the tissue which gives buoyancy to the aquatic plants to help them float in water.  
• Name the tissue that provides flexibility to plants.  
• Name the tissue that forms the husk of coconut. |
| --- | --- | --- | --- |
| 10. | Plant Tissues – Complex Permanent | ➢ Know the characteristic features of complex permanent tissues found in plants. | • Name the tissue that transports water to different parts of a plant  
• Identify the functions performed by the elements of xylem.  
• Name the elements of phloem with which companion cells are associated.  
• Mention another name for bark. |
| 11. | Plant Tissue Systems | ➢ Understand how different tissue systems in plants carry out different functions.  
➢ Appreciate how structural modifications of epidermal cells perform special roles in plants. | • Identify the tissue systems on the basis of their characteristics features.  
• Name the substance which makes thick waxy coating on epidermis in desert plants.  
• Name the two kidney shaped cells that enclose stomata.  
• Identify the substance that makes cork impermeable. |
| 12. | Animal Tissues - Epithelial | ➢ Know the structure of various types of epithelial tissues.  
➢ Appreciate how the structures of various types of epithelial tissues correlate to their unique functions. | • Identify the characteristic feature that best describes epithelium.  
• Mention the major role that stratified epithelium plays in our body.  
• Name the epithelial tissue that forms the lining of kidney tubule. |
13. Animal Tissues
- Connective
> Know the structure of various types of connective tissues.
> Appreciate how the structures of various types of connective tissues correlate to their unique functions.

- Name the component of the blood that forms its liquid part.
- Identify parts of the bone on the basis of their structure.
- Differentiate between tendons and ligaments.
- Name the fat storing tissue found in animals.
- Name the most widespread and abundant tissue found in human body.

14. Animal Tissues
- Muscular & Nervous
> Know the structure of various types of muscular and nervous tissues.
> Appreciate how the structures of various types of muscular and nervous tissues correlate to their unique functions.

- Identify the muscular tissue that is involved in the movements of the arm.
- Name the tissue responsible for transmitting impulses in the body of animals.
- Name the cardiac muscles that control the rhythmic contraction and relaxation of heart.
- Identify the organelles which are expected to be most abundant in human skeletal muscle cells.

3.2.2.4 Pre-test/ Post-test Design

The experimental study was based on pre-test/post-test design. After having defined the objectives, the content which was relevant to meet these objectives was selected. Students were tested to establish their entry behaviour before they were taught the content matter through the chosen teaching strategy. After imparting instruction for the selected topics of Biology, students were tested to find the extent to which they had achieved instructional objectives.
3.2.2.5 Selection of Content

Content was selected carefully ascertaining that it effectively met the objectives defined. While designing and developing instructional material, the content was analyzed through two types of analyses viz. task classification and learning task analysis.

3.2.2.6 Clustering of Objectives into Instructional Unit and Sequencing of Content

Based on the sequence of pre-requisite learning as revealed by analysis of the content, sequencing of content was done. General objectives to be achieved were clustered into instructional units combining similar objectives in one unit.

3.2.2.7 Preparation of Instructional Material

The format of the instructional material is given below:

- Introduction
- How to use the instructional material
- Objectives (Learning outcomes)
  - General
  - Specific
- Entry Behaviour Test
- Input
- Practice Task
- Feedback to practice task
- Summary of Input
- End Module Task
- Feedback to End Module Task

CAI is a self instructional strategy whereas instruction through MMP instructional strategy is imparted by the teacher making use of integration of multimedia to
supplement classroom teaching. So the instructional materials for both the strategies are formatted accordingly.

Both Multimedia presentations and CAIs were prepared on Microsoft Power Point by compiling information, images, diagrams related to the topics taken from the text book published by NCERT for class IX on the subject of Science as well as from the web using the internet. Colourful relevant pictures, clip art, animations and movies taken from web were also inserted at appropriate places linking them with the concepts to be explained by the teacher (Investigator herself).

3.2.2.8 Principles of Learning applied to Instructional Material

While developing the instructional material, the following principles of learning and instruction were taken into consideration:

- Motivating the learners to incorporate new concepts into their prior knowledge.
- Enhancing meta-cognition and facilitating shared vision and understanding.
- Instructing in small steps with immediate feedback accelerates the process of learning.
- Active participation promotes fast learning and retention.
- Learners learn meaningfully whatever is being taught to them without taking refuge to rote learning.
- Fostering creativity
- Providing flexibility in teaching programmes for accommodating individual differences.

