CHAPTER - III

DEVELOPMENT OF TEACHING MATERIAL
In this chapter, two types of teaching material has been developed on two topics namely - Set Theory and Trigonometric Concepts.

3.1 DEVELOPMENT OF PROGRAMMED MATERIAL:

Programmed learning material on the topic of set theory was used which was prepared by Chanchal Singh. A copy of the same is attached in Appendix-I. On the second topic namely Trigonometric Concepts (linear types) was developed by the investigator. The details of the development are given below which include selection of units to programmed deciding initial behaviours about the defining appropriate objectives in behavioural terms, developing text's specific outline of content of programming, writing the draft frames and their editing, individual testing and revision, small group testing and revision, and field testing.
Selection of the Unit: In the selection of unit, the size of unit, its ease, depressed level of learning, logical order of material and special needs of the learner were kept in view as suggested by Lyséught and Williams (1963). The criterion of the depressed level of learning was given more weightage.

The unit 'Trigonometric Ratios' was selected for programming.

Since programmed material was intended for the IX grade mathematics students, it was assumed that they had initial level of knowledge of Mathematics upto VIIIth grade and that they could understand the texts written in English language. With a view to ensure their level of knowledge in Mathematics, they were given a Mathematics test based upon the initial level of knowledge required to understand the programmed texts.

3.2 INITIAL BEHAVIOURS OF THE LEARNER:

The major contribution that programmed instruction has made to educational practice is obvious from the emphatic insistence on the importance of instructional objectives in behavioural terms. Tyler (1932), stressed the need to define objectives in behavioural terms. The same was supported by Bloom's Taxonomy of Educational Objectives and task specifications. The success of a programme depends upon a clear identification of initial behaviours and realisation of terminal behaviours in the learner. These objectives in behavioural terms also help in deciding the programmer as to where from start the programme and where to end it.
Mager (1962) defined an objective as "the intent communicated by a statement describing a proposed change in a learner - a statement of what the learner is likely to be when he has successfully completed a learning experience. It is a description of a pattern of behavioural performance we want the learner to be able to demonstrate". The defining of objectives in behavioural terms provides guidance for selecting appropriate material and instructional procedures to be followed as also provides criteria for the evaluation of the learning outcomes.

Mager (1962) has further distinguished between pre-requisites, course description and objectives. Pre-requisites accounts for what a learner has to be able to do to qualify for a course; course description means as to what the course is about and objectives relate to as to what a successful learner will do at the end of a course.

Mager's recommendations were accepted as guidelines for writing the behavioural objectives in the present study. The terminal behaviours as evidence that the learner has achieved the objective was identified by name, the important conditions under which the particular behaviour will occur were described, criteria of acceptable performance were specified by describing how well the learner must perform to be considered acceptable. Besides, these objectives were written in clear language, they were specific in nature and achievable in specific time with
the programme or method to be used for achieving them. The educational objectives in behavioural terms of the programme are as under:

3.3 EDUCATIONAL OBJECTIVES IN BEHAVIOURAL TERMS:

The students will be able to -

1. define an angle.
2. name the arms of an angle.
3. tell the initial point i.e. vertex of an angle.
4. give the names of the initial and terminal arms of an angle.
5. know that the trigonometric ratio sinθ is equal to Perpendicular / Hypotenous.
6. write that \( \cos\theta = \text{Base} / \text{Hyp} \).
7. give the value of \( \tan\theta \), in terms of \( \sin\theta \) and \( \cos\theta \).
8. calculate from the given data about right angled triangle, the values of different trigonometric ratios.
9. find \( \cos\theta \) when \( \sin\theta \) is given.
10. calculate \( \sin\theta \) when the value of \( \cos\theta \) is given.
11. find \( \tan\theta \) when either of \( \sin\theta \) or \( \cos\theta \) is given.
12. give the values of different trigonometric ratios when \( \theta \) is given.
13. compute the values of different trigonometric ratios when \( \theta \) varies from 0° to 90°.
14. study the behavioural changes of \( \sin\theta \) when \( \theta \) varies from 0° to 90°.
15. give the behavioural changes of \( \cos\theta \) when \( \theta \) varies from 0° to 90°.
16. study the behavioural changes of \( \tan\theta \) when \( \theta \) varies from 0° to 90°.
17. write the different trigonometric ratios in terms of complementary angles.

18. prove the identity \( \sin^2 \theta + \cos^2 \theta = 1 \).

19. know the angle of depression and the angle of elevation.

20. apply the knowledge of the formula \( 1 - \sin^2 \theta = \cos^2 \theta \).

21. write the value of \( \sin 54^\circ \).

22. calculate the value of \( \theta \) when \( \cos \theta = 1/2 \) is given.

23. find an angle \( A \) for which \( \sin A = \cos A \).

24. solve the different identities of trigonometry.

