Chapter III

Planning and programme development

3.0 Introduction:

Napoleon said, “The progress and improvement of mathematics are linked to the prosperity of the state.” [23, P 4]

For the progress and improvement of mathematics we need creative and logical mind. To develop these skills teaching methodology of mathematic is not the most important aspect. How we represent facts and results of this subject in front of students, it plays an important role. Laboratory experiences are an important component of instruction in teaching. The most significant role that the laboratory experiences play is that they provide experiences which are conducive to the development of cognitive skill such as understanding, underlying principles, drawing inferences and conclusion, verifying established relationship, knowing the procedures for carrying out experiment etc. and psychomotor skill such as developing manipulative skills. In addition, these help students to develop capability of making observation, building human relations and attitudes. Hence laboratory teaching programme forms an essential aspect of instructional process in teaching of mathematics.

This chapter deals with planning and programme construction.

3.1 Objectives of construction of LTP:

The objectives of constructing laboratory teaching programme related to three domains – cognitive, psychomotor and affective. Effective LTP should focus on the objectives enlisted bellow:

1. **Apply Theoretical Concepts**

   Laboratory teaching should involve the application of knowledge; use of theoretical concepts and the theoretical evaluation of the results obtain by the practical experience. This should enable the students to achieve the following objective.

   - Define a problem to be investigated.(That is, recognize the problem)
− Formulate hypothesis seeing possible results and probable mode of attack.
− Illustrate underlying principles.
− Plan procedure to test hypothesis.
− Design observation.
− Select suitable equipment, instrument and material.
− List necessary apparatus.

2. **Develop Manipulative apparatus:**

Through laboratory experiences students should be able to carry out a range of manipulative skills which are appropriate for the learning of a particular subject. Through laboratory work students should able to

− Develop familiarity with equipment: knowing instrument’s parts, how it work, how to adjust it.
− Develop manipulative skill: setting up apparatus, describe functions of each practical, handling the equipment properly.
− Work according to design.
− Care for equipment: knowing how to store it, using proper settings, keeping it clean.
− Transforming instrument safely.
− Observe safely rules.
− Realize limitations of measuring instruments.
− Locate faults.

3. **Develop skill in Observation and Recording of Observation.**

Students should be provided with experiences where in they have to record quantitative and qualitative observations and then evaluate results of their observations. So recording observations should be to:

− Carry out observations accurately and systematically.
− Record results accurately: tabulating, classifying the results systematically and completely.
− Perform calculations and drawing figure,
− Determine relationship. (Looking for similarities and dissimilarities and noticing identical and unlike features).
− Interpretation of data, graph etc.
− Draw conclusion.
− Determine accuracy of experimental data. (Verification of result).
4. Develop affective skills:

Development of positive attitude towards laboratory work and attitude as persistence, originality, commitment to practical work etc. should be important objectives of laboratory teaching. So laboratory teaching should help students to:

- Develop initiative and resourcefulness.
- Develop ability to co-operate as member of team and act as a leader of team.
- Inculcate the value of work.
- Develop skill in inter-personal communication.

For this study laboratory teaching programme is developed by investigator with keeping all above objectives in mind. The programme is developed to improve the achievement of student towards mathematics. This general aim leads to the following specific objectives.

1) To construct the LTP that help to develop cognitive, psychometric and affective abilities of students.
2) To construct the LTP that give importance to the learner.
3) To construct the LTP that could be use in ordinary room.
4) To construct the LTP that is very less cost and simple to use.
5) To construct the LTP that could be used by ordinary teacher in an ordinary room.

3.2 Importance of Laboratory teaching programme:

Teaching of mathematics should deal with the process and not just confine to transferring the knowledge from the mind of the teachers to notebooks of through the tip of a pen. For phenomenal changes in teaching of mathematics, a right ambience is required and it is definitely the mathematics LTP. It is because, LTP can act like a concomitant between teacher and students and provides an opportunity to understand and discover the beauty, importance and relevance of mathematics as a discipline. It can be expected to enhance the students’ understanding of the subject as taught at the school and can also provide a glimpse of what is beyond.

