METHODOLOGY

- Method adopted
- Variables used
- Sample for the study
- Materials and Tools used
- Procedure for Data collection
- Experiment conducted
- Statistical Method adopted
The main purpose of the present study was to develop e-learning materials (Multimedia Package, MMP) and to find out its effectiveness with regard to select process skills. It was also found out whether certain independent variables such as certain instructional strategies, namely, MMP self-learning, teacher-assisted MMP learning and activity-based method have any effect on student’s post test scores based on process skills in Physics. For this the investigator developed e-learning material (MMP) on the topics ‘Force’ and ‘Motion’ in Physics for standard VIII students. This MMP was used for teacher-assisted instruction and also for self-learning. The investigator presumed that this package can help to improve process skills among students. This chapter describes the methodology adopted for this purpose.

4.1 METHOD ADOPTED

Survey and experimental methods were used for the present study. In order to analyse the opinion of secondary school teachers on the existing usage of e-learning materials in teaching, survey method was adopted. The various dimensions included under the opinionnaire were training in IT (Information Technology), effectiveness of e-learning, usefulness of e-learning and hindrances in using e-learning. For assessing the effectiveness of the MMP, experimental method was found suitable.

Experimental Design

The design used for the present study is pre-test post-test, non-equivalent group design (experimental groups and control group). The experimental groups were exposed to MMP, both teacher-assisted and self-learning and control group with existing method of teaching (activity-based).

4.2 VARIABLES USED

The variables in the experiment were:
**Independent Variables**

In the present study, the independent variables those considered were the following:

1. MMP self-learning
2. Teacher-Assisted MMP instruction
3. Existing method of teaching (Activity-based)

**Dependent Variables**

The dependent variable considered for the present study are process skills in Physics and retention of process skills with respect to instructional strategies adopted.

**Classificatory Variables**

The classificatory variables considered for the present study are gender of students, locale of the educational institution and type of school.

**Rationale for selecting Independent Variables**

The strategies of instruction employed by the investigator has a very important role in developing process skills in Physics. In the present study, three kinds of instructional strategies (teacher-assisted MMP instruction, MMP self-learning, activity-based method) form important independent variables. The strategies using MMP enables individual approaches to learning. These strategies include text, pictures, graphics, animation and multimedia elements which appeal to the various senses. Students are thus motivated and they learn better in such environments.

**Rationale for selecting Dependent Variables**

The NCERT has identified the process approach as one of the core elements of the integrated science curriculum for secondary schools. Students cannot be evaluated merely on the basis of their achievement scores in the process approach.
In recent years process skills have a predominant place in science education. Teaching science through the process approach helps in developing an inquisitive mind and a scientific approach to problems. How much has been retained after learning through these strategies are measured using retention test. To find out whether retention is more using the process approach, retention of process skills is also taken as a dependent variable.

**Rationale for selecting the Classificatory Variables**

The educational institutions in the state of Kerala are situated either in urban or in rural areas. Therefore, these educational institutions can be clearly categorized into two as urban and rural. It is presumed that students belonging to educational institutions of urban areas are exposed to better facilities and learning conditions. So their post test scores based on process skills is likely to be influenced by urban atmosphere.

It has been experienced that gender difference is a factor which influences the students’ level of learning. Therefore gender of the students undergoing the experiment is considered as a classificatory variable for the present study.

Based on agencies which run the schools there are three categories of schools in Kerala; Government, Aided and Unaided. Government schools are schools managed by the Government of Kerala. Aided schools are run by individuals, corporate, trusts or societies, but funded by government. Unaided schools are run and funded by individuals, corporate, trusts or societies. It has been presumed that the instructional strategies using MMP can be effectively used for a heterogeneous group of students based on the type of school in developing process skills.

**4.3 SAMPLE FOR THE STUDY**

To obtain a sample representative of its population, stratified random sampling has been employed. Gender, locale and type of school has been taken as classificatory variables for the experimental study.
Sample for Opinionnaire of Teachers

The sample for the survey (Opinion of teachers on the existing usage of e-learning in teaching) consists of 202 secondary school teachers covering four districts of Kerala (Thiruvananthapuram, Kollam, Ernakulam, Kozhikode) selected on the basis of stratified random sampling technique. The sample selected were from government, aided and unaided schools and it comprises both male and female teachers, Arts and Science faculties, teachers with graduation and post graduation. The details are given below:

TABLE 4.1
Sample for the Survey (Opinion of teachers on the existing usage of e-learning in teaching)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sub sample</th>
<th>N</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Male</td>
<td>50</td>
<td>24.75</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>152</td>
<td>75.25</td>
</tr>
<tr>
<td>Locale</td>
<td>Rural</td>
<td>96</td>
<td>47.52</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
<td>106</td>
<td>52.48</td>
</tr>
<tr>
<td>Type of School</td>
<td>Government</td>
<td>51</td>
<td>25.25</td>
</tr>
<tr>
<td></td>
<td>Aided</td>
<td>127</td>
<td>62.87</td>
</tr>
<tr>
<td></td>
<td>Unaided</td>
<td>24</td>
<td>11.88</td>
</tr>
<tr>
<td>Computer Qualification</td>
<td>Yes</td>
<td>84</td>
<td>41.58</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>118</td>
<td>58.42</td>
</tr>
<tr>
<td>Teaching Experience</td>
<td>Less than 10 yrs</td>
<td>90</td>
<td>44.55</td>
</tr>
<tr>
<td></td>
<td>10-20 yrs</td>
<td>87</td>
<td>43.07</td>
</tr>
<tr>
<td></td>
<td>Above 20yrs</td>
<td>25</td>
<td>12.38</td>
</tr>
</tbody>
</table>

