Chapter-III

METHODOLOGY OF THE STUDY

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CHAPTER-III

METHODOLOGY OF THE STUDY

3.1 Introduction

The present study aims at ascertaining the effectiveness of multimedia method of instruction (multimedia package) with conventional method of instruction in the subject of Biology IX standard students at high school level. The purpose of the study were two fold, firstly the development of multimedia package in Biology and secondly validation of such a package. Comparison of Multimedia Method of Instruction (MMI) and Conventional Method of Instruction (CMI) is not only comparison of two modes of instruction but two theoretical paradigms. Conventional method of instruction represents a paradigm whereby knowledge is transmitted from teacher to student. Something is poured in learners' brain and the learner is a passive recipient of knowledge. Teacher plays an active part in this mode of instruction. Multimedia method of instruction represents a paradigm where knowledge is constructed and sought by the learner. Learner plays an active role in learning process. Learning is individualized, self paced and hands on.
This study has been completed in two phases, during the first phase a multimedia method of instruction package was developed by the researcher. The second phase of the study was experimentation with multimedia method of instruction package to determine its effectiveness in terms of student learning. Researcher also constructed three instruments has been used in the study. These instruments included an observation schedule for teachers was used to evaluate the quality of multimedia package, achievement test was used as pre-test and post-test performance measurement of the students and opinionnaire was used to collect experimental group students opinion towards multimedia package, support for learning Biology.

3.2 Design of the Study

The design found to be most useful for the purpose of this study was the pre test and post test experimental and control groups design. These groups were obtained through paired matching on the basis of intellectual capacity of the students. Raven's Progressive Matrices were used to measure the intellectual capacity of the students. Forty pairs of equal intellectual capacity were selected and assigned randomly to the experimental and control groups.
Following is the symbolic representation of the groups design:

**Figure: 3.1 Symbolic Representation of the Groups Design**

![Diagram of groups design]

<table>
<thead>
<tr>
<th>O1</th>
<th>X1</th>
<th>O2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test performance</td>
<td>Treatment MMI</td>
<td>Post-test (Achievement test)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>O3</th>
<th>X2</th>
<th>O4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test performance</td>
<td>Treatment CMI</td>
<td>Post-test (Achievement test)</td>
</tr>
</tbody>
</table>

Where:

O1 = Observation in pre-test of experimental group
X1 = Treatment Multimedia Method of Instruction
O2 = Observation in post-test of experimental group
O3 = Observation in pre-test of control group
X2 = Treatment Conventional Method of Instruction
O4 = Observation in post-test of control group

### 3.3 Rationale for Experimental Design

Reasons for employing pre test post test experimental and control groups design on matched groups in the present study were as follows:
1. Campbell and Stanley (1969) recommend pre-test and post-test control group and experimental group design for experiments with different teaching methods for the entirely new subject matter, even though they argue pre-test and post test settings are appropriate. In the present experiment subject matter to be taught the experimental and the control groups was entirely new. It was neither grounded in the Biology curricula of previous classes nor in continuation with the text material read in the previous classes. Therefore pre-test and post-test in this situation was considered appropriate and experimental and control groups design was employed.

2. Randomization does not ensure equality for small groups. Group size in the present study was initially decided to be twenty students. A group of less than thirty students is considered a small group. Therefore, paired matching was considered necessary to ensure equality of groups on mediating variable having a strong effect on student learning i.e., intellectual capacity of the students. Pairing was possible in three ways:

- On the basis of previous knowledge
- On the basis of intellectual capacity
- On the basis of both the previous knowledge and intellectual capacity.
Previous knowledge reflecting the standing of the student with respect to the subject was not relevant to the text material to be taught during the experiment. As the concepts to be taught during treatment had no foundation in the previous learning of the students, the impact of previous knowledge was not considered as a significant contributor towards student learning. Intellectual capacity of the student is a major contributor towards student learning. It would be a strong mediating factor if not controlled. Therefore, both the experimental and the controlled groups were matched on intellectual capacity. Matching of groups on two traits requires a large initial sample (Fraenkel and Wallen, 1993; Gay, 1996). As a large initial sample was not available, it was not possible to match the groups on two traits i.e., previous knowledge and intellectual capacity.

3.4 Population

The purpose of this study was to development and validation of multimedia package and to observe the effectiveness of multimedia method of instruction by using multimedia package in comparison with conventional method of instructional on the academic achievement of high school students in the subject of Biology of IX standard students. Therefore, high school students of IX standard, studying Biology subject constituted the population of the study.
3.5 Sample

A state wide sample representing high school students of Karnataka is ideal for the study. But due to practical constraints, the study was confined to students of studying in IX standard Biology (science part-2) of the Karnataka state board text book. Assuming that it is the representative of the three standards of high school education. The investigator limited the area of investigation to only one branch of science, that is Biology. The investigator was able to prepare multimedia package focussed on two chapters in Biology of IX standard. Considering the availability of the sample, the study has been concentrated on IX standard high school students of Bijapur city of Karnataka state in India.