The mathematics laboratory is a unique concept in the field of mathematics educations that was introduced in the year 1994. It has come a long way in enriching mathematics at primary, secondary and senior secondary level. In developed countries, the mathematics laboratory is an integral part of regular curriculum. However, in India, teachers, researchers, experts and scalars of mathematics education have been giving thought to the present system of teaching of mathematics and to change it to learner centered, but the efforts have proved to be futile as they are tending towards teacher centered. Mathematics laboratory has now become an inevitable component to be absorbed as one of the mainstream methods of teaching of mathematics, which might
make the learning of mathematics learner centered. In spite of the fact the mathematics laboratories are established in some of the schools, still the method of teaching in mathematics laboratory is at large teacher centered. The following reasons can be attributed as factor influencing the teaching of mathematics, a teacher centered method.

1. Manual manipulation being used to explain mathematical concepts.
2. A classroom of mathematics in India at large is a mixture of heterogeneous potentials and psychologies, apart from being large in size, which is much more than what is stipulated by the national education commission.
3. Virtual manipulative such as computers, embedded environments are not integral part of mathematics laboratory.
4. Lack of expertise and exposure on the part of teacher of mathematics to use virtual manipulative or embedded environments in an effective way to make teaching lively.
5. Lack of previous knowledge in teachers of mathematics about mathematics laboratory.

**Merits of Laboratory Teaching Method:**

1. It is interesting and joyful for the learner. He likes to do something with his two hands.
2. It is based on two sound psychological principles namely, “proceed from concrete to abstract” and “learn by doing.”
3. The learner acquires a clear understanding of the subject. He finds or discovers facts with his own efforts.
4. It provides great scope for independent work and individual development. It helps in the growth of self-reliance.
5. It inculcates the spirit of cooperation and exchange of idea when the students are required to perform laboratory work in groups.
6. A successful experiment is a source of joy and encouragement to the learner.
7. Shyness of hand is removed, as the learner has to handle apparatus and material.
8. The application of mathematics becomes increasingly evident to the learner. Thus the subject becomes functional and meaningful to him.
9. Some topics of mathematics are best understood through this method.

**Drawbacks of Laboratory teaching method**

1. The method is very expensive. Every school cannot afford to spend a large amount of money on laboratory equipments.
2. Laboratory work is not typical mathematical work; and hence this method, if exclusive used, does not give any training to the learner in true mathematical thinking.

3. It acquaints the students with facts and not with mathematical reasoning.

4. All the topics of mathematics cannot exclusively be taught by this method.

5. It needs through planning and supervision, otherwise students may just play with instruments without deriving any substantial gain. Since teacher will be required to pay individual attention, it may not be practicable in large classes.

6. It is an exceedingly laborious and slow method.

7. It is not at all easy to make the students discover mathematical facts experimentally, especially in lower classes.

8. It may sometimes degenerate into a kind of manual training only.

9. The tendency of cooking up results or copying may develop among them, as it is not easy to check.

The salient features maintained in the LTP

1. The LTP is very low cost. Every school can afford to spend a little amount of money on laboratory equipments.

2. The LTP has been developed in such a way that student have to use their original thinking and mathematics reasoning as per book syllabus.

3. Almost all chapters covered in this LTP.

4. LTP has been developed in systematically.

5. LTP is prepared for standard VIII so there is no so much writing in this LTP to reduce laborious work.

6. The LTP has been writing in a simple and lucid language.

7. Each experiment contains essential theory and detailed procedure with logical and systematic step, for successful performance of the experiment.

8. Systematic and proper tables (blanks) have been given to record the observations and steps of calculation.

9. Figures, tables and blank space for drawing have been given neatly.

10. Sample of observation have been given in some experiments in reading material.

11. At the end of experiment some questions have been given for better understanding of the experiment and also to see its applications.

12. This LTP is complete in all respects to meet the requirements of normal teacher and student.

13. Experiments have been classified into chapters and chapter arrange in same order as syllabus break-up.

14. In some programme content complete theory has been given for all topics. This has been done to maintain continuity.
15. Experiment have been described systematically covering all parts, especially the procedure has given step wise.

16. In order to guide the students about recording the observations in the worksheet a specimen table no. has been given in the procedure.