3.2.2.9 Learners’ Involvement

In order to keep students actively involved in teaching learning process, following techniques were used

- Conversational format
- Self Assessment questions
- Highlighting main information
• Incorporating relevant pictures, animations and movies explaining the concepts.

3.2.2.10 Validation

After compilation and development of instructional material viz. MMP and CAI, the same were evaluated for validation by three ways – self evaluation, evaluation by students and expert appraisal.

The content matter of the instructional materials was checked by the investigator for factual accuracy as well as for its relevance to the objectives defined.

To check whether the developed instructional material was according to the mental level of the students of class IX and was effective in acquisition of Biological concepts, ten students studying in different schools were chosen to go through the material and give their feedback.

Suggestions and comments of 10 biology teachers/experts about the developed material were taken who evaluated whether it incorporated essential characteristics of an effective instructional material.

3.2.2.11 Final Instructional Material

Taking into consideration the outcomes of self evaluation, evaluation by students and appraisal by the experts, necessary modifications were made and final MMPs and CAI modules were prepared.

3.3 DEVELOPMENT OF ACHIEVEMENT TEST

An achievement test evaluates a learner's understanding of a specific course or study programme. As the investigator could not get any appropriate standardized achievement test for evaluating learners’ achievement in selected topics of Biology of class IX, the same was developed and standardized by the investigator herself.
3.3.1 Planning the Test

The following aspects were taken into consideration while planning the test:

- Students for whom the test was intended
- What was to be measured?
- The timings of the measurement.

Considering the above mentioned aspects, it was decided that:

- The test was meant for the students of age group 14 – 15 years studying in class IX in different schools of Chandigarh where computer facilities were available and the medium of instruction was English.
- Acquisition of Biological concepts was to be measured and the cognitive domain of objectives to be realized were knowledge, understanding, reasoning, skill, application and comprehension.
- Measurement of the achievement was to take place before the experiment began (pre-test) and immediately after the completion of the experiment (pot-test).

3.3.2 Preparation

Fourteen topics of Biology of Class IX were selected for the present study. The achievement test consisting of all multiple choice items related to the selected topics was devised by the investigator keeping in mind the objectives and the content of items. It was ensured that no objective remained untested. The test items with their specifications have been given in table 3.2
<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Topics</th>
<th>Number of Objectives as per Table 3.1</th>
<th>Number of Items (Multiple choice)</th>
<th>Item Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Discovery of the Cell &amp; The Cell Theory</td>
<td>5</td>
<td>5</td>
<td>1,2,3,4,6</td>
</tr>
<tr>
<td>2.</td>
<td>Cell – Diversity &amp; Types</td>
<td>4</td>
<td>4</td>
<td>5,7,14,16</td>
</tr>
<tr>
<td>3.</td>
<td>Cell Membrane &amp; Diffusion Process</td>
<td>3</td>
<td>3</td>
<td>8,11,15</td>
</tr>
<tr>
<td>4.</td>
<td>Osmosis, Exocytosis &amp; Endocytosis</td>
<td>4</td>
<td>4</td>
<td>9,10,12,13</td>
</tr>
<tr>
<td>5.</td>
<td>Cell Structure – Cytoplasm &amp; Nucleus</td>
<td>2</td>
<td>2</td>
<td>19,24</td>
</tr>
<tr>
<td>7.</td>
<td>Cell Structure – Lysosomes &amp; Mitochondria</td>
<td>3</td>
<td>3</td>
<td>18,21,26</td>
</tr>
<tr>
<td>8.</td>
<td>Cell Structure – Plant &amp; Animal Cells</td>
<td>2</td>
<td>2</td>
<td>17,22</td>
</tr>
</tbody>
</table>
Haladyna and Downing (1989) summarized common rules for writing multiple choice test items. The following points were considered while writing multiple choice test items:

- Each item was constructed to assess a single written objective.
- Language used was simple to express items precisely, clearly and simply.
- Vocabulary used was appropriate for the level of the test. Using unnecessarily difficult vocabulary was avoided.
- Each item was tested for basic grammar, punctuation, and spelling. To avoid giving clues to the right answer, parallel grammar was used for all the option choices.
- Each item was laid out in a clear and consistent manner.
• Instructions were clear and simple.
• To avoid testing rote facts, text language was avoided.
• The question or problem situation was presented in the stem of the item, not the options.
• Interdependence among items was avoided.
• Such items that provide a clue to the answer of other items were avoided.
• Use of specific determiners like always, never, seldom, sometimes etc. were avoided.
• Use of the alternatives “all of the above” and “none of the above” were avoided as use of the same has been found in several studies to decrease item discrimination and test score.
• The option choices addressed the same content, and the distracters were reasonable choices for a student with limited or incorrect information.
• Options were arranged in systematic manner; dates of events arranged chronologically, numerical quantities in ascending order of size, and names in alphabetic order.
• The number of test items framed initially was larger than the number of items retained finally.