Sample of the study was 80 students (40 boys and 40 girls) out of total 117 students in the age group 13.5 to 14.5 who are studying in IX standard, PDJ high school Bijapur city, Karnataka. Sample of the study was drawn on the basis of intellectual capacity measured on Raven's Standard Progressive Matrices (Raven’s SPM), the instrument to measure intellectual capacity. Raven’s SPM was administered to all 117 students in the IX standard, those all are present on the day of administration of the instrument. 117 students were classified into four intellectual capacity grades i.e., intellectually
superior, above the average in intellectual capacity, intellectually average and below average in intellectual capacity. Seven students were intellectually superior (Grade I), nine students were above the average in intellectual capacity (Grade II), forty one students were found in intellectually average (Grade III) and sixty students were found to be below average in intellectual capacity (Grade IV).

Forty pairs of equal intellectual capacity were to be taken as a sample of the study. It could be done in three ways that is proportionately, randomly and selectively. Scores on SPM revealed that six percent students were intellectually superior, eight percent students were above the average in intellectual capacity, thirty two students were intellectually average and fifty one percent students were found to be below average in intellectual capacity. In case of proportionate selection twenty eight pairs out of forty would have been selected from below average intellectual capacity students, eight from average and two pair from above average students, and only two pairs from students were intellectually superior. Similarly random selection also might have increased the number of below average students. Excessive number of similar category that is below average intellectual capacity students could cause decreased variability in achievement scores. Therefore, keeping in view the composition of the
group, all possible pairs form superior, above average and average students were selected to maximize their representation. In spite of that selected forty pairs included forty five percent superior, above average and average students and fifty five percent below average students.

3.6 Variables Involved in the Study

**Controlled variables:** Age of the students, Intelligence and Treatment (Conventional Method of Instruction and Multimedia Method of Instruction)

**Dependent variable:** Achievement mean scores

**Independent variables:** Sex of the students

3.7 Development of Multimedia Package (Software)

3.7.1 Designing of Instructional Media

Instructional design refers to application of well defined procedural steps for designing instructional resources materials. A number of related activities, such as identification of objectives, formulation of instructional strategies, and development of media based components and evaluation of learning outcomes are also involved in the designing.
A group of academicians Heinich, Molenda, Russel and Smaldno in USA (1990) propose the ASSURE model for designing, planning and delivering instructions that incorporates media. This model forces on planning, surrounding the actual classroom use of media. The acronym ASSURE stands for six steps for designing an instructional procedure.

**Step-1. Analyze the Learner**

Identification of learners is the first step in planning. The learners can be analyzed in terms of general characteristics, specific entry competencies, knowledge, skills and attitudes about the topic.
Step-2. State Objectives

The next step is to state objectives specifically. The objectives may be derived from a course syllabus taken from curriculum guide or developed by the investigator. The objectives should be stated in terms of what the learner will be able to do as a result of instructions.

Step-3. Select Materials

Once the identification of the learners and statement of objectives are established, the selection of available media and materials, modification of them and designing new materials are the three options before the instructors. The most important step in preparation of any media based resource material is the development of a script. Script is the sequence of pages/scenes, frames or units in which desired media format is arranged for presentation. It helps one to think clearly and take correct decision, save time and cost, ensure continuity and puts the director in total command.

Step-4. Utilize Materials

Having either selected, modified or designed the materials, plan how the materials will be used and how much time will be spent in them. Next step is to prepare the class, ready the necessary
equipments and present the materials using the 'showmanship' techniques in which the instructor can direct and hold the attention of the learners during presentation.

**Step-5. Require Learner Performance**

Learners must practice what they are expected to learn and should be reinforced for the correct response. There should be activities within the lessons that allow learner to respond and to receive feedback on the appropriateness of their performance or response.

**Step-6. Evaluate and Revise**

Finally, it is important to validate the materials developed, its impact and effectiveness in the process of instruction. The media option should be evaluated for its academic and motivational values. The concepts treated should be relevant to the objectives and help in ensuring the learning outcomes.

**3.7.2 Design of Multimedia**

As no multimedia package (software) covering the topics of high school level Biology was available, multimedia package (Appendix-vi) to be used in the experiment was developed by the researcher. It was
decided to develop the multimedia package (software) in English medium IX standard Biology of Karnataka State Board Syllabus.

The first step in designing an application is to decide which methodology to use. For the vast majority of computer applications it is hard to say that one correct implementation is better than another. There is always a certain amount of artistry involved in evaluating two correct implementations usually involving subjective arguments based on the preferences of the evaluator. An investigator may, for instance, prefer one method for developing a certain type of application while another person prefers another. In a package such as this where there is only one programmer involved, an investigator would say that the design methodology to use is the one that the programmer can achieve results with most confidence. The methodology does not have to agree exactly with any well known methodology.

Personally, an investigator feels most confident with mixed design methodology. An investigator had selectively used the objects of, top-down and bottom-up design based on the current task to solve the problem. Overall the development structure could be called evolutionary with some rapid prototyping. Most of the professional programmers that the investigator knows use some variation of the
technique when designing small to medium sized applications. It allows the flexibility of matching a particular style to the task in hand.