3.3 Planning of LTP:

In the beginning investigator studied the various model of teaching. Form all the models and method investigator found that one should work on laboratory method because very less work has been done in this field in India and abroad in mathematics subject. So investigator decided to work in this area. Investigator visited some mathematics laboratories in Ahmedabad, Rajkot, Vallabh Vidhyanagar, New Delhi etc. Even investigator referred some books related to teaching aid and mathematics laboratory. Investigator took guidance from experts in this field like, Prof. A.R.Rao, Prof.P.K.Vyas, Prof.H.M.Vasavada at Vikram Sarabhai Community Science Centre. Investigator attended two workshops related to maths lab one in Faridabad and other at R.K.Puram Delhi. Also investigator himself developed mathematics laboratory in Delhi Public School, Ahmedabad. Investigator organized a workshop for ‘making of mathematical model’ in Delhi Public School. Investigator conducted workshop on mathematic teaching model in GLS B.Ed College and M. N. Shukla B.Ed College Ahmedabad. So investigator has good amount of experience and valuable support from experts in the field of mathematics laboratory. While planning of laboratory teaching programme investigator considered following three dimensional learning domain

1. Cognitive domain

   1) Knowledge: Remembering/recalling of previously learned material like facts, information etc.
   2) Comprehension: Ability to understand the meaning of the material
3) Application: Ability to use learned material in new and concrete situations. e.g. application of rule, method, principle and law etc.
4) Analysis: Ability to break down the material into component parts and determine the hierarchy/relations among components.
5) Synthesis: The ability to assemble the parts into a whole with emphasis on creative behavior and formulation of new patterns.
6) Evaluation: Ability to judge the value of materials and methods used for given purpose. The outcomes on this level are the highest cognitive hierarchy.

2. Psychometric domain: This domain has following levels which progress from simple to complex skills.

1. Observation: Careful watching and recording something, the result or record of observing something such as natural phenomenon and noting development.
2. Recording: Collection of data, put something into lasting form, note something, indicate measurements etc.
3. Performing: To carry out an action or accomplish task with care and skills.
4. Calculation: Mathematical process of calculating something. The process of working out the answer to problem.
5. Manipulate: To move, operate or handle something to work and control on data and instruments.
6. Interpretation: An explanation or establishment of the meaning, an ascription of a particular meaning or significance to something.
7. Conclusion: To make a decision or an opinion formed after considering the relevant facts or evidence.

3. Affective Domain:-

This domain consist five levels receiving, responding valuing, organization and characterization. The successive levels involve greater internalization of the felling/attitude by the learner. Above level considered in following level in these LTP.

1. Initiation-resource.
2. Ability to write report.
5. Confident building.
6. Modify and apply to other similar requirement, situation.
7. Co-operate to each other in group.
3.4 Topic of LTP:

The investigator prepared ten programmes form ten topics relating to VIII standard mathematics. These programmes consists 68 different experiments. The topics and sub topics of LTP are given below.

1. **Set theory**
   - Analysis of information.
   - Concepts of ‘belongs to’ and ‘does not belong to’.
   - Roster & set builder form of sets.
   - Union, Intersection, complement of sets.
   - Venn diagram.

2. **Expansion**
   - \((a + b)^2\)
   - \((a – b)^2\)
   - \((a – b)(a – b)\)
   - \((a + b + c)^2\)
   - \((a + b)^2 – (a – b)^2\)
   - \((x + a)(x + b)\)

3. **Point, line and distance**
   - Postulate.
   - Relation between point and line.
   - Collinear and non collinear points.
   - Concept of distance.

4. **Analysis of data**
   - Variable
   - Class interval
   - Frequency distribution table
   - Mean and average mean

5. **Line segment, ray, plane and angle**
   - Midpoint of line segment
   - Ray
   - Plane
   - Coplanar and non coplanar points & lines
   - Inside and outside part of angle
   - Measurement and type of angles
   - Linear pair of angle

6. **Factorization**
− Factor of quadratics polynomials
− \(x^2 + 2x + 2, x^2 + 7x + 10, 2x^2 5xy + 2y^2, x^2 + 2x − 8, 2x^2 + xy − y^2\)

7. **Parallel lines and construction**
   − Corresponding, Alternate and interior angles
   − Testing of parallel lines
   − Intercept made by transversal of the parallel lines
   − Construction of divining line segment in equal parts

8. **Construction:**
   − Construction of congruent angles.
   − Bissection of the angle.
   − Construction of angles of \(60^\circ, 90^\circ, 120^\circ, 30^\circ\).
   − Construction of the perpendicular on the line from point out side of the line.
   − Construction of the perpendicular bisector of the line segment.