After scrutinizing the items closely, the investigator prepared the preliminary draft of Achievement test comprising of 76 items. This test was given to 10 Biology teachers/experts to

• critically analyze the items for the content and language,
• correct ambiguities,
• check that all the defined objectives are tested,
• add any other area of relevance
• suggest any other relevant question.

Scoring key was also made and got scrutinized. Suggestions made by Biology teachers/experts were considered for framing the first draft. The test was
also given at individual level to 25 students of class X studying in different
schools.

3.3.3 Selection of Items for the Second Draft

The answer scripts of the students were evaluated with the scoring key. Discussions with students and subject teachers/experts were held individually. On
the basis of the performance of the students and suggestions made by students and
the Biology teachers/experts, the preliminary test was reframed to prepare the
second draft by dropping 11 items and modifying a few. Thus the first draft
comprised of 65 multiple choice items.

3.3.4 Final Draft

The second draft was administered individually to a sample of 50 students
of class X studying in different schools of Chandigarh. The answer scripts were
evaluated and arranged in descending order of scores and subjected to Kelley’s
item analysis technique (1939) to find the difficulty value (DV) and discriminating
power (DP). Item analysis is the process to evaluate the effectiveness of items in a
test by exploring the examinees' responses to each item. The following formulae
were used to calculate the difficulty value (DV) and discriminating power (DP):

\[
DV = \frac{(RU+RL)}{n}
\]

\[
DP = \frac{(RU-RL)}{(n/2)}
\]

Where

RU – Number of correct response in the upper group.

RU - Number of correct response in the lower group.

n – Size of sample in upper and lower groups.

The upper and lower groups were made as follows

- All the answer scripts of the students were arranged in descending order on
  the basis of total marks obtained.
- The first 27% cases formed the upper group and the last 27% cases formed
  the lower group.
Kelley (1939) suggested that using the upper and lower 27% is the best way for computing discrimination. The difficulty value (DV) and discriminating power (DP) for each item of the achievement test are shown in Table 3.3.

Table 3.3: Difficulty Value (DV) and Discriminating Power (DP) of Achievement Test