Perhaps the best way to illustrate the method is to go through the design process of the package in roughly chronological order. It has to be said that the design did not occur wholly before the implementation, rather it was an ongoing process throughout the implementation. The separation of the design from implementation is something that is inherent to the Waterfall method of designing a method which is widely regarded as a nice idea, and perhaps even the ideal, but not something that accurately reflects programming reality. A design is not properly assessed until it is implemented, by which time, according to the Waterfall method, it is too late to change the design. This is even more apparent in experimental studies, such as this one, where there is little readily available knowledge as to which package design is correct because nobody has implemented experimentally this kind of package before. The objective for designing this package was to develop an experimental time constrained package, implement it, assess the design, redesign if necessary and then move on to the next part of the package.
A multimedia project need not be interactive to be called multimedia; users can sit back and watch it just as they do a movie or the television. In such cases the project is linear, starting at a beginning and running through to an end. When the users are given navigational control and can wonder through the content at will, multimedia becomes non linear and interactive, and a very powerful personal gateway to information.

Multimedia elements are typically sewn together into a project using authoring tools. These software tools are designed to manage individual multimedia elements and provide user interaction. In addition to providing a method for users to interact with the project, most authoring tools also offer facilities for creating and editing text and images. Sounds and movies are usually created with editing tools dedicated to these media, and then the elements are imported into the authoring system for playback and how it is presented to the viewer is the human interface. This interface is just as much the rules for what happens to the user's input as it is the actual graphics on the screen. The hardware and software that govern the limits of what can happen are the multimedia platform or environment.
3.7.3 Medium

Medium is very important while discussing about multimedia concepts. Media refers to the types of information or types of information carriers. In general, one describes medium as a means for distribution and presentation of information. Examples of medium are alphanumerical data, images, audio, and video.

There are many ways to classify media. Common classifications are based on physical formats and media relationships with time, and different criteria like perception, representation, presentation, storage, transmission, and information exchange.

3.7.4 Types of Medium

Under the classification of physical formats and media relationship with time, the media is classified based on whether there is a time dimension to the media. Under this classification, there are two classes of media: static and dynamic (or time continuous).

Static media do not have a time dimension, and their contents and meanings do not depend on the presentation time.
Static media is also called discrete media. Static media include alphanumeric data, graphics and still images.

Dynamic media have a time dimension, and their meanings and correctness depend on the rate at which they are presented. Dynamic media include animation, audio, and video. These media have their intrinsic unit interval or rate. For example, to have a perceptually smooth movement, video must be played back at 25 frames per second, sometimes 30 frames per second, depending on the video system used. Similarly, where we play back a recorded voice message or music, only one playback rate is natural or sensible. Play back at a slower or faster rate distorts the meaning or the quality of the sound. Because these media must be played back continuously at a fixed rate, they are often called continuous media. They are also called isochronous media because of the fixed relationship between each media unit and time.

3.7.5 Classification of Medium on Different Criteria

As has been already discussed the media can also be classified with respect to different criteria like perception, representation, presentation, storage, transmission, and information exchange.
The Perception Medium

Perception media help humans to sense their environment. The perception of information occurs mostly through seeing or hearing the information. There is a primary difference between seeing and hearing information when using a computer. For the perception of information through seeing, the visual media such as text, image and video are used. For the perception of information through hearing, auditory media such as music, noise, and speech are relevant.

The Representation Medium

Representation media are characterized by internal computer representations of information. The various formats are used to represent media information in a computer. For example

- A text character is coded in ASCII or EBCDIC code.
- Graphics are coded according to standard GKS (graphics kernel system)
- An audio stream can be represented using a simple PCM (pulse coding method) with a linear quantization of 16 bits per sample.
- An image can be coded in JPEG or GIF format.
A combined audio/video sequence can be coded in media flash and different TV standard formats, and stored in the computer using an MPEG format.

- Macromedia flash 8.0
- Adobe Photoshop CS-3
- Sound Forge

The Presentation Medium

Presentation media refer to the tools and devices for the input and output of information. The media like paper, screen, and speaker are used to deliver the information by the computer (output media), keyboard, mouse, camera and microphone are the input media.

The Storage Medium

Storage media refer to a data carrier which enables storage of information. The various media's are floppy disk, hard disk, and CD ROM's are examples of storage media.

The Transmission Medium

The transmission medium characterizes different information carriers that enable continuous data transmission. The media's used for transmitting information are, over networks, which use wire and
cable for transmission, such as coaxial cable and fiber optics, as well as free air space transmission, which is used for wireless traffic.

The Information Exchange Medium

The information exchange medium includes all information carriers for transmission, i.e., all storage and transmission media. Here the information exchange can be done through intermediate storage media, where the storage medium is transported outside the computer networks to the destination, through direct transmission using computer networks, or through combined usage of storage and transmission media (example is electronic mailing system).