9. **Circle**
   − Radius, diameter and chord
   − Perpendicular on the chord from the centre
   − Relation between the chord and the line segment joining the centre of circle & the midpoint of chord.
   − Congruent chords
   − Central, subtended angle of chords.
   − Cyclic quadrilateral.

10. **Surface area and volume**
    − Surface area of cylinder, cuboids and cone.
    − Volume of cylinder, cuboids and cone.
    − Relation between the volume of cone & cylinder.
    − Relation between slant height, height and radius of cone.

### 3.5 Format of LTP:

Investigator considered three dimensional learning domains cognitive, psychometric and affective domain. The format of each programme was dividing in following parts.

1. Information about programme.
2. Reading material
3. Worksheet
4. Kit(equipments)

**1. Introduction about programme:** In this part investigator has mentioned information about experiment. How to feel observation, how to write answers and conclusion, handling kit and some precaution related to kit.
II. **Reading material**: In this part the theoretical aspects of each programme have been discussed briefly. If require some of explanations have been given with examples & figures. These reading materials have been in compact and sufficient form.

III. **Work sheet**: In work sheet several experiments has been included. Each experiment contained aim, equipments, procedure, observation table (blank) and conclusion. In some work sheet include with separate experiment sheet.

IV. **Kit**: A separate kit has been prepared by investigator for each experiment. For programmes like set theory, expansion, factorization one kit was prepared for two students. For programmes like point, line and distance, line segments, ray, plane and angle, parallel lines, construction and circle individual kit was prepared. For programme like surface area and volume one kit was used for whole class but class has been divided in three equal groups for sequence of six experiments. For analysis of data no kit was used.

All these kits made by hard coloured chart papers. Also some experiment cuboids, cylinder cone measuring cylinder, jug, compass, protractor scale, string, transparent paper, small coins and playing card were used. In geometric experiment A-4 size paper was used for construction and measurement.

The following example will give some idea about experiment. But there is variation in content and equipment.

**Programme 5:**

**Experiment 10:**

**Aim**: To be familiar with angle of linear pair **Equipment**: scale, protector.

**Procedure**: (1) angles of linear pair are drawn in one of the following square. (2) Draw angles of linear pair in the other square and give names. Measure all angles then write answers of the following questions.

![Figure 1](image1.png)  ![Figure 2](image2.png)
Figure 1: m∠ABD = _______, m∠DBC = _____, m∠ABD + m∠DBC = _______

Figure 2: m∠_____ = _____, m∠_____ = _____, m∠_____ + m∠_____ = ______

Conclusion: Angles of linear pair are_____________________.

3.6 Time period of LTP:

After taking consideration various factors like students, class size, content, facility of school and convenience of school a period of nine months was selected for implementation of LTP.

3.7 Blue print of the programme:

<table>
<thead>
<tr>
<th>Programme name</th>
<th>No.of exp.</th>
<th>Learning domain</th>
<th>Reading material</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set theory</td>
<td>3</td>
<td>Cognitive, Psychometric, Affective</td>
<td>yes</td>
<td>80 min.</td>
</tr>
<tr>
<td>Expansion</td>
<td>6</td>
<td>Cognitive, Psychometric, Affective</td>
<td>no</td>
<td>80 min.</td>
</tr>
<tr>
<td>Point, line and distance</td>
<td>7</td>
<td>Cognitive, Psychometric, Affective</td>
<td>yes</td>
<td>80 min.</td>
</tr>
<tr>
<td>Analysis of data</td>
<td>3</td>
<td>Cognitive, Psychometric, Affective</td>
<td>yes</td>
<td>80 min.</td>
</tr>
<tr>
<td>Line, ray, plane, angles</td>
<td>11</td>
<td>Cognitive, Psychometric, Affective</td>
<td>yes</td>
<td>90 min.</td>
</tr>
<tr>
<td>Factorization</td>
<td>6</td>
<td>Cognitive, Psychometric, Affective</td>
<td>yes</td>
<td>80 min.</td>
</tr>
<tr>
<td>Parallel line and construction</td>
<td>7</td>
<td>Cognitive, Psychometric, Affective</td>
<td>yes</td>
<td>90 min.</td>
</tr>
<tr>
<td>construction</td>
<td>8</td>
<td>Cognitive, Psychometric, Affective</td>
<td>no</td>
<td>90 min.</td>
</tr>
<tr>
<td>Circle</td>
<td>11</td>
<td>Cognitive, Psychometric, Affective</td>
<td>yes</td>
<td>90 min.</td>
</tr>
<tr>
<td>Surface area and volume</td>
<td>6</td>
<td>Cognitive, Psychometric, Affective</td>
<td>yes</td>
<td>90 min.</td>
</tr>
</tbody>
</table>

