CHAPTER III

METHODOLOGY

- Requirement Analysis
- Software design for M-LMS
- Software selection
- Development of M-LMS
- Selection and arrangement of a topic for validation
- Validation of the Developed software
  - Design of the study
  - Variables of the study
  - Tools used for the study
  - Sample used for the study
  - Data collection procedure
  - Statistical techniques
The main purpose of the study was the development of a web based Learning Management System and its validation. Many software packages were used for the development of the web based LMS. Similarly, different statistical techniques were used for the validation of the developed LMS.

The first part of the study is the software development. Server programs, web based programming languages, animation programs, Database Management Systems (DBMS) and features of web management systems were utilised for the development of the web based Learning Management System.

The second part of the research methodology deals with the validation procedure of the developed M-LMS. Experimental study and trend analysis were conducted for the completion of validation procedure.

The following are the objectives of the study

• To develop and validate a Moodle based Learning Management System in Physics for secondary school students of Kerala.

• To tryout the developed Moodle based Learning Management System on Secondary School students of Kerala for the whole sample and the relevant subsamples.
Methodology

• To compare the effectiveness of the developed Moodle based Learning Management System in achievement in Physics for the whole sample and relevant sub samples of Secondary School students of Kerala.

• To compare the achievement in Physics of students taught through Moodle based Learning Management System with that of the students who were taught through the existing method of teaching with respect to the whole sample and the relevant subsamples of secondary school students of Kerala.

Based on the objectives the following hypotheses were formulated.

• There exists significant difference in achievement in Physics of students taught through Moodle based Learning Management System and that of the students taught through the existing method of teaching.

• The Moodle based Learning Management System is effective in the teaching of Physics as evidenced by gain score analysis of Secondary School Students.

• The mean post-test scores in Physics achievement of experimental and control groups will differ significantly, with advantage to the experimental group, when the effect of pre-test score is controlled.
The Moodle based Learning Management System is effective in teaching of Physics for Secondary School Students as evidenced by trend analysis.

**Stages of Software Development and Validation**

The below given steps were followed for the development of Moodle based Learning Management System and its validation.

- Requirement Analysis.
- Software design for M-LMS.
- Software selection
- Development of M-LMS.
- Selection and arrangement of a topic for validation.
- Validation of the developed software.

The implementation of the above mentioned procedure is detailed below:

**Requirement Analysis**

In this step, the investigator analysed the procedure and structure of the existing learning and evaluation system in secondary schools of Kerala. After focus group discussions with students, teachers and experts in the field the investigator collected data regarding present learning and evaluation
procedure. The teachers from high schools and teacher training institutions were participated in the discussion. The manuals and instructions for Continuous and Comprehensive Evaluation (CCE) procedures were also reviewed for this purpose.

Based on the focus group discussions and reference of the manuals, the investigator identified the components needed for the development of Moodle based Learning Management System (M-LMS). The components identified in the customisation of M-LMS are detailed below:

- Software components for Individual participation in Learning,
- Software components for Involvement in group activities in learning.
- Software components for evaluation and data store.

**Software components for individual participation in learning**

In learning process, pupils are involved in different activities which include individual efforts and group activities. The assessment of the individual participation in learning process is important in continuous and comprehensive evaluation. So, in the software development the following options or subcomponents are required for the handling of individual participation in the learning process and its assessment.

- Individualised Learning Materials.
- Provision to compute the time taken to complete the learning process.
• Calculate the number of attempts made during learning process.
• Provision to enter the attendance of the individual in the class.
• Provision to enter the participation in extra-curricular activities.
• Features to give learning assignments and individual projects.

**Software components for group activities in learning**

Group activities are also important in the learning process. The sub-components required to evaluate the group participation in learning process are given below.

• Software components to evaluate group cohesiveness and group dynamics
• Software components to assess leadership and initiation
• Software components to identify the acceptance among group
• Provisions for online group discussions
• Class blogging features.
• Provisions for wiki editing.

**Software components for evaluation and data store**

Strategies for formative and summative evaluations are required in the development of learning management software. Formative evaluation module should be activated automatically during pupils encounter with the developed
software. Similarly, final tests and its evaluation are essential after the completion of each topic.

The facilities for storing and retrieving of data are another essential component for learning management software. It helps to store relevant data related to the learners and provide the desirable feedback to students, teachers and parents.

All of these components were considered in the development of the Moodle based Learning Management System. The designs for all these three major components are described below under the title software design.

**Software Design for M-LMS**

The design of a technology-enhanced learning and evaluation tool, and specifically in an interactive learning environment, is a challenge. This is because it must address issues ranging from learning theory to software engineering. Developers face fundamental challenges in building tools to adequately address the issues raised during the design process. However, understanding and resolving each of the requirements and the mental state of participants is essential to the success of a tool.