3.7.6 Steps in Multimedia Software Development

- Clear understanding of the problem on hand. Problem specification.
- Careful solution design paying attention to all the constraints.
- Transform design into a multimedia program. Abstraction and coding.
- Complete debugging. Error removal.
- Thorough testing.
- Maintenance dictated by the environmental changes.
3.7.7 Problem Specification

The essential function of Biology instruction is to teach theory and process of change in their evolution. The computer software may be found suitable for communicating process of Biology work effectively to the students.

3.7.8 Design

a. Output Design

Output, generally refers to the results and information that are generated by the application. For many end-users, output is the main reason for developing the system and the basis on which they will evaluate the usefulness of the application, when designing output, investigator accomplished the following:

1. Determine what information is to be presented.
2. Decide whether to display, print, or sound the information and select the output medium.
3. Arrange the presentation of information in an acceptable format.
4. Decide how to distribute the output to intended recipients.
b. Design of Input

The design of input includes the following input design details:

1. How to navigate.
2. What medium to use.
3. How the information should be arranged or coded.
4. The voice to guide users to go ahead.
5. Right answers and transactions needing validation to detect errors.
6. Methods for performing input validation and steps to follow when errors occur in evaluation.

c. Design of Procedure

Procedures specify what tasks must be performed in using the application. The important procedures include:

- Navigation procedures: Methods for how to move towards the information on the screen.
- Run-Time procedure: Steps and actions taken by end-users who are interacting with the application to achieve the desired results.
- Error-handling procedures: Actions to take when unexpected answers occur in evaluation.
d. Design of Program Specification

Designing computer software is important to ensure that:

- The actual programs produced perform all tasks and do so in the manner intended.
- The structure of the software permits suitable testing and validation to be sure procedures are correct.
- Future modifications can be made in an efficient manner.

e. Stages in the Development

According to Akkar (1999) development focuses on complex and innovative tasks. Usually very few validated principles are available for structuring and supporting the design and developmental activities of the package that are developed.

The development deal with the development of multimedia including the video and the computer presentations as well as the development of the tests and the problems encountered during development.

The development of multimedia involved the following:

- Literature search to gather information regarding the development of study material.
• Accumulating the necessary graphics-digital images and drawings.
• Mastering the software to compile the programs.
• Creating the video and the computer presentations.
• A model was designed based on the information and the purpose of the study.
• The model was tested against the real life equivalent. This process is called validation, as shown in Figure 3.3.
• A multimedia model was created, as shown in the Figure 3.4
• The model was improved and further testing carried out until it behaves as much like the real learning as is possible.
• Then the model was used to examine unknown situations.

**Figure: 3.3 Validation Model of Development.**

![Diagram of Validation Model of Development](image-url)
f. Coding

After designing the user interface, the next stage was to decide how each control reacts to user actions, such as click of a mouse, key strokes, and so on. As the application does not determine the flow of, instead, the events caused by the user determine the flow of the application. Hence coding is essential to react to various external conditions (events), and the users' actions determine the applications flow.

g. Testing

Testing is the major quality control measure employed during multimedia software development. Its basic function is to detect errors in the multimedia software. During requirements, analysis and design, the output is usually textual. After the coding phase, computer programs are available that can be executed for testing purpose. This implies that testing, not only has to uncover errors introduced during coding, but also errors introduced during the previous phases. Thus, the goal of testing is to uncover requirements, design or errors in the programs.

The starting point of the testing was unit testing. In this a module was tested separately and is often performed by the code.
himself simultaneously with the coding of the module. The purpose was to exercise the different parts of the module code to detect coding errors. After this the modules were gradually integrated into subsystems, which were then integrated by themselves to eventually form the entire application. After the system was put together, application testing was performed. Here the application was tested against the requirements to see if all the requirements are met and the application performs as specified by the requirements.

**Figure: 3.4 Structure of Multimedia Model**
The structure of multimedia model is broadly classified into Device layer, System layer, and Application layer. All these different layers are discussed here:

**Device Layer**

This layer describes the basic concepts for the processing of digital audio and video data that are based on digital signal processing. The digital representation of video data is also taken care in this layer. The compression methods are part of all these types of data, because of data rates and sizes. The diminishing cost of optical storage space has contributed significantly to the current development of computer technology. Almost all developments are based on CD-DA (Compact Disc-Digital Audio). On the other side, networks, with their higher bandwidth and their capacity for transmitting all media types, have led to networked multimedia systems. The development is also taking place towards a full digital working system.

**System Layer**

The interface between the device layer and the system layer is specified by the computer technology. To utilize the device layer,
Several system services are required. Basically, three such services exist. These services are mostly implemented in software.

- The operating system serves as an interface between computer hardware/system software and all other software components. It provides the user with a programming and computational environment, which should be easy to operate. In its function as an interface, the operating system provides different services that relate to the computer resources, such as: processor, main memory, secondary memory, input and output devices and network.

- The database system allows access to the data stored and a management of large databases.

- The communication system is responsible for data transmission according to the timing and reliability requirements of the networked multimedia application.