3.8 Pre pilot tryout of LTP:

In the beginning the investigator had prepared ten LTP on the mathematics of standard VIII. The manuscripts containing these programmes were prepared in handwritten form. This manuscript is known as pre pilot LTP. The manuscript was tried out on a very small group of students, the mathematics teacher, teacher educators and expert of mathematics subject to make LTP more reliable.

The objectives of pre pilot tryout were as under:

1. To see whether the students understand the procedure of experiments.
2. To confirm whether the equipments are of proper size.
3. To check whether students are comfortable with the kits.
4. To check whether students are able to derive conclusion of experiment.
5. To know the teacher, expert and teacher educators have to suggest anything before the programme is to be mimeographed.
6. To determine appropriate period required to complete the programme.

At the time of pre pilot tryout of LTP following points were observed.

1. Time requirement is differ for different programme.
2. Teacher educator and subject experts have suggested to remove some experiments and also to change some problems in LTP. Even some experts have suggested appropriate equipment for some experiments.
3. In some of programmes it was observed that size of equipment was very small to handle so investigator changed it.
4. Few difficult words were replaced.
5. Due to time constrains some long programmes were shorten.

From the above observations and suggestions made by experts, the investigator had made necessary corrections, added some experiment, improved kits and changed some words in respective programme.

3.9 Pilot tryout of LTP:

In this investigation the pilot tryout of the programme was undertaken to remove ambiguities, to enhance clarity and to study student’s reaction. The pilot tryout of LTP was administered with the following objectives.

1. To get an idea of the administration of LTP.
2. To check whether the reading materials and other information are sufficient and useful.
3. To check whether programme is easy to understand.
4. To observe the reactions of students regarding the LTP as this would be their first experience.
5. To get an idea of appropriate time duration to be required to complete the whole experience.

For this, a representative sample was selected from the population viz., the students of standard VIII of Gurukrupa Vidhyalaya, Ahmedabad. The sample of pilot tryout consists of twenty students. In the beginning, the general instructions regarding this programme were given. Each programme provided to every students. During the pilot tryout, the investigator made following observations.

1. Kits and reading materials were easy to understand.
2. The LTP could be taught to any type of students, i.e. low, average or brilliant without any difficulty.
3. The students showed interest in each experiment.
4. Most of students were able to derive conclusion.
5. In the beginning students took more time to complete one programme. Later on they were able to complete programme in proper time.
6. To derive conclusions students were seen to think originally.
7. Creative and cooperative atmosphere was found while the programme duration.

Now taking into consideration the observations during the pilot tryout, the necessary modifications were made in the LTP and again it was revised. The final form of LTP is included in Appendix 1. The number of experiments and content remained same. If require some additional guidance and help provided to students in some programmes. The content is given in 3.10.

3.10 Content of the programme:

The content of the LTP is described in the form of experiment. For reading material, kit, procedure and other thing reader is requested to see Appendix 1.

**LTP 1: Set theory**

Experiment 1: To divide living beings in proper groups.

Experiment 2: To make sets according to given condition than fill the blanks.

Experiment 3: To make Venn diagram.

**LTP 2: Expansion**

Experiment 1: To expand 

Experiment 2: To expand 

Experiment 3: To expand 

Experiment 4: To expand 

Experiment 5: To find value of 

Experiment 6: To get expansion of 

**LTP 3: Point, line and concept of distance.**

Experiment 1: To be acquainting with properties of point and line.