The developed M-LMS provides a teacher controlled, computer managed, learning and evaluation environment to the students. During the encounter between the software and the pupils, special modules arranged in
the software assess both individual and collaborative involvement of the pupil. It is also capable to conduct summative and formative evaluation.

The overall design of the M-LMS is given in Figure 1. Four major parts are included in this design. They are Learning and Reference Material Design (LRMD), Individual Participation Assessment Module (IPAM), Group Participation Assessment Module (GPAM) and Performance Assessment Module (PAM).

Figure 1. Overall design of M-LMS
Individual Participation Assessment Module (IPAM) is used to assess and evaluate the individual activities of the student. The IPAM utilises the individual learning activities arranged in LRMD for the evaluation of individual activities. Group Participation Assessment Module (GPAM) is used to assess and evaluate the activities of the student in a group. GPAM uses the group activities arranged in LRMD for the evaluation of group activities. Performance Assessment Module (PAM) deals with the summative and formative evaluations and unit tests included in the M-LMS. Each of these elements included in the M-LMS are detailed below.

**Software design to provide individual participation in learning process**

Based on the components identified, a software segment is designed to provide individual activities and learning. This software segment is named as Individual Participation Assessment Module (IPAM). This module contains Individual Learning and Reference Materials (ILRM), Automated Assessment Part (AAP) and Teacher Controlled Entry-form (TCE). The diagrammatic representation of IPAM is given in Figure 2.
The AAP calculates the speed, accuracy, number of trials taken, and knowledge level of the pupils automatically. A set of programs calculates these aspects and puts the details into data store while students work with the individual learning materials arranged in the software.

Arrangements of Learning and reference materials are important in a learning management system. The individual learning activities are part of Learning and Reference Material Design (LRMD). AAP analyses the individual activities performed by the student and calculates the speed, accuracy and number of trials taken to complete the activity. Hit counter

Figure 2. Design of individual participation assessment module (IPAM)
arranged in the AAP calculates the number of hits and hanging time of a particular user on a web based learning material.

The individual learning and reference materials furnished in the M-LMS design include interactive learning materials, Reference materials, tutorials, chat with expert, email query, assignments and tests. It is shown in Figure 3.

**Figure 3.** Individual learning activities arranged in LRMD of M-LMS

IPAM design also helps to store the attendance details and details about participation in the extra-curricular activities of the students. TCE is designed to achieve this. Through TCE, the teacher can enter these details directly into data store. After the assessment and evaluation, the IPAM gives feedback to learners, teachers and administrators.
Software Design to Provide Group Participation in Learning Process

Individual activities as well as group activities are important in learning process. So, provision for group activities are also needed in the LMS. The participation in group activities can be assessed by analysing the pupils’ communication with others through computer medium. Four types of computer mediated communications are implemented and assessed through a GPAM. The four types of computer mediated communications include one alone, one to one, one to many, many to many communications using computers.

Design chart for the assessment for group participation in collaborative learning process is given in Figure 4.

*Figure 4.* Design of the assessment of individual participation in group learning process using GPAM.
Discussion forums, chatting, wiki editing and class blogs are arranged as group activities under this design. GPAM utilises all these group activities arranged with the help of AAP and TCE arranged in it.

Discussion forum holds conversations in the form of posted messages. In the M-LMS design provided, the students and teachers can start a forum based on their subject matter. The design also evaluates the participation of students in the forums that is started by the teacher and the discussions that are initiated by peers.

Wiki facility arranged in this design allows any user to add and edit content. This facility is included in the M-LMS design as a group activity. The students can develop a wiki based on the topic of discussion. The provisions to evaluate each student’s role in the creation of Wiki is also included in the M-LMS environment with the help of AAP and TCE arranged in GPAM.

Class blog is another technique used in the M-LMS environment to assess group activities. All the students have provision to put their own entries into the class blog or subject blog. Unlike individual blogs class blogs and subject blogs are maintained by the class, not by the individual. Through class blogs the M-LMS analyses the area of interest of the students by assessing the head they selected in the development of class blog.
Some provisions included in the individual participation assessment were also used for Group Participation Assessment. This includes e-mails and chatting among individuals with teachers and peers. These assessments also can be combined with other group activity components to get overall performance in a group.

Software components for the above mentioned facilities are designed in GPAM of the M-LMS. The evaluation and scoring of the performance of the pupils are fully based on these components.

**Software design for evaluation and data-store**

A Performance Assessment Module (PAM) is included in the M-LMS design for evaluation and data-store. The PAM is used for the assessment of individual as well as group activities with the help of IPAM and GPAM. The components of this module include Speed Counter, Trial Counter, Hit Counter and Teacher Controlled Entry-form. The scores after summative and formative evaluations are also can be considered here. The software components of PAM and their uses are detailed below.