**Application Layer**

The services of the system layer are offered to the application layer through proper programming abstractions. Application layer is also capable of handling documents, a document consists of a set of structured information, represented in different media, and generated.
or recorded at the time of presentation. Many functions of document-
handling and other applications are accessible and presented to the
user through a user interface.

3.7.9 Properties of Multimedia System

Multimedia system is any system which supports more than a
single kind of media. Not only text and graphics there are several
other medias like animation, sound and video. A multimedia system
uses all these different Medias in any combination. A multimedia
system distinguishes itself from other systems through several
properties.

The properties are:

Combination of Media

Not every arbitrary combination of media justifies the usage of
the term multimedia. A simple text processing program with
incorporated images is often called a multimedia application because
two media are processed through one program. But one should talk
about multimedia only when both continuous and discrete media are
utilized. A text processing program with incorporated images is
therefore not a multimedia application.
**Independence**

An important aspect of different media is their level of independence from each other. In general, there is a request for independence of different media, but multimedia may require several levels of independence. The media are dependent or independent depends on application. For example, video recorder stores audio and video information, but there is an inherently tight connection between the two type of media.

**Computer Supported Integration**

The multimedia system should support all Media that are being used should provide the possibility of combining media in arbitrary forms. Therefore it must be emphasized in terms of integrated multimedia system. Simply say, in such systems, everything can be presented with video and sound that is presented with text and graphics today. For example in conventional systems, a text message can be sent to the other users, but, a multimedia system with a high level of integration allows this function also for audio messages or even for a combination of audio and text.
Communication Systems

Communication capable multimedia systems must be approached. A reason for this is that most of today's computers are interconnected, considering multimedia functions from only the local processing viewpoint would be a restriction. Another reason is that distributed environments enable particularly interesting multimedia applications. Here multimedia information cannot only be created, processed, presented and stored, but also be distributed above the single computer's boundary.

3.8 Hypotheses

1. There is no significant difference between post test mean scores of students under multimedia method of teaching and conventional method of teaching in Biology.

2. There is no significant difference between post test mean scores of boys students under multimedia method of teaching and conventional method of teaching in Biology.

3. There is no significant difference between post test mean scores of girls' students under multimedia method of teaching and conventional method of teaching in Biology.
4. There is no significant difference between post test mean scores of boys and girls students under multimedia method of teaching and conventional method of teaching in Biology.

5. There is no significant difference between pre test and post test mean scores of students under conventional method of teaching and multimedia method of teaching in Biology.

6. There is no significant difference between pre test and post test mean scores of boys students under conventional method of teaching and multimedia method of teaching in Biology.

7. There is no significant difference between pre test and post test mean scores of girls students under conventional method of teaching and multimedia method of teaching in Biology.

8. There is no significant difference between pre test and post test mean scores of boys and girls students under conventional method of teaching and multimedia method of teaching in Biology.

9. There is no significant difference between post test mean scores of boys and girls students under conventional method of teaching in the topic The Living World.

10. There is no significant difference between post test mean scores of boys and girls students under multimedia method of teaching in the topic The Living World.
11. There is no significant difference between post test mean scores of boys and girls students under conventional method of teaching in the topic The Study of Cells.

12. There is no significant difference between post test mean scores of boys and girls students under multimedia method of teaching in the topic The Study of Cells.

13. There is no significant difference between pre and post test mean scores of boys students under conventional method of teaching in the topic The Living World.

14. There is no significant difference between pre and post test mean scores of boys students under multimedia method of teaching in the topic The Living World.

15. There is no significant difference between pre and post test mean scores of girls students under conventional method of teaching in the topic The Living World.

16. There is no significant difference between pre and post test mean scores of girls students under multimedia method of teaching in the topic The Living World.

17. There is no significant difference between pre and post test mean scores of boys students under conventional method of teaching in the topic The Study of Cells.
18. There is no significant difference between pre and post test mean scores of boys students under multimedia method of teaching in the topic The Study of Cells.

19. There is no significant difference between pre and post test mean scores of girls students under conventional method of teaching in the topic The Study of Cells.

20. There is no significant difference between pre and post test mean scores of girls students under multimedia method of teaching in the topic The Study of Cells.

21. There is no significant difference between pre and post test mean scores of students under conventional method of teaching in the topic The Living World.

22. There is no significant difference between pre and post test mean scores of students under multimedia method of teaching in the topic The Living World.

23. There is no significant difference between pre and post test mean scores of students under conventional method of teaching in the topic The Study of Cells.

24. There is no significant difference between pre and post test mean scores of students under multimedia method of teaching in the topic The Study of Cells.
3.9 Materials and Tools Used for Experiment and Data Collection

Instruments were developed to measure the dependent variables and to record perception, personal, and situational data.

Data was collected by using:

- Raven's Standard Progressive Matrices (R-SPM) were used to measure the intellectual capacity of the students for the purpose of paired matching.
- Achievement test has been used as pre-test and post-test.
- Multimedia package was used to teach the experimental group.
- Observation schedule for teachers has been used to evaluate the quality of multimedia package.
- Opinionnaire to collect learners’ opinion towards multimedia package.