Sample for Multimedia Package Evaluation Scale (MPES) of Teachers

The sample for the opinionnaire to know the opinion of teachers towards MMP consisted of 75 secondary school teachers covering four districts of Kerala (Thiruvananthapuram, Kollam, Ernakulam, Kozhikode) selected on the basis of stratified random sampling technique. The sample selected was from government, aided and unaided schools and it comprises both male and female teachers, Arts and
Science faculties, teachers with graduation and post graduation. The details are given below:

**TABLE 4.2**

Sample for the Survey (Opinion of teachers towards MMP)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sub sample</th>
<th>N</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>31</td>
<td></td>
<td>41.33</td>
</tr>
<tr>
<td>Female</td>
<td>44</td>
<td></td>
<td>58.67</td>
</tr>
<tr>
<td><strong>Locale</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>42</td>
<td></td>
<td>56.00</td>
</tr>
<tr>
<td>Rural</td>
<td>33</td>
<td></td>
<td>44.00</td>
</tr>
<tr>
<td><strong>Type of School</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Government</td>
<td>25</td>
<td></td>
<td>33.33</td>
</tr>
<tr>
<td>Aided</td>
<td>25</td>
<td></td>
<td>33.33</td>
</tr>
<tr>
<td>Unaided</td>
<td>25</td>
<td></td>
<td>33.33</td>
</tr>
<tr>
<td><strong>Computer Qualification</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>38</td>
<td></td>
<td>50.67</td>
</tr>
<tr>
<td>No</td>
<td>37</td>
<td></td>
<td>49.33</td>
</tr>
<tr>
<td><strong>Teaching Experience</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 10yrs</td>
<td>42</td>
<td></td>
<td>56.00</td>
</tr>
<tr>
<td>More than 10yrs</td>
<td>33</td>
<td></td>
<td>44.00</td>
</tr>
<tr>
<td><strong>General Qualification</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PG</td>
<td>42</td>
<td></td>
<td>56.00</td>
</tr>
<tr>
<td>Degree</td>
<td>33</td>
<td></td>
<td>44.00</td>
</tr>
</tbody>
</table>

**Sample for Perception Scale of Students**

The sample for the perception scale (Perception towards developed MMP) consisted of 467 secondary school students of Kozhikode district. The sample selected was from government, aided and unaided schools and it comprised both male and female students from rural and urban areas. The details are given below:
Sample for the Survey (Perception of students on the MMP)

<table>
<thead>
<tr>
<th>Groups</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>217</td>
<td>46.47</td>
</tr>
<tr>
<td>Female</td>
<td>250</td>
<td>53.53</td>
</tr>
<tr>
<td><strong>Locale</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>152</td>
<td>32.55</td>
</tr>
<tr>
<td>Urban</td>
<td>315</td>
<td>67.45</td>
</tr>
<tr>
<td><strong>Type of School</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Government</td>
<td>82</td>
<td>17.56</td>
</tr>
<tr>
<td>Aided</td>
<td>222</td>
<td>47.54</td>
</tr>
<tr>
<td>Unaided</td>
<td>163</td>
<td>34.90</td>
</tr>
</tbody>
</table>

**Sample for the Experiment**

The sample for the experimental study consisted of 471 secondary school students of Kozhikode district selected on the basis of stratified random sampling technique. The sample selected was from government, aided and unaided schools and it comprised both male and female students from rural and urban areas. It was decided to select the sample from 6 schools in Kozhikode district only. Standard VIII students were selected as representative sample of secondary school students in Kerala.

Two experimental groups and one control group was drawn from each school. The schools selected were St. Josephs Anglo Indian Higher Secondary School, St. Josephs Boys Higher Secondary School, Silver Hills Higher Secondary School situated in urban areas and Kunnamangalam Government Higher Secondary School, BeeLine Public School, Atholi Government Higher Secondary School situated in rural areas. A total of 471 students from these schools consisting of 231 boys and 240 girls were selected. The selected sample included 207 students from urban areas and 264 students from rural areas. Of these 90 were government school students, 190 aided school students and 191 unaided school students.
Finally 158 students were selected to comprise the experimental group I (Multimedia Package self-learning), 154 students in experimental group II (Teacher-assisted Multimedia Package) and 159, the control group (Activity-based Method). Distribution of the students in the three groups (control and experimental) was as follows:

TABLE 4.4
School wise Distribution of the Students in the Sample

<table>
<thead>
<tr>
<th>Name of School</th>
<th>Control Group</th>
<th>Experimental Group I</th>
<th>Experimental Group II</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Boys</td>
<td>Girls</td>
<td>Boys</td>
<td>Girls</td>
</tr>
<tr>
<td>Silver Hills HSS</td>
<td>24</td>
<td>15</td>
<td>22</td>
<td>15</td>
</tr>
<tr>
<td>BeeLine Public School</td>
<td>9</td>
<td>15</td>
<td>16</td>
<td>13</td>
</tr>
<tr>
<td>St. Josephs Boys HSS</td>
<td>15</td>
<td>-</td>
<td>9</td>
<td>-</td>
</tr>
<tr>
<td>Anglo Indian Girls HSS</td>
<td>-</td>
<td>20</td>
<td>-</td>
<td>21</td>
</tr>
<tr>
<td>Atholi GHSS</td>
<td>14</td>
<td>16</td>
<td>16</td>
<td>14</td>
</tr>
<tr>
<td>Kunnamangalam HSS</td>
<td>16</td>
<td>15</td>
<td>19</td>
<td>13</td>
</tr>
<tr>
<td>Total</td>
<td>78</td>
<td>81</td>
<td>82</td>
<td>76</td>
</tr>
</tbody>
</table>

TABLE 4.5
Distribution of Students on the basis of Sub sample

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
<th>Urban</th>
<th>Rural</th>
<th>Government</th>
<th>Aided</th>
<th>Unaided</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Group</td>
<td>78</td>
<td>81</td>
<td>74</td>
<td>85</td>
<td>30</td>
<td>66</td>
<td>63</td>
<td>159</td>
</tr>
<tr>
<td>Experimental group I</td>
<td>82</td>
<td>76</td>
<td>67</td>
<td>91</td>
<td>30</td>
<td>62</td>
<td>66</td>
<td>158</td>
</tr>
<tr>
<td>Experimental group II</td>
<td>71</td>
<td>83</td>
<td>66</td>
<td>88</td>
<td>30</td>
<td>62</td>
<td>62</td>
<td>154</td>
</tr>
</tbody>
</table>
4.4 MATERIALS AND TOOLS USED

The following materials and tools were used for collecting data in the present study:

4.4.1 Opinionnaire to analyze opinion of teachers on the existing usage of e-learning materials in teaching.

4.4.2 E-learning materials (Multimedia Package, MMP) in select topics in Physics.

4.4.3 A Multimedia Package Evaluation Scale (MPES) for teachers to evaluate the developed MMP.

4.4.4 A perception scale for students to evaluate the developed MMP.

4.4.5 Process Skill Test in select topics in Physics for secondary school students.

The above mentioned tools were constructed and standardized by the investigator in collaboration with the supervising teacher. The details regarding the preparation of the materials and tools employed for the present study are outlined below:

4.4.1 Opinionnaire of Teachers (Scale of Opinion on the existing usage of E-learning materials in teaching)

In order to analyze the opinion of teachers on the existing usage of e-learning materials in teaching, an opinionnaire was prepared and its details are given below.

Selection of the Items

By going through the literature and in discussion with experts, the investigator designed 70 positive and negative statements for the construction of the opinionnaire. For screening the statements, the criteria suggested by Edward (1957), Kilpatrick (1948) and Likert (1932) were applied.

The opinionnaire was typed out and presented to a group of experts in the field for their critical comments. In the light of criticism and comments of the
experts some statements were modified and 9 statements were deleted. Thus the draft opinionnaire consisted of 61 statements and were classified under the following 4 categories.

TABLE 4.6
Classification of Statements in the Opinionnaire (Draft form)

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Category</th>
<th>No. of statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Training in IT</td>
<td>3,4,5,6,7,8,10,12,18,37,38,41,46,51,53 (15)</td>
</tr>
<tr>
<td>2</td>
<td>effectiveness of E-learning</td>
<td>1,2,11,13,20,23,30,32,33,34,36,44,45,56,58,61 (16)</td>
</tr>
<tr>
<td>3</td>
<td>usefulness of E-learning</td>
<td>9,19,22,25,26,28,39,43,47,48,49,55,57,60 (14)</td>
</tr>
<tr>
<td>4</td>
<td>Hindrances in using e-learning</td>
<td>14,15,16,17,21,24,27,29,31,35,40,42,50,52,54,59 (16)</td>
</tr>
</tbody>
</table>

In each category an equal number of positive and negative statements as far as possible were arranged at random. The statements were arranged in the draft form on a five point scale with the responses Strongly Agree, Agree, Undecided, Disagree and Strongly Disagree.

Scoring of the Statements

For scoring, numerical values were assigned to the five categories of the responses as indicated below.

TABLE 4.7
Assignment of the Scores for the Opinion

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive or favourable</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Negative or unfavourable</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
The score for each individual was computed by summing the weightage of the individual item responses.

Validity

Content Validity

The related literature was the source for the items. The tool prepared was subjected to scrutiny, criticism and comment of the experts in the field of Educational Technology. The tool was modified in the light of their comments and suggestions.

Reliability

In order to know the reliability, test-retest method was used and the reliability coefficient was found to be 0.74. Thus it was inferred that the tool is reliable for the population.