<table>
<thead>
<tr>
<th>Q. No.</th>
<th>Upper Group RU</th>
<th>Lower Group RL</th>
<th>DV/DP</th>
<th>A/R</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>12</td>
<td>7</td>
<td>0.73/0.38</td>
<td>A</td>
</tr>
<tr>
<td>2.</td>
<td>8</td>
<td>3</td>
<td>0.42/0.38</td>
<td>A</td>
</tr>
<tr>
<td>3.</td>
<td>13</td>
<td>7</td>
<td>0.76/0.46</td>
<td>A</td>
</tr>
<tr>
<td>4.</td>
<td>9</td>
<td>6</td>
<td>0.57/0.23</td>
<td>A</td>
</tr>
<tr>
<td>5.</td>
<td>10</td>
<td>5</td>
<td>0.57/0.38</td>
<td>A</td>
</tr>
<tr>
<td>6.</td>
<td>7</td>
<td>4</td>
<td>0.42/0.23</td>
<td>A</td>
</tr>
<tr>
<td>7.</td>
<td>10</td>
<td>7</td>
<td>0.65/0.23</td>
<td>A</td>
</tr>
<tr>
<td>8.</td>
<td>8</td>
<td>5</td>
<td>0.5/0.23</td>
<td>A</td>
</tr>
<tr>
<td>9.</td>
<td>12</td>
<td>10</td>
<td>0.85/0.15</td>
<td>R</td>
</tr>
<tr>
<td>10.</td>
<td>10</td>
<td>4</td>
<td>0.54/0.46</td>
<td>A</td>
</tr>
<tr>
<td>11.</td>
<td>10</td>
<td>9</td>
<td>0.73/0.076</td>
<td>R</td>
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<tr>
<td>12.</td>
<td>8</td>
<td>5</td>
<td>0.54/0.23</td>
<td>A</td>
</tr>
<tr>
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<td>12</td>
<td>7</td>
<td>0.73/0.38</td>
<td>A</td>
</tr>
<tr>
<td>14.</td>
<td>10</td>
<td>7</td>
<td>0.65/0.23</td>
<td>A</td>
</tr>
<tr>
<td>15.</td>
<td>11</td>
<td>8</td>
<td>0.73/0.23</td>
<td>A</td>
</tr>
<tr>
<td>16.</td>
<td>7</td>
<td>6</td>
<td>0.5/0.076</td>
<td>R</td>
</tr>
<tr>
<td>17.</td>
<td>11</td>
<td>7</td>
<td>0.69/0.3</td>
<td>A</td>
</tr>
<tr>
<td>18.</td>
<td>12</td>
<td>10</td>
<td>0.84/0.15</td>
<td>R</td>
</tr>
<tr>
<td>19.</td>
<td>5</td>
<td>8</td>
<td>0.5/-0.23</td>
<td>R</td>
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<td>12</td>
<td>8</td>
<td>0.77/0.31</td>
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<td>21.</td>
<td>8</td>
<td>4</td>
<td>0.46/0.31</td>
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<td>23.</td>
<td>13</td>
<td>6</td>
<td>0.73/0.23</td>
<td>A</td>
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<tr>
<td>24.</td>
<td>10</td>
<td>4</td>
<td>0.54/0.46</td>
<td>A</td>
</tr>
<tr>
<td>25.</td>
<td>12</td>
<td>7</td>
<td>0.73/0.38</td>
<td>A</td>
</tr>
<tr>
<td>26.</td>
<td>10</td>
<td>2</td>
<td>0.46/0.62</td>
<td>A</td>
</tr>
<tr>
<td>27.</td>
<td>8</td>
<td>7</td>
<td>0.57/0.076</td>
<td>R</td>
</tr>
<tr>
<td>28.</td>
<td>13</td>
<td>8</td>
<td>0.81/0.38</td>
<td>A</td>
</tr>
<tr>
<td>29.</td>
<td>12</td>
<td>6</td>
<td>0.69/0.46</td>
<td>A</td>
</tr>
<tr>
<td>30.</td>
<td>7</td>
<td>7</td>
<td>0.54/0</td>
<td>R</td>
</tr>
<tr>
<td>31.</td>
<td>13</td>
<td>11</td>
<td>0.92/0.15</td>
<td>R</td>
</tr>
<tr>
<td>32.</td>
<td>6</td>
<td>4</td>
<td>0.38/0.15</td>
<td>R</td>
</tr>
<tr>
<td>33.</td>
<td>9</td>
<td>4</td>
<td>0.5/0.38</td>
<td>A</td>
</tr>
<tr>
<td>34.</td>
<td>12</td>
<td>9</td>
<td>0.81/0.23</td>
<td>A</td>
</tr>
<tr>
<td>35.</td>
<td>8</td>
<td>3</td>
<td>0.42/0.38</td>
<td>A</td>
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<tr>
<td>36.</td>
<td>11</td>
<td>9</td>
<td>0.77/0.15</td>
<td>R</td>
</tr>
<tr>
<td>37.</td>
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<td>10</td>
<td>0.65/-0.23</td>
<td>R</td>
</tr>
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<td>38.</td>
<td>10</td>
<td>9</td>
<td>0.73/0.76</td>
<td>R</td>
</tr>
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<td>39.</td>
<td>13</td>
<td>8</td>
<td>0.81/0.38</td>
<td>A</td>
</tr>
<tr>
<td>40.</td>
<td>12</td>
<td>3</td>
<td>0.57/0.69</td>
<td>A</td>
</tr>
<tr>
<td>41.</td>
<td>6</td>
<td>2</td>
<td>0.31/0.31</td>
<td>A</td>
</tr>
<tr>
<td>42.</td>
<td>12</td>
<td>11</td>
<td>0.81/0.076</td>
<td>R</td>
</tr>
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<td>7</td>
<td>0.65/0.23</td>
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<td>6</td>
<td>0.53/0.15</td>
<td>R</td>
</tr>
<tr>
<td>45.</td>
<td>7</td>
<td>3</td>
<td>0.38/0.31</td>
<td>A</td>
</tr>
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<td>46.</td>
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<td>3</td>
<td>0.53/0.23</td>
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<td>3</td>
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<td>7</td>
<td>6</td>
<td>0.5/0.076</td>
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</tr>
<tr>
<td>Sr. No.</td>
<td>Difficulty Value</td>
<td>Discriminating Power</td>
<td>Outcome</td>
<td></td>
</tr>
<tr>
<td>--------</td>
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<td>54.</td>
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<td>5</td>
<td>0.65/0.54</td>
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</tr>
<tr>
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<td>5</td>
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<td>57.</td>
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<tr>
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<td>61.</td>
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<td>65.</td>
<td>11</td>
<td>5</td>
<td>0.62/0.46</td>
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</table>

The items having difficulty value (DV) ranging from 0.25 to 0.75 and the items ranging from 0.20 to 0.90 on the discriminating power (DP) were retained. The items at Sr. No. 9,11,16,18,19,27,30,31,32,36,37,38,42,44 and 53 were rejected and items at Sr. No. 3,20,28,34,39,50 and 56 were modified and retained. Thus a total of 50 items were retained for the final draft of the achievement test.