3.9.1 Raven’s Standard Progressive Matrices (Raven’s SPM)

Standard Progressive Matrices (1983 edition) is a test of a person’s capacity at the time of the test to apprehend meaningless figures presented for his observation, see the relations between them, conceive the nature of the figure completing each system of relations presented, and by doing so, develop a systematic method of reasoning. Standard Progressive Matrices was designed to cover the
widest possible range of mental ability and to be equally useful with persons of all ages, whatever their education, nationality or physical condition. For comparative purposes Standard Progressive Matrices is used internationally, it can be given either as an individual, a self-administered or a group test (Raven, Court and Raven, 1983).

If total score of person on Standard Progressive Matrices and his age is known, his percentile point can be found on tables given in the norm of the instrument. Percentile point helps to determine the intellectual capacity grade of a person. If total score of person on Standard Progressive Matrices classify the respondents into five intellectual capacity grades according to the criteria as given below:

GRADE I  "Intellectually Superior", if the score lies at or above the 95th percentile for the people of his age group.

GRADE II  "Definitely above the average in intellectual capacity", if the score lies at or above the 75th percentile; II+ if score lies at or above the 90th percentile.

GRADE III  "Intellectually average", if the score lies between 25th and 75th percentiles; III+, if the score is the greater than the median or 50th percentile; III-, if the score is less than the median.
GRADE IV "Definitely below average in intellectual capacity", if the score lies at or below the 25th percentile; IV-, if the score lies at or below 10th percentile.

GRADE V "Intellectually defective", if the score lies at or below the 5th percentile for his age group.

(Source: Raven, Court and Raven, 1983)

3.9.2 Achievement Test

Achievement test (Appendix-ii) has been used as pre-test and post-test was developed by the investigator. Test comprised of sixty multiple choice items. This test was based on the text material and vocal explanation included in the multimedia package instruction and conventional method of instruction. A comprehensive table of specification (Appendix-i) for the test was framed. Cells in the two way chart of specification gave the detail of number of test items by content and instructional objectives. The criterion for instructional objectives was worked out by the investigator. This criterion was developed by classifying the objectives of teaching Biology as given in the curriculum of Biology for class IX. Objectives were classified in terms of the categories in cognitive domain of the taxonomy of educational objectives. Proportion of items to be included in the test, was computed by relative proportion of emphasis laid in the
objectives. Pre test and post test comprising sixty multiple choice items have 22 items to measure knowledge, 18 items to measure understanding, 12 items to measure application and 8 items to assess the skill ability of the students.

Validation and Pilot Testing

A panel of seven experienced teachers (two field experienced high school teachers who taught Biology, three teacher educators who deal method of teaching Biology and one subject expert in zoology and one teacher educator in English methodology) validated the test. Pilot test was containing 130 items it was conducted by administering the test to 20 students of IX standard who were not included in the study. On the basis of item analysis, 70 items were deleted and slight modifications were made in some items. The final form of the test contained 60 objective type multiple choice items and the duration of the test was one hour. After item analysis the reliability coefficient alpha was computed on Predictive Analysis Software (PASW). Reliability coefficient alpha (Cronbach alpha) is model of internal consistency based on average inter-item correlations. This coefficient is a general form of the Kuder Richardson-20 (KR-20) formula. Pilot test data revealed the reliability coefficient of the sixty items test to be 0.74 it was considered...
acceptable according to a thumb rule suggested by Fraenkel and Wallen (1993) that reliability of a test for research purposes should be at least 0.70 and preferably higher.

**Validity:** A logical examination of instructional objectives and the contents to be taught was done by a panel of experts, one associate professor in the field of subject, three assistant professors in the field of education and two senior teachers of the subject concerned from the high schools and one teacher educator in English methodology. The agreement of the views of seven experts was taken as the index of the content validity of the achievement test.

**Preparation of the Final Test**

More than required number of items was included in the test under each objective and content unit. This was done so as to get enough items for the final test. Out of 117 items included in the pilot test, 60 items were selected for the final test based on the difficulty index and discriminative power. The test items were prepared based a blueprint, by giving due weightage to content, objective, and difficulty level which were fixed in concurrence with a number of general and special teachers who are expert in the content, methodology and field experience. A question booklet with
instructions was given to the students on how to answer the questions in the final form question booklet (Appendix-B). The items were arranged in the order of difficulty level and the time limit was fixed to 60 minutes. Separate answer sheets (Appendix-C) were provided for writing the correct response.