**Speed counter**

Speed counter is a facility provided in the PAM. Using this facility the software can assess the time taken by the pupil for completing the activities included in the software.
**Trial counter**

This is another component in the PAM of the M-LMS environment. This facility helps to count number of trials taken by the pupil to complete an interactive activity and to store it in to the database.

**Hit counter**

This facility assesses the place of an individual in a group. With the help of hit counters provided in PAM, it can easily evaluate the position of an individual blog page among his peers. Numbers of responses to individual’s blog posts are also considered by the hit counter designed in the PAM. Checking of the hits to the HTML based pages arranged in the reference part by the student is another duty of hit counter.

**Teacher controlled entry-form (TCE)**

Provisions for manual assessment and computer based assessment are provided in the M-LMS. TCE is included in the software for manual data entry. The teacher can enter the details of the students into the software directly using TCE. The teachers’ entry include the attendance of the pupil, grade awarded to pupils by the teacher for participation in discussions, achievements in extracurricular activities, etc.
Validation of grading procedure and implementation of grading in the software

Based on the individual participation and group participation assessment each score should be converted into grades according to a grading criterion. The criteria for grading is determined by using the supporting documents collected. Before grading, the assessed value from each component goes through a standard error calculation (Standard error of the mean) in order to avoid the eccentric values in the sample.

Database design

All the data generated using each module should be stored into the data-store of the software. Database design is the back-born of the data-store. The structure of database design is explained below with the help of an entity relationship diagram below in Figure 5.
Figure 5. Entity – Relationship diagram of database design
Software Selection

Software selection is another important step in computer based software development research. Combination of computer based learning environments with the Internet can provide anytime anywhere access to science laboratories to overcome inherent difficulties in science instruction. By considering these things the investigator had identified the needed software for the M-LMS during literature review. They are furnished in Table 1.

Table 1

*Software Selected for M-LMS Development*

<table>
<thead>
<tr>
<th>Software</th>
<th>Usage during software development</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHP</td>
<td>Web page designing, database management, to provide online interactivity, etc.</td>
</tr>
<tr>
<td>MySQL</td>
<td>Database and table creation</td>
</tr>
<tr>
<td>Apache</td>
<td>The server software used in the development</td>
</tr>
<tr>
<td>AdobeFlash</td>
<td>Interactive learning material development, Animals and graphics</td>
</tr>
<tr>
<td>Python</td>
<td>Graphics and performance assessment module programs</td>
</tr>
<tr>
<td>MOODLE</td>
<td>Adopted Course Management System</td>
</tr>
</tbody>
</table>

**PHP**

A web based programming language software is necessary for the development of the M-LMS software because, a web based programs that is
hosted on Internet or local Intranet can provide anytime anywhere access. The teacher can communicate with the pupils at on school hours as well as on non-school hours. The web-based programming language selected by the investigator for this purpose is PHP.

PHP is originally stood for "Personal Home Page". It also stands for "PHP: Hypertext Preprocessor". It is a widely-used Open Source general-purpose scripting language that is especially suited for Web development and can be embedded into HTML. PHP can be deployed on most web servers and as a standalone interpreter, on almost every operating systems and platforms free of charge.

PHP is used in the developed M-LMS software for web designing, database connectivity for data store and record keeping, publishing and overall management.

MySQL and Apache

The presence of a Database Management System (DBMS) can be seen in all computer managed educational software. The M-LMS also utilised a DBMS for data storing or record keeping. The data to be stored while running the software include attendance of the students, grades awarded for extracurricular activities, assessments prepared and the grades awarded for each, project reports and the grade awarded; chats, mails and forum discussions of
students, etc. The DBMS used in the M-LMS software environment is MySQL.

The MySQL database is an open source database with high performance, high reliability and ease of use. It is also the database of choice for a new generation of applications built on the LAMP stack (Linux, Apache, MySQL, PHP / Perl / Python) which is used in the M-LMS. That is, M-LMS is running in LAMP stack with the help of Apache server, PHP and MySQL included in it.

Adobe Flash

The use of animation software is also needed for the development of the M-LMS software. It is for the development of interactive learning materials and getting attraction to the overall software design. The animation software used by the investigator for this purpose is Adobe Flash.

Adobe Flash is used to add animation, video, and interactivity to web pages. Flash content may be displayed on various computer systems and devices, using Adobe Flash Player, which is available free of charge for common web browsers, certain mobile phones and a few other electronic devices. Interactive Learning materials are arranged in the Learning and Reference Material Part of the (LRMP) the M-LMS. These interactive learning materials are developed by using Adobe Flash.
Python

The provision for web based as well as standalone applications has done in the M-LMS software. For the development of web-based applications the use of web based programming language is a better choice. The programming language 'Python' is selected by the investigator for the development of standalone functionalities.