Item Analysis

Item analysis emphasizes the extent to which an item predicts segregations of testees into ‘high versus low’ criterion scores. The total score for each statement was calculated from the opinion score of each respondent. For the final selection of the items, the critical ratio of each statement was calculated. Critical ratio is a measure of the extent to which a given statement differentiates between the high and low groups of respondents.

As suggested by Edwards (1957) the thumb rule of rejecting items with ‘t’ value of less than 1.75 was followed. The experimental try-out was conducted on a sample of 60 teachers from various schools in Kerala. Care was taken to include in the final tool only those items which have high ‘t’ values.

After the item analysis 21 statements were rejected. Finally 40 statements were selected for the final tool. The classification of statements in the final tool is as follows:
TABLE 4.8

Classification of Statements in the Opinionnaire (final form)

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Category</th>
<th>No. of statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Training in IT</td>
<td>1,2,4,6,11,24,25,27,31,36 (10)</td>
</tr>
<tr>
<td>2</td>
<td>Effectiveness of e-learning</td>
<td>5,7,15,20,21,23,30,37,38,40(10)</td>
</tr>
<tr>
<td>3</td>
<td>Usefulness of e-learning</td>
<td>3,12,14,17,26,29,32,33,34,39(10)</td>
</tr>
<tr>
<td>4</td>
<td>Hindrances in using e-learning</td>
<td>8,9,10,13,16,18,19,22,28,35(10)</td>
</tr>
</tbody>
</table>

Out of the 40 statements, 20 were of positive polarity and remaining 20 were of negative polarity. 10 statements were to rate the views on training in IT, 10, to rate the views on usefulness of e-learning, 10, to rate the views on effectiveness of e-learning, and 10 to rate the opinion of the respondent on hindrances in using e-learning.

The opinionnaire used for the draft, item analysis and final are given in the Appendix as 1A, 1B and IC respectively.

4.4.2 Development of E-learning Materials (MMP) in Physics

The areas for teaching Physics was selected from the Kerala State syllabus prescribed for standard VIII for the schools of Kerala. The area selected was ‘Force’ which is divided into nine sub areas and ‘Motion’ which was divided into six sub areas.

A detailed course outline was also prepared for the guidance of the students in control group. It contains activities, questions, exercises similar to those given in the multimedia package and evaluation items. The areas selected and instructional objectives specified were the same for both the experimental groups and control group.
Procedure (Experiment Conducted)

Students in the three groups were expected to master the specified concepts on an equal basis. For this, the control group was exposed to the existing method (activity-based) and the experimental groups were exposed to the e-learning teaching strategies, both teacher-assisted and self-learning. The control group followed the prescribed text books in Physics (Kerala Physics for standard VIII), whereas the experimental groups followed the MMP developed by the investigator.

The MMP in Physics on the topics “Force” and “Motion” for standard VIII students was developed by the investigator. It was aimed at developing various science process skills with regard to each concept. First, the student’s needs and characteristics were identified. The learning goals and objectives were set accordingly. The various learning activities were listed and organized. Suitable graphics was identified. Visuals were constructed that illustrated a concept. The various concepts illustrated in ‘Force’ were Effects of Force, Net-Force, Contact and Non-Contact Forces, Balanced and Unbalanced Forces, Internal and External Forces, Newton’s 1st law of Motion, Friction and Inertia. The various concepts in ‘Motion’ were Rest and Motion, Types of Motion, Distance and Displacement, Uniform and Non-Uniform Motion, Speed, Average Speed, Uniform Speed and Velocity. The material consisted of various screens with animated pictures and textual materials for understanding the various concepts and exercises for evaluation. A website is also designed using HTML for the same units for self study by students.

The following softwares were used to prepare the multimedia package.

ADOBE. FLASH CS3 for animation
ADOBE. ILLUSTRATOR CS3 for creating characters.
ADOBE. PHOTOSHOP CS3 for texturing.
SONY. SOUNDFORGE 8 for sound editing and recording.

The MMP is presented in Appendix VI.
Content Validity of MMP

The draft material was checked by the supervising teacher and other experts in the field and necessary corrections were made. The investigator tried out the package on actual members of the population. Necessary changes were then made in the MMP by carefully noting down student’s responses, questions and comments.

After completely preparing the MMP, validity was established through submitting the package to science teaching experts and IT experts in India and abroad in the form of online questionnaires and expert’s evaluation matrix (Appendix IVA, IVB) for reviewing. According to the recommendations of the reviewers, modifications regarding accuracy, language clarity and functionality were made.

4.4.3 Multimedia Package Evaluation Scale (MPES) for Teachers

The investigator, with the help of the supervising teacher constructed an opinionnaire, namely ‘Multimedia Package Evaluation Scale’ applicable to Physical Science teachers of Kerala state. The developed MMP was shown to the teachers personally by the investigators by projecting it onto a screen to be viewed by teachers. The Multimedia Package Evaluation Scale (MPES) was administered on the teachers to evaluate the developed package.