**Weightage to Content**

The weightage to different units and sub units in the content of the achievement test are given in Table-3.1

**Table: 3.1: Weightage to Content in the Achievement Test in Biology for IX Standard**

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Units</th>
<th>Sub-units(Contents)</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The Living World</td>
<td>Multicellular animals</td>
<td>3</td>
<td>5.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Porifera</td>
<td>4</td>
<td>6.67</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Coelenterate</td>
<td>4</td>
<td>6.67</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Platyhelminthes</td>
<td>3</td>
<td>5.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Aschelminthes</td>
<td>3</td>
<td>5.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Annelida</td>
<td>4</td>
<td>6.67</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Arthropoda</td>
<td>3</td>
<td>5.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mollusca</td>
<td>3</td>
<td>5.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Echinodermata</td>
<td>3</td>
<td>5.00</td>
</tr>
<tr>
<td>2</td>
<td>The Study of Cells</td>
<td>Structure of Chromosomes</td>
<td>7</td>
<td>11.67</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mitosis</td>
<td>9</td>
<td>15.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meiosis</td>
<td>9</td>
<td>15.00</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>13</td>
<td>60</td>
</tr>
</tbody>
</table>
**Weightage to Objectives**

The weightage given to different objectives in the achievement test are given in Table-3.2

**Table: 3.2: Weightage to Objectives in the Achievement test in Biology for IX Standard**

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Objectives</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Knowledge</td>
<td>22</td>
<td>36.67</td>
</tr>
<tr>
<td>2</td>
<td>Understanding</td>
<td>18</td>
<td>30.00</td>
</tr>
<tr>
<td>3</td>
<td>Application</td>
<td>12</td>
<td>20.00</td>
</tr>
<tr>
<td>4</td>
<td>Skill</td>
<td>8</td>
<td>13.33</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td>60</td>
<td>100.00</td>
</tr>
</tbody>
</table>

**Weightage to Difficulty Level of Questions**

The weightage to difficulty level are given in Table-3.3

**Table: 3.3: Weightage to Difficulty Level of Question in the Achievement Test in Biology for IX Standard**

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Difficulty level of questions</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Easy</td>
<td>12</td>
<td>16.00</td>
</tr>
<tr>
<td>2</td>
<td>Average</td>
<td>36</td>
<td>72.00</td>
</tr>
<tr>
<td>3</td>
<td>Difficult</td>
<td>12</td>
<td>12.00</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td>60</td>
<td>100.00</td>
</tr>
</tbody>
</table>

**Blueprint**

A blue print was prepared by giving due weightage to the objectives, content and form of questions. The cell in the blue print
represents the number of items to be included in the test in relation to any particular objective.

Table: 3.4: Blue Print of the Achievement Test in Biology for IX Standard

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Units</th>
<th>Objective</th>
<th>Knowledge</th>
<th>Understanding</th>
<th>Application</th>
<th>Skill</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Sub-units (Contents)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>The Living World</td>
<td>Multicellular Animals</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Porifera</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Coelenterate</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Platyhelminthes</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Aschelminthes</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Annelida</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Arthropoda</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mollusca</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Echinodermata</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>The Study of Cells</td>
<td>Study of cell</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Structure of Chromosomes</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mitosis</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meiosis</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>2</td>
<td>13</td>
<td>22</td>
<td>18</td>
<td>12</td>
</tr>
</tbody>
</table>

**Difficulty Index and Discriminative Power**

Difficulty index and Discriminative power were computed. According to Ebel and Frisbie (1986) items with discrimination power of 0.40 and above are very good ones, items with discrimination power of 0.30 to 0.39 are reasonably good but possibly subject to
improvement and items with discrimination power of 0.20 to 0.29 are marginal items and usually need improvement. Similarly, difficulty index of multiple choice items having four distracters should be from 0.375 to 0.625. Keeping in view the above mentioned criteria items having discrimination power less than 0.30 and having difficulty index below 0.20 (very difficult items) and above 0.80 (very easy items) were improved. Difficulty index criterion was relaxed for items having good discrimination power. Items with good discrimination power and with difficulty index from 0.20 to 0.80 were accepted.

Finalized sixty items achievement test is composed of two sub tests:

a) Sub test with respect to topic: The Living World, it contains 30 items with respect to content areas and instructional objectives.

b) Sub test with respect to topic: The Study of Cells, it contains 30 items with respect to content areas and instructional objectives.
3.9.3 Opinionnaire:

Learners' Opinion towards Multimedia Package

The investigator had used opinionnaire to collect learners' opinion towards multimedia package (Appendix-v) support for Biology learning from the experimental group.

It was constructed by the investigator and comprising twenty statements related to various educational aspects. The opinionnaire comprised twenty statements inviting response on five point scale i.e. from strongly agree to strongly disagree. Scoring was done by assigning values of one to five for strongly disagree to strongly agree responses. Eight statements invited the respondents to opine about the content presentation in multimedia package, four statements invited opinion about questioning in multimedia package, another four statements sought response about individualization and self pacing of multimedia package and another four statements invited the respondents to compare multimedia package with the conventional method of instruction and opine in favor of multimedia package or vice versa. Scoring was done by assigning values of one to five for strongly disagree to strongly agree responses. This instrument elicits student opinion about content presentation, questioning (multiple choice items with immediate feedback) individualization and
on the whole impact of multimedia package in terms of liking and disliking as compared with the traditional method of instruction.