Modular object oriented dynamic learning environment (MOODLE)

The base of the developed software is MOODLE. The investigator customised MOODLE and localised into Kerala School Curriculum context. MOODLE supports the features like email, chat-room, forum management, wiki, etc. Readymade materials for these purposes are now available with open source licence. The investigator decided to use modules from free software MOODLE for these purposes.

MOODLE is a web based Course Management system (CMS). It is a free and open source e-learning software. MOODLE was originally developed to help educators to create online courses with a focus on interaction and collaborative construction of content. As a web based interactive e-learning material, the investigator used all relevant features of MOODLE. In other words the developed software is a customised version of MOODLE. It is done by the investigator after installing MOODLE software in WAMP/LAMP
server. WAMP server is used in Windows operating systems and Lamp server is used in Linux based Operating Systems.

**Development of M-LMS**

In a developmental Research, the development of the software and validation of its effectiveness are very important. The investigator developed an M-LMS environment by using relevant software. The software design and selected software were described in the previous head. The strategies used for the development of M-LMS are coming under this section.

Development of M-LMS is based on web based programming environments. The contents in the software for the proper functioning of the MOODLE based learning management are described in Table 2.

Table 2

*Components of M-LMS*

<table>
<thead>
<tr>
<th>Modules of M-LMS</th>
<th>Software Developed/Included in Each Modules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual Participation</td>
<td>Interactive learning materials, Reference materials, tutorials, blogs, e-mails, etc.</td>
</tr>
<tr>
<td>Assessment Module (IPAM)</td>
<td>Automated Assessment Part (AAP), Teacher Controlled Entry Form (TCE) for the assessment of individual activities</td>
</tr>
<tr>
<td>Group Participation Assessment Module (GPAM)</td>
<td>Discussion forums, wiki, online conferences, class blog, etc.</td>
</tr>
<tr>
<td>Performance assessment Module (PAM)</td>
<td>Automated Assessment Part (AAP), Teacher Controlled Entry Form (TCE) for the assessment of group activities</td>
</tr>
</tbody>
</table>

- Speed counter, trial counter, hit counter, teacher controlled entry form, etc.
Development of IPAM

In the developed M-LMS an Individual Activity Assessment Module (IPAM) is included to control and assess all the individual activities included in the software. The Automated Assessment Module (AAP) included in IPAM automatically assesses the performance of the student work with the materials arranged in the M-LMS. The learning materials developed or included in this module are detailed below.

**Interactive learning materials (ILM)**

Interactive Learning materials used in IPAM include the materials developed by the investigator and materials collected from various sources. The investigator used the software Adobe Flash for the development of interactive materials. Specimens of interactive content frame and evaluation frames included in the material are given in Figure 6 and Figure 7. Specimen of evaluation frame after successful completion is given in Figure 8. Specimens of frames used in the interactive materials are attached as Appendix I and the complete material is included in the attached software DVD.
**Figure 6**: A specimen for interactive content frame

**Figure 7**: A specimen of evaluation frame
Figure 8: A specimen of evaluation frame after successful completion

Besides the developed software, many interactive software programs were collected by the investigator to include in the M-LMS software. List of collected materials and their features are included in Table 3. The specimens of frames included in collected interactive material are given in Appendix II.

Table 3

List of Interactive Materials Collected to Include in M-LMS

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Name of Material</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Genius Maker Free Edition</td>
<td>Refraction of rays, Lens and mirrors.</td>
</tr>
<tr>
<td>2</td>
<td>PhET</td>
<td>Interactive materials for learning Physics.</td>
</tr>
<tr>
<td>3</td>
<td>PSRC-AAPT</td>
<td>Refraction of Light</td>
</tr>
<tr>
<td>4</td>
<td>The Quantum exchange</td>
<td>Light and refraction of light</td>
</tr>
</tbody>
</table>
Reference materials and tutorials

Wiki contents were used mainly as reference materials. Links to major websites related to topic content were also provided to get additional references. Interactive textbooks developed by IT@School was also included in the reference section. Specimen of a reference page is given as Figure 9. More specimens of reference materials given to the students are included in the attached software DVD.

Figure 9: A specimen of reference page

Individual blogs and emails

Individual blogging and e-mailing facilities are also provided in the M-LMS. The facilities included in Moodle software itself was used to
implement these facilities. The students participated in the study developed their own blogs using these facilities. A specimen of such blog is given as Figure 10. All individual blogs maintained by the students at the time of experiment are included in the soft copy.

Figure 10: A specimen of individual blog created by a student at the time of experiment
AAP and TCE for the assessment of individual activities

Automated Assessment Part (AAP), Teacher Controlled Entry Form (TCE) for the assessment of individual activities is also included in the M-LMS. This part is completely developed by the investigator. The web based programming language PHP was used for the development of AAP and TCE.