3.3.5 **Reliability of the Achievement Test**

Test reliability refers to the degree to which a test is consistent and stable in measuring what it is intended to measure. Reliability has been defined as "the degree to which test scores for a group of test takers are consistent over repeated applications of a measurement procedure and hence are inferred to be dependable and repeatable for an individual test taker" (Berkowitz, et al. 2000). A reliable test minimizes error and provides repeatable consistent results.

To find the reliability of the Achievement Test, test-retest method was used. The test was administered on a sample of 70 students of class X students of Government Girls Senior Secondary School, Sector 18, Chandigarh twice at an
interval of three weeks and then correlated to ensure reliability of the scores. The coefficient of reliability was found to be 0.93 indicating the test to be reliable.

### 3.3.6 Validity of the Achievement Test

Validity refers to the degree to which the test actually measures what it claims to measure. It is essential for a test to be valid in order for the results to be accurately applied and interpreted.

Content validity is a non-statistical type of validity that involves “the systematic examination of the test content to determine whether it covers a representative sample of the behaviour domain to be measured” (Anatasi & Urbina, 1997). A test has content validity built into it by careful selection of which items to include (Anatasi & Urbina, 1997). Items are chosen so that they comply with the test specification which is drawn up through a thorough examination of the subject domain.

Content validity is a logical process where connections between the test items and the objectives of a particular domain are established. To determine the content validity of the Achievement Test developed for the present study, 10 Biology teachers/experts were given this test individually to review the test items and comment on whether each item appropriately matched to the content area specified. As the table of specifications and the items were found to match adequately, the content validity of the achievement test was ascertained.

### 3.3.7 Normality of the Achievement Test

A test is said to be normal if the difficulty level of the items is balanced. On the basis of the difficulty index calculated for test items, many test items were either rejected or modified which ensured that the difficulty index of the test items was normally distributed. A copy of the Achievement Test is appended at the end (Annexure-1).
3.4 OPINIONNAIRES

Opinionnaires were designed by the investigator to elicit responses of students about effectiveness of Multimedia Presentation (MMP) and Computer Assisted Instruction (CAI) as instructional strategies.

3.4.1 Formation of Statements

The opinionnaire contained 15 items seeking opinion of students in the following areas:

- Content and level of MMPs and CAIs.
- Relevance of instructional objectives.
- Relevance of entry and terminal behaviour tests.
- Integration of new and old knowledge.
- Impact of integration of technology on learning.
- Understanding of the concepts.
- Comparison with traditional method of instruction.
- Self learning through CAI.
- Interactive nature of instructional material.
- Students’ interest for learning through MMPs and CAIs.
- According to mental level of students.

3.4.2 Criteria for framing Items

Items were framed based on the following criteria:

- Selected items should be relevant to the attributes to be measured.
- Items should be stated in simple, clear and precise words.

3.4.3 Format of the Scale

All statements in the opinionnaire favouring a position were scored using a five point Likert type scale which is as follows:
Strongly agree
Agree
Undecided
Disagree
Strongly disagree

Students were instructed to express their opinions by selecting one out of the five alternatives.

3.4.4 First Try Out

The opinionnaire developed by the investigator was given to the experts and teachers for validation. Modifications were made on the basis of the suggestions given by them after critically analysing the items in terms of any ambiguity, level of difficulty and inadequacy of language.

Out of 20 statements, each for the opinionnaire scales of MMPs and CAIs, 15 were retained after incorporating modifications suggested by the experts and teachers. The opinion scales are appended at the end (Annexure III).

3.4.5 Administration of Opinionnaire

To obtain the frank opinion of students about the effectiveness of MMP and CAI as teaching strategies, investigator explained them the purpose of the Opinionnaire and also informed them that there were no wrong or right responses. The Opinionnaire scale was administered on the respondents after asking them to follow instructions. There was no time limit to complete it. The percentage response of students for each statement has been discussed in Chapter IV.