3.9.4 Observation Schedule

The structured observation schedule for teachers has been designed by the investigator to evaluate the quality of multimedia package (Appendix-iv). This observation schedule has observed on three point scale from agree, no opinion (neutral) and disagree, the space was provided for response to each statement. It comprises 12 statements which refer to the technical aspects of the software. Their aim was to evaluate its technical adequacy to the learning objectives of the program. They deal mainly with statements related to the general structure of the package navigation, interactivity, design and other aspects that can favour or hinder the learning process. Overall 22 statements refer to curricular design aspects, usefulness and intend to evaluate the integration capacity of the program in the learning process of Biology.

3.10 Procedure of Experiment

To compare multimedia method of instruction with conventional method of instruction on students achievement in Biology, an experiment was conducted at BDE Society’s PDJ high
school 'A' Raven's Standard Progressive Matrices (R-SPM) was administered to 117 students of IX standard students who were present on the day of test administration. Two matched groups of 40 (20 boys + 20 girls) students each were taken to conduct the experiment. Experimental group students received treatment in the form of multimedia method of instruction in the computer laboratory of the school while the control group students received instruction as usual from the investigator everyday during the second period of school time, this arrangement was made by the Head mistress of the school, on investigators' request. Investigator himself supervised the students of experimental group while receiving multimedia method of instruction in the laboratory everyday evening. Investigator remained present in the computer laboratory all the time during the treatment sessions.

Role of the investigator was to:

- Keep record of students' daily progress.
- Keep the students busy in purposeful activities by advising them to follow the instructions strictly.
- Observe the behaviour of each student in the laboratory and keep record of interest, sense of responsibility and attitude towards learning through multimedia method of instruction.
• Maintain discipline in the laboratory during treatment sessions.
• Help students if they had any problem with the usage of multimedia software.

There was no chance of mixing of the students of the control group with students of the experimental group. Treatment given in two weeks continuously, after immediate completion of the treatment a post test was administered to both the groups and an opinionnaire to multimedia method instruction group to elicit their opinion at the end of the treatment.

The structured observation schedule for teachers has been designed by the investigator to evaluate the quality of multimedia package. This observation schedule contains 12 statements which refer to the technical aspects of the software. Their aim was to evaluate its technical adequacy to the learning objectives of the program. They deal mainly with statements related to the general structure of the package navigation, interactivity, design and other aspects that can favour or hinder the learning process. Overall 22 statements refer to curricular design aspects, usefulness and intend to evaluate the integration capacity of the program in the learning process of Biology. Observation schedule was given to 10 teachers.
and they were asked to mark (✓) on three point scale where the space was provided for response to each statement.

3.11 Procedure of Data Collection

The experimental group students received treatment in the form of multimedia method of instruction in the computer laboratory of the school while the control group students received instruction as usual from the investigator everyday second period of school time. Investigator himself supervised the students of experimental group while receiving multimedia method of instruction in the laboratory everyday evening. Investigator remained present in the computer laboratory all the time during treatment sessions.

The pre-test was administered to both the group just before the beginning of treatment (Appendix-ii). Both groups were equated on the basis of Raven's SPM test scores. After the completion of treatment (teaching), the post test (Appendix-ii) was administered immediately.

Data were collected from 80 students, 40-(20 boys + 20 girls) from each group. The purpose of this test was to measure the achievement of students constituting the sample of the study.
Opinionnaire (Appendix-v) was administered to the students of the experimental group after immediate completion of the treatment (multimedia method instruction), to collect their opinion towards the multimedia method of instruction, this data were collected from 40 students of experimental group, (20 boys + 20 girls).

The structured observation schedule (Appendix-iv) for teachers has been used by the investigator to evaluate the quality of multimedia package. Observation schedule was given to 10 teachers and asked to mark (✓) on three point scale. Investigator aim was to evaluate technical adequacy to the learning objectives of the multimedia package.

3.12 Statistical Techniques Used for Data Analyses

Achievement test administered as pre-test and post-test to both the experimental and control groups not only gave total achievement scores in Biology of the students but also sub totals of achievement with respect to two topics: The Living World and The Study of Cells and boys and girls students' achievement scores. To compare the achievement test scores of the experimental group with the control group students on achievement test paired 't'test was employed. Comparison was done on the basis of total achievement score and
sub totals of achievement with respect to two topics: The Living World and The Study of Cells and boys and girls students’ achievement scores. Significance of difference between the expected scores and observed mean achievement scores was determined by applying paired ‘t’ test.

Data collected on structured observation schedule was used to evaluate the quality of multimedia package by the teachers. Its purpose was to evaluate its technical adequacy to the learning objectives of the program. The teacher observations on three point scale it was analysed by percentage technique.

Data collected on the opinionnaire was analysed by computing the mean of response values for every statement. The number for strongly agree responses for a statement are denoted by SA, agree by A, slightly agree by S, disagree by D and strongly disagree are denoted by SD, then formula for computing average response weight for the statement is:

$$\text{Average response} = \frac{SA \times 5 + A \times 4 + S \times 3 + D \times 2 + SD \times 1}{\text{Total number of responses}}$$

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