The specimen of TCE interface window is shown in Figure 11. The complete code is included in Appendix III.

*Figure 11: A specimen of TCE interface window*
Assignments

The facility to download assignment worksheets is an important part included in M-LMS. Specimens of assignment download window and assignment worksheet are given as Figure 12 and Figure 13.

Figure 12: A specimen of download window
Assignment 1

Refraction of rays

Name:
Class: \hspace{1cm} No:
School:

I. Complete the table with the help of ‘Activity 2’.

<table>
<thead>
<tr>
<th>No</th>
<th>Medium 1</th>
<th>Medium 2</th>
<th>Incident Angle</th>
<th>Refracted Angle</th>
<th>Reflected Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vaccum</td>
<td>Water</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Vaccum</td>
<td>Water</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Vaccum</td>
<td>Water</td>
<td>30</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Vaccum</td>
<td>Benzene</td>
<td>30</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Vaccum</td>
<td>Benzene</td>
<td></td>
<td>35.26</td>
<td></td>
</tr>
</tbody>
</table>

II. Write a short note on the table 1 after completing it.

---

Figure 13: A specimen of assignment worksheet
The facility to upload the filled assignment worksheet is also a part of IPAM of M-LMS. A specimen of assignment upload window is given as Figure 14.

**Figure 14:** A Specimen of assignment upload window

**Online quiz**

The investigator also arranged quiz modules in the M-LMS. A specimen quiz frame used in M-LMS is given as Figure 15.
Development of GPAM

In the developed M-LMS a Group Activity Assessment Module (GPAM) is included to control and assess the individuals in the group. The facilities developed or included in this module are detailed below.

Discussion forums

To provide group activities discussion forums are included in M-LMS. It helps the students to initiate a discussion and take part in the discussions.
introduced by others and the teacher. The facility available in Moodle itself was used to enable discussions. Sample discussion page of a student is given as Figure 16. The complete discussion held at the time of treatment is given in the soft copy.

Figure 16: A specimen of discussion initiated by a student
Wiki

Development of wiki and wiki editing is also available in Moodle. The investigator used this facility of MOODLE as a group activity in the customised M-LMS. Four to five members in a class were maintaining wiki pages during the treatment sessions. A specimen of wiki page maintained by a group is given as Figure 17. The complete wiki pages that were maintained by each group are given in the soft copy.

Figure 17: A specimen of wiki page developed by a group
Online conferences

The chat facility available in Moodle was used for online conferences in the developed M-LMS. Each and every student engage with the teacher or their peers during online conference session. The text chat facility was mainly used for online conferences. A specimen of chat session window during the study is given in Figure 18. All the online conference sessions are given in the attached soft copy.

Figure 18: A specimen of an online conference session
Class blog

The customised M-LMS also has the blogging facility available in MOODLE. Beside individual blogs each class were maintaining separate class blogs during the treatment sessions. The home page of a class blog is given as Figure 19. All the four class blogs available after the study are included in the soft copy.

Figure 19: Home page of a class blog
AAP and TCE for the assessment of group activities

Automated Assessment Part (AAP) and Teacher Controlled Entry Form (TCE) for the assessment of group activities are also included in the M-LMS. The web-based programming language PHP was used for the development of AAP and TCE. Specimen of the GPAM interface is shown in Figure 20. The complete code is included in Appendix III.

Figure 20: A specimen of FPAM interface included in TCE.
Database development

All the database tables available with MOODLE are also the part of M-LMS. Besides these tables some other tables were also included by the investigator in order to save the additional details collected through IPAM, GPAM and TCE forms. The additional tables included by the investigator is marked in Figure 21.

![Image of database tables](image)

**Figure 21:** Additional database tables added

Development of PAM

In the developed M-LMS, a Performance Assessment Module (PAM) is included to control and evaluate the individuals separately and to evaluate
the role of individual in a group. The facilities developed or included in this module are detailed below.

**Speed counter**

Speed counter included in the M-LMS is mainly used to assess the time taken by an individual to complete an activity. It is working with each and every individual activity.

**Trial counter**

Trail counter is also a part of PAM. It counts the number of trails taken to complete an individual activity. Like speed counter it also works with each and every individual activity.

**Hit counter**

A hit counter module available in Content Management System (CMS) named wordpress is adopted here to fulfils the need of a hit counter. It was used in different areas of the M-LMS. In IPAM it was used to count the hits to individual blogs and the individual’s hit to the reference areas. In GPAM it was used to count the hits to class blogs.
Teacher controlled entry form

Teacher Controlled Entry Form (TCE) for the assessment of group activities as well as individual activities is also included in the PAM of M-LMS. This part is completely developed by the investigator. The web based programming language PHP was used for the development of AAP and TCE. The interface is shown in Figure 22. The codes used for the development of speed counter, trial counter, hit counter and teacher controlled entry form are given in Appendix III.