Experiment 2: To measure distance between two points.

Experiment 3: To find number related to given points.

Experiment 4: To calculate distance between two points by using related number.
Experiment 5: To find related number of points which at certain distance from given points.

Experiment 6: To find value of unknown ’x’.

Experiment 7: To calculate distance between two cities from given map.

**LTP 4: Analysis of data**

Experiment 1: To calculate average marks of a group.

Experiment 2: To calculate average height of a group.

Experiment 3: To calculate average marks and height of the class.

**LTP 5: Line segment, ray, plane and angle**

Experiment 1: To be familiar with line segment.

Experiment 2: To find number related to the midpoint of line segment.

Experiment 3: To be familiar with ray.

Experiment 4: To be familiar with plane.

Experiment 5: Relation between line and plane.

Experiment 6: To be familiar with coplanar and non co-planar lines.

Experiment 7: To be familiar with interior and exterior parts of angle.

Experiment 8: To calculate sum of angles.

Experiment 9: To be familiar with right angle, acute angle, obtuse angle, complimentary angle and supplementary angle.

Experiment 10: To be familiar with angle of linear pair.

Experiment 11: To be familiar with vertically opposite angles.

**LTP 6: factorization**

Experiment: Evaluate factors of given polynomial.

Experiment 1: \(x^2 + 3x + 2\)  
Experiment 2: \(x^2 + 7x + 10\)  
Experiment 3: \(2x^2 + 5xy + 2y^2\)  
Experiment 4: \(x^2 + 2x - 8\)  
Experiment 5: \(2x^2 + xy - y^2\)
**LTP 7: Parallel lines**

Experiment 1: To find relation between corresponding angles made by parallel lines and its transversal.

Experiment 2: To find relation between alternate angles made by parallel lines and its transversal.

Experiment 3: To find relation between interior angles of one side made by parallel lines and its transversal.

Experiment 4: To check weather lines are parallel.

Experiment 5: To find relation between intercepts made by parallel lines.

Experiment 6: To divide line segment in five equal parts.

Experiment 7: To calculate measurement of unknown angle and line segment.

**LTP 8: Construction of angles**

Experiment 1: To construct congruent angles.

Experiment 2: To bisect the given angle.

Experiment 3: To construct a 60° angle.

Experiment 4: To construct a 120° angle.

Experiment 5: To construct a 90° angle.

Experiment 6: To construct angles of measurements 15°, 30°, 45°, 75° and 105°.

Experiment 7: To construct perpendicular from the point outside of the line to the line.

Experiment 8: To construct perpendicular bisector of line segment.

**LTP 9: Circle**

Experiment 1: To be familiar with radius, diameter and chord of circle.

Experiment 2: To find the relation between the perpendicular to the chord from the centre and the chord.

Experiment 3: To find the relation between the chord and the line segment made by joining the midpoint of the chord and the centre.
Experiment 4: To find the relation between the congruent chords and the perpendicular from the centre to them.

Experiment 5: To find the relation between the congruent chords and their central angles.

Experiment 6: To be familiar with arcs made by transversal of a circle.

Experiment 7: To find the relation between the central angle and subtended angles of the chord.

Experiment 8: To find the relation between the congruent chords and their subtended angles.

Experiment 9: To find the measurement of angle of the semi circle.

Experiment 10: To find the relation between opposite angles of a cyclic quadrilateral.

Experiment 11: To find the measurements of the unknown angles.

**LTP 10: Surface area and volume.**

Experiment 1: To calculate the volume of irregular object.

Experiment 2: To derive formula of volume and surface area of the cylinder and cuboids.

Experiment 3: To calculate of volume and surface area of the given cuboids.

Experiment 4: To calculate of volume and surface area of the given cylinder.

Experiment 5: To find the formula for volume of the cone.

Experiment 6: To calculate of volume and surface area of the given cone.

**3.11 Summary:**

This chapter contains the description of the laboratory teaching programme, the stage of its development, pre pilot tryout, the pilot tryout and the reactions of teachers, teacher’s educators and expert of the subject and students participated in the tryout.

The execution of LTP is taken in the next chapter.