Selection of Statements

After consulting with experts in the field and teacher educators, selection of statement was done as follows:

The investigator reviewed books, periodicals and other descriptive materials to procure the material to construct the statements for the Likert type opinionnaire. Experts in the field were also consulted and their suggestions were taken into consideration. It was decided to include five dimensions of opinion towards MMP. These were learnability, efficiency, flexibility, user satisfaction and attractiveness. Initial pools of 70 statements were prepared. This pool of statements was given to ten experienced and qualified teachers. After this the language was checked for
ambiguity of wordings, if any. The panel of teachers was asked to evaluate the statements keeping in mind the following points:

1) Whether there were enough statements under each of the opinion dimensions.
2) Accuracy and relevancy of each statement
3) Simplicity of language used for each statement

Based on their suggestions, those statements, which were complex, vague, over-generalised were deleted. The remaining 60 statements formed the draft of the opinionnaire.

Out of the 60 statements, 41 were of positive polarity and the remaining 19 were of negative polarity. 17 statements were meant to rate the views on learnability of MMP, 8 to rate the views on efficiency of MMP, 13 to rate the views on flexibility, 13 to rate the attitude of the respondent on user satisfaction and 9 statements to rate the views on attractiveness of the MMP.

**Initial Try Out**

The 60 statements were arranged as in Likert type. To avoid any error or tendency to stereotyped response items of positive polarity and negative polarity were evenly arranged. Directions for the respondents were also prepared. The teachers were asked to assign any one of the five categories after carefully reading the statement. The five categories were SA- Strongly Agree, A- Agree, U- Undecided, DA- Disagree and SD- Strongly Disagree. After the administration of the scale, it was scored by keeping into consideration the scoring procedure suggested by Likert (Edwards, 1957).

For scoring the scale, a score of 5, 4, 3, 2, and 1 was given to category SA, A, U, DA and SD for a positive statement and score of 1, 2, 3, 4 and 5 was given to the category SA, A, U, DA and SD for a negative statement. Appropriate response sheet was also prepared along with the draft form of the scale.

The classification of statements in the draft tool is as follows:
TABLE 4.9

Classification of Statements in the MPES for Teachers (draft form)

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Category</th>
<th>No. of statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Learnability</td>
<td>1, 5, 7, 13, 15, 18, 21, 28, 32, 34, 38, 42, 43, 45, 46, 47, 48 (17)</td>
</tr>
<tr>
<td>2</td>
<td>Efficiency</td>
<td>3, 4, 9, 17, 19, 35, 52, 60 (8)</td>
</tr>
<tr>
<td>3</td>
<td>Flexibility</td>
<td>2, 8, 12, 16, 26, 27, 29, 30, 36, 37, 49, 50, 59 (13)</td>
</tr>
<tr>
<td>4</td>
<td>User Satisfaction</td>
<td>6, 14, 20, 22, 31, 39, 44, 51, 53, 54, 56, 57, 58 (13)</td>
</tr>
<tr>
<td>5</td>
<td>Attractiveness</td>
<td>10, 11, 23, 24, 25, 33, 40, 41, 55 (9)</td>
</tr>
</tbody>
</table>

**Item Analysis**

The draft scale was administered to a representative sample of 40 high school teachers. The sum of the scores of all the items constituted the total score of the scale. The selection of items for the final form of the scale, MPES, was done as per the procedure suggested by Edwards (1957). The response sheets of the individuals were arranged in the descending order of the total scores. The highest 27% and the lowest 27% of the response sheets were separated. These were criterion groups in terms of which to evaluate the individual statements. In evaluating the responses of the high and low groups of the individual statements, the ‘t’ ratio was found.

The ‘t’ value for each item was calculated. The statements for which ‘t’ value is greater than or equal to 1.75 was regarded as an item which possesses internal consistency and hence discriminating power. Thus, 45 statements were selected for the final tool. Out of the 45 statements, 20 were of negative polarity and 25 were of positive polarity.

**Final form**

The final form of the MPES contained 45 statements and specific directions for the respondents. An appropriate response sheet was also prepared. For scoring
the MPES, a score of 5, 4, 3, 2, and 1 was given to category SA, A, U, DA and SD for a positive statement and score of 1, 2, 3, 4 and 5 was given to the category SA, A, U, DA and SD for a negative statement.

The total number of items in the MPES was 45. The maximum and minimum scores which teachers may score on MPES, was 45x5 and 45x1 respectively.

The reliability of scale, calculated by test-retest method was found to be 0.86. Thus the scale is a reasonably valid and reliable one.

The draft form, item analysis details and final form of the scale are given as Appendices II A, II B and II C respectively.

4.4.4 Perceptionscale to know the Perception of students on the developed MMP

As a preliminary step for making the perception scale, a list of 50 statements on the various aspects of the multimedia package was prepared and was submitted to experts for necessary modifications. Based on their suggestions, some items were modified and some were deleted. A perception scale for pilot study consisting of 41 statements was prepared (Appendix IIIA). This was administered to a sample of 100 students. The respondents were requested to mark each item in terms of their agreement/disagreement by putting a tick mark in any one of the five columns, strongly agree, agree, undecided, disagree and strongly disagree. The answer sheets were then collected and scoring was done.

For scoring the perception scale, a score of 5, 4, 3, 2, and 1 was given to category SA, A, U, DA and SD for a positive statement and score of 1, 2, 3, 4 and 5 was given to the category SA, A, U, DA and SD for a negative statement.