![Figure 22: The TCE interface window](image-url)
Feedback and progress report

Feedback and progress report are another feature included in PAM. This facility helps the student, teacher, parent and administrators to assess the performance and progress of a student in learning process. Specimen for individual progress report and consolidated progress reports are given as Figure 23 and Figure 24.
Figure 24: A specimen of consolidated progress report

Selection and Arrangement of a Topic for Validation

After the development of M-LMS and before the validation procedure, a topic from the secondary curriculum was selected to arrange in the M-LMS software platform. The investigator selected the topic ‘Refraction of Light’ from 9th standard Physics Curriculum of Kerala state. After the software
development the investigator arranged the contents of the topic to the M-LMS. The steps followed are given below.

- Selected a topic from secondary school curriculum
- Developed model lesson plan, to arrange the content of the selected topic in MLMS.
- Conducted training for physical science teachers based on the content arranged in MLMS.
- Collected feedback and suggestions from experts and teachers participated in the training.
- Developed a new unit plan according to the feedback given by the experts and teachers.
- Changed the MLMS content based on the newly developed unit plan.

The list of teachers and experts participated in the training are attached as Appendix IV and the developed unit plan is attached as Appendix V. Based on the newly developed lesson plan, the M-LMS arrangements were changed. After that, the modified software was utilised for the experimental treatment and trend analysis.
Validation of the Developed Software

This step was to investigate the effectiveness of the customised M-LMS. The methodology for this procedure is presented in the following heads.

- Design of the study.
- Variables of the study.
- Tools Used for the study.
- Sample Used for the study.
- Data collection procedure.
- Statistical techniques used for the analysis.

Design of the study

The design selected for the experiment was the pretest-posttest non-equivalent group design. The design of the study is illustrated as follows. Four experimental groups and one control group were used in the experiment.

<table>
<thead>
<tr>
<th>G1</th>
<th>O1</th>
<th>X</th>
<th>O2</th>
<th>O3</th>
<th>O5</th>
<th>O7</th>
<th>O9</th>
<th>O10</th>
</tr>
</thead>
<tbody>
<tr>
<td>G2</td>
<td>O3</td>
<td>X</td>
<td>O4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G3</td>
<td>O5</td>
<td>X</td>
<td>O6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G4</td>
<td>O7</td>
<td>X</td>
<td>O8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G5</td>
<td>O9</td>
<td>C</td>
<td>O10</td>
<td>O2</td>
<td>O4</td>
<td>O6</td>
<td>O8</td>
<td>O10</td>
</tr>
</tbody>
</table>

- Pretest
- Posttest
Here ‘X’ is the exposure of a group to an experimental (Treatment) variable, ‘C’ is the exposure of a group to the controlled condition. ‘O’ is the observation of the test administered.

Trend analysis was also used in the study. Three different achievement tests were conducted on each of the four experimental groups. The first test was conducted before the implementation of M-LMS based learning and the second and third tests were conducted after the implementation of M-LMS based learning.

The details of achievement tests conducted during trend study is given in Table 4.

Table 4
Details of the Achievement Tests Conducted for Trend Analysis

<table>
<thead>
<tr>
<th>Tests</th>
<th>Topic</th>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test 1</td>
<td>Gravitation</td>
<td>9</td>
<td>Before the implementation of MOODLE based LMS and after the completion of the topic Gravitation.</td>
</tr>
<tr>
<td>Test 2</td>
<td>Refraction of Light</td>
<td>9</td>
<td>MOODLE based LMS was used to transact the topic Refraction of Light. Then, the test was conducted.</td>
</tr>
<tr>
<td>Test 3</td>
<td>Work, Power, Energy</td>
<td>9</td>
<td>After the implementation of MOODLE based LMS and completion of the topic Work-Power-Energy.</td>
</tr>
</tbody>
</table>
Variables of the study

The experimental design consists of manipulating levels or amount of selected independent variables to examine their influence on dependent variables. The independent, dependent and control variables have been explained below.

Independent variable

The independent variables selected for the study are two Learning methods using M-LMS and Conventional Method.

Dependent variable

Dependent variable selected for the study is achievement in Physics.

Control variable

The variable controlled by the study is the initial status of the students in terms of achievement in Physics as measured by pretest.

Tools used for the study

Preparation of M-LMS was the main objective of the study. The methodology used for the development of M-LMS is already explained in the beginning of this chapter. Other tools used for the study were three achievement tests in different topics in Physics for pre-test and post-test. The
planning and standardization procedure of the achievement test are given below.

**Planning of the test**

Three achievement tests in Physics for the units Gravitation, Refraction of Light and Work-Energy-Power were prepared and standardized by the investigator. These tests were used to measure the achievement in physics of 9th standard students of Kerala. All the three tests were prepared in accordance with the scientific procedure for preparing achievement tests. An analysis of the objectives and content in physics textbook of standard IX was done. It was decided to follow the Blooms taxonomy of educational objectives for test construction. Only the objectives of knowledge, understanding and application were selected for preparing the test due to the limited area of the content.

The designs adopted for the development of these tests are given below:

**Weightage to objectives**

The objectives included in the tests were knowledge, understanding and application. The weightage assigned to each objective of each test is given in table 5, 6 and 7.
### Table 5
**Weightage to objectives – test I (Gravitation)**

<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>6</td>
<td>24</td>
</tr>
<tr>
<td>2</td>
<td>Understanding</td>
<td>11</td>
<td>44</td>
</tr>
<tr>
<td>3</td>
<td>Application</td>
<td>8</td>
<td>32</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>25</td>
<td>100</td>
</tr>
</tbody>
</table>

### Table 6
**Weightage to objectives – test II (Refraction of Light)**

<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>6</td>
<td>24</td>
</tr>
<tr>
<td>2</td>
<td>Understanding</td>
<td>12</td>
<td>48</td>
</tr>
<tr>
<td>3</td>
<td>Application</td>
<td>7</td>
<td>28</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>25</td>
<td>100</td>
</tr>
</tbody>
</table>

### Table 7
**Weightage to objectives – test III (Work, Energy and Power)**

<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>7</td>
<td>28</td>
</tr>
<tr>
<td>2</td>
<td>Understanding</td>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>Application</td>
<td>9</td>
<td>32</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>25</td>
<td>100</td>
</tr>
</tbody>
</table>
Weightage to content

The weightage to content of each of the tests are given below in Table 8, 9 and 10.

Table 8
Weightage to content – test I (Gravitation)

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Content</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gravitation Introduction</td>
<td>8</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Mass and Weight</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Free fall</td>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>Centre of gravity and equilibrium</td>
<td>7</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>25</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 9
Weightage to content – test II (Refraction of Light)

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Content</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Types of lenses, Focus and Focal Length of lenses</td>
<td>8</td>
<td>32</td>
</tr>
<tr>
<td>2</td>
<td>Convex and concave Lenses</td>
<td>9</td>
<td>36</td>
</tr>
<tr>
<td>3</td>
<td>Magnification and Lens Formula</td>
<td>8</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>25</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 10

*Weightage to content – test III (Work, Energy and Power)*

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Content</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Work</td>
<td>8</td>
<td>32</td>
</tr>
<tr>
<td>2</td>
<td>Energy, Potential energy, Kinetic Energy</td>
<td>9</td>
<td>36</td>
</tr>
<tr>
<td>3</td>
<td>Power</td>
<td>8</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>25</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

*Weightage to difficulty level*

The weightage given to difficulty level of tests are given as Table 11, 12 and 13.

Table 11

*Weightage to difficulty level – test I (Gravitation)*

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Difficulty Level</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Easy</td>
<td>6</td>
<td>24</td>
</tr>
<tr>
<td>2</td>
<td>Average</td>
<td>14</td>
<td>56</td>
</tr>
<tr>
<td>3</td>
<td>Difficult</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>25</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Table 12

*Weightage to difficulty level – test II (Refraction of Light)*

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Difficulty Level</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Easy</td>
<td>6</td>
<td>24</td>
</tr>
<tr>
<td>2</td>
<td>Average</td>
<td>13</td>
<td>52</td>
</tr>
<tr>
<td>3</td>
<td>Difficult</td>
<td>6</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>25</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
Methodology

Table 13

Weightage to difficulty level – test III (Work, Energy and Power)

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Difficulty Level</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Easy</td>
<td>6</td>
<td>24</td>
</tr>
<tr>
<td>2</td>
<td>Average</td>
<td>15</td>
<td>60</td>
</tr>
<tr>
<td>3</td>
<td>Difficult</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>25</td>
<td>100</td>
</tr>
</tbody>
</table>

**Blueprints**

Two-dimensional blueprints of the tests specifying the weightage assigned to different categories were prepared and are given in the Table 14, 15 and 16.