Item Analysis

Item analysis was done to select suitable items for the final perception scale.

The total score obtained for each respondent (student) was calculated and the response sheets were arranged in the order of magnitude of the total score. Then the highest 27 percent and the lowest 27 percent were taken out for analysis since 27
percent provides the best compromise between two desirable and inconsistent aims: (i) to make extreme groups as large as possible and (ii) to make extreme groups as different as possible.

The scores obtained for each item in these extreme groups were used for calculating the discriminating power of each item. The discriminating power was obtained by calculating the critical ratio ‘t’ (Edwards, 1957, p.153).

The items having t-values 1.75 or more were retained in the final tool. The statements having ‘t’ value lower than 1.75 were rejected from the draft form. The remaining 28 positive statements and 12 negative statements were retained in the final form.

Reliability of the Perception Scale

In the present study, the reliability coefficient of the perception scale was calculated using test-retest method. The reliability coefficient of the perception scale was found to be 0.72. This indicated that the scale was highly reliable.

Validity

The perception scale was constructed by taking care to cover all aspects relating to the MMP. Moreover, it was submitted to experts for necessary modifications and the draft scale was item analysed and only the items which have required discriminating power have been selected. Thus the perception scale can be considered valid and reliable.

The draft form, item analysis details and final form of the scale are given as Appendices III A, III B and III C respectively.

4.4.5 Process Skill Test in Physics on the Topics ‘Force’ and ‘Motion’

The process skill test in Physics was developed by the investigator for quantifying student’s process skills in Physics. The steps followed and the techniques employed in the construction of the process skill test in Physics are described below.

The intention of the test was to quantify the process skills of students. This type of learning is intellectually stimulating and scientifically authentic.
Planning of the Test

In order to quantify process skill test for secondary school students, questions to measure process skills in Physics was constructed by the investigator. It was decided to develop a test comprising of 60 multiple choice items for ninety minutes duration. Process skill test in Physics included certain fundamental areas of Physics syllabus. The areas are ‘Forces’ and ‘Motion’.

Items writing

Since the purpose of the test was to measure the process skills in Physics achieved by the secondary school students of Kerala, the items prepared were from areas of secondary school Physics. The investigator took precautions to include the items which have practical applications in day-to-day life. Special care was given so that the mental operations while answering the questions were the natural outcomes of Physics teaching and learning in classroom situations.

The classification of objectives by Klopfer (1971) & Obourn (1960) was used as the basis for the development of different steps of this tool. The classification of process skills and sub skills are presented.

i) Recognising and defining a problem.
   a) Students recognise scientific problems in a new situation
   b) Students isolate the major idea of a problem
   c) Students state problems as definite and concise questions

ii) Formulating hypothesis
   a) Students suggest tentative solution to the problem.

iii) Collecting data
   a) Students select a suitable test of hypothesis
   b) Students design experiment
   c) Students select equipment for experiment
   d) Students observe objects and phenomena
   e) Students measure objects and changes
iv) **Interpreting data**

a) Students organize data collection  
b) Students identify relationships  
c) Students interpret relationships

v) **Evaluating hypothesis**

a) Students formulate conclusion on the basis of relationship found  
b) Students evaluate hypothesis in relation to the data interpreted

evi) **Formulating generalization**

a) Students apply conclusion to new situation  
b) Students formulate generalizations on the basis of relationships identified and conclusions formed and applied.

The investigator initially pooled 100 questions. The different sources used for item development were textbooks, reference books, question banks and the following special literature.

1) Science Teaching and testing (Nedelsky, 1965)  
2) Science Education in Nineteen Countries – Empirical Studies (Comber & Keeves, 1973)  
3) Teaching Physical Sciences in Secondary Schools (Gupta, 1981)  
4) Science Teaching in Schools (Das, 1985)  
5) Test of process outcomes in Biology (Suresh, 1991)  
6) Integrated Process Skills Test (Okey & Dillashow, 1979)  
7) Text Books in Physics for standards VII, VIII and IX (Govt. Of Kerala, 2010)

The items were subjected to scrutiny by subject experts in science. The list of experts are given in Appendix IV A. The items were re-edited in light of expert criticism. Thus the number of items was brought down to 70. Items were grouped under 6 sections and one section intended for each skill of the scientific process thus
covering six subsections of the scientific process listed earlier. Details of the sections are given below.

a) **Recognising and defining a problem**

Problematic situations were included in this test. The student’s recognition of a problem may pass through several states, that is from awareness of the problem area to identification of a specific problem. In this test item the students would choose the correct response from the alternative responses given thereby indicating their behavior. This sub skill included 12 items from Physics.

b) **Formulating hypotheses**

The test item in this section contains the tentative solution to the posed problems. Here the students seek whether the specific problem is susceptible to experimental investigation and it might lead the students to formulation of working hypothesis that would give direction to investigation. In the test item four hypotheses are given as the probable solution to the problem. The student is required to select the appropriate one. The sub skill included 11 items.

c) **Collecting data**

This section contains experiments and constitutes a valid test of hypotheses. This category focuses on the behavior of the science students involving an inquiry. The designing of procedure for performing experimental tasks, the student’s observation and measurement of things, using appropriate measuring instruments are all included in this section. This sub skill included 12 items.