Table 14

Blueprint – test I (Gravitation)

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Content</th>
<th>Objectives</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Knowledge</td>
<td>Understanding</td>
</tr>
<tr>
<td>1</td>
<td>Gravitation Introduction</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Mass and Weight Free fall Centre of gravity and equilibrium</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>6</td>
<td>11</td>
</tr>
</tbody>
</table>
Table 15

*Blueprint – test II (Refraction of Light)*

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Content</th>
<th>Objectives</th>
<th></th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Knowledge</td>
<td>Understanding</td>
<td>Application</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Types of lenses, Focus and Focal Length of lenses</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>Convex and concave Lenses Magnification and Lens Formula</td>
<td>0</td>
<td>6</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>6</strong></td>
<td><strong>12</strong></td>
<td><strong>7</strong></td>
<td><strong>25</strong></td>
</tr>
</tbody>
</table>

Table 16

*Blueprint – test III (Work, Energy and Power)*

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Content</th>
<th>Objectives</th>
<th></th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Knowledge</td>
<td>Understanding</td>
<td>Application</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Work</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>Energy, Potential energy, Kinetic Energy</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>3</td>
<td>Power</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>7</strong></td>
<td><strong>11</strong></td>
<td><strong>7</strong></td>
<td><strong>25</strong></td>
</tr>
</tbody>
</table>
The investigator initially prepared 45 multiple-choice items in order to get valid and reliable items in the final test. The distracters were selected in such a way that there is least possibility of guessing. Three distracters were prepared for each multiple-choice item. The achievement tests are given as Appendix VII, VIII and IX.

These tests, being objective type ones, the answers are in the form of letters. One score is given for each correct answer and zero score for each incorrect answer.

The draft test was conducted on a sample of 140 pupils from standard 9 in DKBMMHSS Thrithala and GJHSS Naduvattam. The sample for tryout was selected on the basis of sex of the pupil, locale of school and management category of the school.

During item analysis, the scores of the selected answer sheets were arranged in descending order of the total scores and the highest 27% and Lowest 27% were separated as upper group and lower group respectively. The difficulty index and discriminating power of each item of each test was found out. Items for the final tests were based on these indices. Finally, 25 items were selected for each achievement test.

The investigator prepared the tests based on the designs giving ample weightage to objectives and content and hence has ensured content validity
for the same. Reliability of each test was established by using split half method.

**Sample used for the study**

The effectiveness of the developed M-LMS in classroom was tested by selecting samples from the secondary schools. In the experimental design, five independent samples were selected from 9th standard pupils. Four groups were taught using M-LMS and the fifth group with existing method of teaching. All the four experimental groups were used in the trend analysis part of the study also. The breakup of the sample is given in Table 17 and Table 18.

Table 17

*Breakup of the Sample (Experiment)*

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>School Name</th>
<th>No. of Batches</th>
<th>No. of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GVHSS Koppam</td>
<td>2</td>
<td>68</td>
</tr>
<tr>
<td>2</td>
<td>GHSS Pattambi</td>
<td>1</td>
<td>28</td>
</tr>
<tr>
<td>3</td>
<td>DKBMMHSS Thrithala</td>
<td>2</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>5</td>
<td>158</td>
</tr>
</tbody>
</table>
Table 18

Breakup of the sample (Trend Analysis)

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>School Name</th>
<th>No. of Batches</th>
<th>No. of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GVHSS Koppam</td>
<td>1</td>
<td>34</td>
</tr>
<tr>
<td>2</td>
<td>GHSS Pattambi</td>
<td>1</td>
<td>28</td>
</tr>
<tr>
<td>3</td>
<td>DKBMMHSS Thrithala</td>
<td>2</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>4</td>
<td>124</td>
</tr>
</tbody>
</table>

Data collection procedure

Before starting the experiment pre-test in Physics achievement were conducted on all of the four experimental groups and control group to measure the initial status of the subjects. After the administration of the pre-test the experimental groups were treated with M-LMS and control group was treated with existing method of teaching. After the completion of the treatment a post test in Physics achievement was administered to measure the post experimental status of all the four experimental groups and the control group. The obtained pre-test and post-test scores were used for final analysis.

For trend analysis, three different achievement tests were conducted on each of the four groups. First test was conducted before the implementation of M-LMS based learning. The second test was administered immediately after the implementation of M-LMS. The third test was used after the completion
of one more unit but without the experimental treatment. The obtained test scores were made ready for analysis.

**Statistical techniques used for analysis**

The statistical techniques used for the study are described below:

**t-test**

Test of significance (t-test) for differences between means was used to compare pre experimental and post experimental status in Physics achievement of all the four experimental groups and the control group in experimental design.

Test of significance (t-test) for differences between means was also used to compare the three achievement test scores in the subjects Physics during trend analysis.

**Analysis of variance (ANOVA)**

ANOVA was used to find out whether any significant difference exists among the mean achievement scores of all of the four experimental groups involved in experimental design.
Analysis of covariance (ANCOVA)

ANCOVA was used to find out the effectiveness of the M-LMS in Physics achievement of secondary school students of Kerala after controlling the pretest scores.

All these statistical procedures were done by using SPSS.