d) **Interpreting data**

In this section the student process the data obtained from experimentation or presented to him in the form of recorded observations and measurements to yield quantitative and qualitative judgments. First, the student analyses the results of experiment. This includes the behavior of manipulating, adjusting and organizing his observations and measurements. Again present these data in the form of functional
relationships. Besides this, the student interprets the relationship. This sub skill included 12 items.

e) **Evaluating hypothesis**

A report by student about his performance and thinking is most common for evaluation. The student selects a valid test of hypotheses. The experiments are designed and carried out, data having been collected, organized and interpreted, the student needs to check whether or not the findings verifies the hypotheses. Therefore the student is expected to find out whether the evidence is consistent with the hypotheses. This sub skill included 12 items.

f) **Formulating generalisation**

A report by the students about his performance and thinking is most common for evaluation. The student selects a valid test of hypotheses. Formulating generalization is a complex behavior involving higher mental process. The student considers the result of his experiments with other similar inquiries. If this original finding is corroborated with others, he is justified in formulating an empirical generalisation. The sub skill included 11 items.

**Blue print**

The blueprint is a document that gives a complete picture of the test. It shows the distribution of questions and marks assigned for different sub process skill and the content. It helps the test constructor to prepare appropriate questions to suit the purpose of test construction. Thus the blueprint was prepared showing the distribution of questions and scores for the six sub process skills. The details are given in Table 4.10.
Each of the seventy items was pooled initially for each process skill. Some of the test items were adapted from school Physics text books, published texts and from available literature cited earlier from the topics ‘Force’ and ‘Motion’. A panel of Physics teachers was formed for establishing the face validity. Each item was discussed at length in terms of its appropriateness, complexity, subject matter and exactness of information. Based on the scrutiny of experts, items which were found appropriate and valid were selected. These items constitute the draft process skill test in Physics. Instructions for the respondents, scoring key and appropriate form of the response sheet were prepared.

The draft process skill test was pre tried out to a group of 10 students of eighth standard randomly selected from Providence Girls HSS, Kozhikode in order to ensure the clarity of the wordings and directions.

Based on the pre-tryout, final draft process skill test consisted of 70 items.

**Standardization**

The draft test was administered to 390 students drawn from standard VIII of schools in Kozhikode district which had all the characteristic features of the sample drawn for the experimental study including government, aided, unaided, urban, rural, girls and boys. For the smooth and efficient administration of the test, the co-

---

**TABLE 4.10**

**Blue Print**

<table>
<thead>
<tr>
<th>Content</th>
<th>Recognising and defining a problem</th>
<th>Formulating hypotheses</th>
<th>Collecting Data</th>
<th>Interpreting data</th>
<th>Evaluating hypothesis</th>
<th>Formulating generalisation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Force</td>
<td>6(1)</td>
<td>7(1)</td>
<td>6(1)</td>
<td>6(1)</td>
<td>7(1)</td>
<td>4(1)</td>
<td>36(1)</td>
</tr>
<tr>
<td>Motion</td>
<td>4(1)</td>
<td>1(1)</td>
<td>5(1)</td>
<td>5(1)</td>
<td>4(1)</td>
<td>5(1)</td>
<td>24(1)</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>8</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>9</td>
<td>60</td>
</tr>
</tbody>
</table>

*The number in parentheses shows the marks*
operation of the teachers was sought. One score was given for a correct response and no score was given for wrong answers. The sum of the scores for the 70 items was taken as the total score for the test. Among the 390 response sheets, after rejection of incomplete answer sheets as well as random rejection of a few answer sheets, 370 answer sheets were used for item analysis.

**Item analysis**

For item analysis, the procedure suggested by Ebel (1972) was used. Accordingly, the scored answer sheets were arranged in order of scores from high to low. Then separated upper 100 and lower 100 response sheets. The middle 170 was discarded. Each item in the response sheet were tallied for the 100 high scores (U) and 100 low scores (L). Through the process of difficulty index and discriminating power, the reliability of easiness and hardness of item can be assessed.

Difficulty index of an item is represented by percentage of students who responded correctly each item. Difficulty index is calculated using the formula,

\[ Di = \frac{(U + L)}{2N} \]

where,

- \( U \) = Number of correct responses in the upper group,
- \( L \) = Number of correct responses in the lower group,
- \( N \) = Number of students in any group.

Discrimination power of an item is the quality of an item at which it discriminates between students with high and low marks. The discrimination power of each item is found out using the formula,

\[ Dp = \frac{(U - L)}{N} \]

where,

- \( U \) = Number of correct response in the upper group,
- \( L \) = Number of correct responses in the lower group,
- \( N \) = Number of students in any group.
For the selection of items, difficulty index above 0.40 were readily selected. Items which have difficulty index above 0.375 were selected as reasonably good. An item satisfying this condition was accepted for inclusion in the test. Other items having difficulty index below 0.375 and discriminating power below 0.30 were rejected and thus 60 items were selected for the final test. The draft, item analysis details, scoring key of draft, final Process Skill Test in Physics, response sheet and scoring key are given as Appendices V A, V B, V C, V D, V E and V F respectively. The duration of the test is fixed 90 minutes and the maximum mark is 60.

**Validity and Reliability**

Content validity of the test requires the determination of the adequacy of each item to be a sample of the process skills which are supposed to be measured. It was ensured through careful planning of the test, satisfying the adequacy of sampling of test items by following the standard theoretical models of the construct to be measured and meticulous analysis of the test items by experts. In the process skill test, all the six process skills were given almost equal weightage.

The investigator used test-retest method to find out the reliability of the test. The test-retest reliability of the tool was worked out on a representative sample of 50 students after an interval of 3 weeks time. The reliability of the present test computed by test-retest method was 0.86. This indicated that the test is reliable in measuring process skills in Physics.

### 4.5 Procedure for Data Collection (Survey)

Towards the middle of the academic year the headmasters of the schools were contacted personally and prior permission was sought for administration of the tools. The finalised tools such as Opinionnaire, Multimedia Package Evaluation Scale (MPES) and Perception Scale were administered on the sample keeping in view all the precautions to be taken care of in a survey. Necessary instructions were given to teachers and students to respond to the items in the tools. The filled in opinionnaire, MPES and perception scale were collected back on the same day itself.
4.6 EXPERIMENT CONDUCTED

In order to conduct the experiment, three divisions of standard VIII were selected from 6 schools in Kozhikode. Out of the three divisions, two were taken as the experimental groups and the third as the control group. A pre test was administered to the three groups. The developed MMP was then given to experimental group I. They were asked to learn the units by themselves using the MMP under the supervision of the investigator. Experimental group II was taught using MMP by the investigator. The control group was taught the same units by the activity-based method by the investigator herself. After completing the topics, post test was administered to all the three groups on the same day. The post test scores were collected and used for analysis.

**Design of the Study**

The objectives of the study enabled the investigator to conduct the study using the experimental design. The design used for the present study is the design of *pre-test post-test, non-equivalent group* (control and experimental groups). The experimental groups were exposed to MMP, both self-learning and teacher-assisted and control group with existing method (activity-based) of teaching. The Head masters of the schools were contacted earlier by the investigator.

**Administration of the Tests**

In administering the tests the instructions given in the respective test manuals were strictly followed and explained to the students. Ideal examination conditions as prescribed in the test manuals were followed for test administration.

A Pre test in Physics based on process skills was conducted during the first phase of the experimental study.

**Learning by the Experimental Group I (MMP Self-Learning)**

The experimental group I was exposed to self-learning by MMP. There was no time limit given to complete the lessons. It was self-paced. They had the option
of moving to the previous screens whenever any doubts arose. Self evaluation questions were provided at the end of each module.

Learning by the Experimental Group II (Teacher-assisted MMP)

This group was taught by the investigator with the help of the MMP. A period of 40 minutes was given to learn one lesson. A total of 30 periods were taken for mastering the concepts.

Learning by the Control Group (Activity-based method)

Control group was taught through the activity-based method of instruction by the investigator following the course outline and prescribed textbook. Duration of a period of 40 minutes was given to teach a lesson. A total number of 30 periods was taken for teaching the specified course on “Force” and “Motion” in Physics.

Post test based on Process Skills

After completion of the teaching on the specified area, the three groups were given a post test based on process skills, which was used for determining the effectiveness of the various instructional strategies.

Retention Test

A retention test helps to find out the retention capacity of the subjects. The retention test prepared in this study was almost the same as the post test with respect to the weightage given to the various process skills. There was slight change in the order of questions in the retention test. The retention test evaluates how much of the presented material the student can remember and use the process skills developed.

4.7 STATISTICAL METHOD ADOPTED

Scoring of the answer sheets of the pre test, post test and retention test were done on the basis of the pre-fixed scoring key. After valuing the answer sheets the scores were tabulated separately for the experimental groups and the control group. The analysis was done on the basis of the obtained data.
**Statistical techniques used**

The main objective of the study was to find the effectiveness of the MMP constructed by the investigator. For the purpose of analyzing data, t-test, Analysis of Variance (ANOVA) and ANCOVA were used in the present study taking into account the multiple variables in the experiment.

The mean and standard deviation of the scores of each test were found out. As the aim of the study was to test the effectiveness of the MMP in developing process skills in Physics, ‘t’ test was done using the pre test and post test scores. The important statistical measures pertaining to central tendency and dispersion of the pre test and post test scores were calculated to study the nature of the scores.

In the present study, there were three groups for comparison as one control and two experimental groups. Within each group the scores were affected by several variables. The critical ratio was found out for comparing the pre test and post test scores based on process skills of the experimental groups and control group.

ANOVA was employed to test whether there exists significant difference among groups (control, experimental I and experimental II) for the sample.

The experiment was done using intact, previously non-equated groups and hence they may differ in their initial variables. Analysis of Covariance (ANCOVA) is a method that enables the researcher to equate the pre-experimental status of the groups in terms of their relevant known variables. Differences in the initial status of the groups can be removed statistically so that they can be computed as though their initial status has been removed (Best, 1996). Thus, the researcher decided to adopt the technique of ANCOVA for sharper experimental comparison of process skills between experimental groups and control group, in the present study.