3.4 DEVELOPING CRITERION TEST :

A criterion test measures the terminal behaviour or performance of learner whose behaviour or performance the programmer wants to shape through the programme. A criterion test is quite different from an achievement test. An achievement test is always designed to measure achievement of the learner while criterion test measures the effectiveness of the programme, that is, how much the programme is successful in shaping the behaviour of the learner. Pipe (1966) has distinguished between an achievement test and a criterion test on the basis of rigorous condition, difficulty range and normality condition required for an achievement test which do not figure in the same rigid sense in a criterion test.

A criterion test can also be distinguished from an achievement test on the basis of objectives. Whereas the objectives of an achievement test is to grade the learner. The object of a criterion test is not to grade the learner while developing a criterion test,
programmer has to think very clearly about the situation which will elicit the desired behaviour - the behaviour which will be in consonance with the terminal objective. The main object of this test is to see as to what percentage of learners attempt what percentage of items correctly; so the criterion test is not concerned with the spread of items according to difficulty from 0 to 100, as in the case of an achievement test.

At the planning stage, the content to be taught in a particular unit was thoroughly studied in the light of terminal objectives. The terminal objectives contained the three areas out of six areas of Bloom's Taxonomic Classification in the cognitive domain. The weightage given to these areas is given in Table 3.1.

The test was developed before writing actual programme so as to minimize the replication of items in frames and in test items.

**TABLE 3.1**

<table>
<thead>
<tr>
<th>Knowledge</th>
<th>Understanding</th>
<th>Application</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>6</td>
<td>7</td>
<td>24</td>
</tr>
</tbody>
</table>

The first draft of criterion test consisted of twenty four items. Eleven items pertained to knowledge area, 6 items to
understanding and 7 items to Application respectively. The items included in the criterion test were of multiple choice type, completion type, calculating type, simple recall type and short answer type. The first draft was carefully edited for language, clarity and content. The help of subject-matter experts and technique experts were duly taken and their suggestions were accepted and changes were made in the first draft. In arranging the items the principle from simple to complex or from known to unknown was followed. The first draft was got duplicated for administration. The criterion test was administered on a representative sample of 40 students who had already been through the content.

Kelley's (1939) formula of 27 percent cases in each group was employed, for calculating the difficulty values (D.V.) and the discriminating powers (D.P.). The following formulae were used:

\[ D.P. = \frac{RU - RL}{0.5 N} \]
\[ D.V. = \frac{RU + RL}{N} \]

Where RU stands for number of correct responses in upper group on each item
RL stands for lower group.
N stands for total Number of students in both groups.

Those items whose Difficulty value was either below .25 or above .75 were rejected and those items whose D.V. ranged between .25 to .75 were selected.
Ebel's (1966) criterion was followed for selecting items on the basis of D.P. Those items whose D.P. was .40 or above were retained as such, those items whose D.P. was less than .40 but was above .20 were retained for revision and modifications and others were rejected. The table 3.2 given below shows the distribution of discriminating power of the items of the first draft of the criterion test.

### Table 3.2

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>D.P.</th>
<th>Frequency</th>
<th>Item No.</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>.40</td>
<td>16</td>
<td>1-3, 6-10, 12-18, 23</td>
<td>Selected as such</td>
</tr>
<tr>
<td>2.</td>
<td>Between .20 to .39</td>
<td>7</td>
<td>4, 5, 11, 19, 21, 22, 24</td>
<td>Revised and modified</td>
</tr>
<tr>
<td>3.</td>
<td>Below .20</td>
<td>1</td>
<td>20</td>
<td>Rejected</td>
</tr>
</tbody>
</table>

Table 3.2 shows that out of 24 items, 16 were accepted as such, 7 items were included in the second draft after modification and one item was deleted.

Thus after rejecting one item and revising others on the basis of D.V.'s and D.P.'s, second draft of the criterion test
was prepared, which was administered to a sample of 50 students. Again D.V.'s and D.P.'s were calculated on the same lines as in 1st draft.

The items, which were rejected, accepted or accepted after revision and modification, are given in Table 3.3.

**TABLE 3.3**

The Distribution of the Discriminating Power of the Items of Second Draft of the Criterion Test

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>D.P.</th>
<th>Frequency</th>
<th>Item No.</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>.40 and above</td>
<td>20</td>
<td>1-4, 6-19, 22, 23</td>
<td>Accepted as such</td>
</tr>
<tr>
<td>2.</td>
<td>Between .20 to .39</td>
<td>3</td>
<td>5, 21, 24</td>
<td>Revised and Modified</td>
</tr>
<tr>
<td>3.</td>
<td>Below .20</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 3.3 reveals that 20 items were accepted as such, 3 were accepted after revision and no item was rejected on the basis of D.P. of items.

After modifying items on the basis of the D.P. and D.V., the final draft of the criterion test was prepared. The structure of the final draft with respect to weightage to the various categories of objectives is given in Table 3.4.
TABLE 3.4
Weightage to various Objective Areas in the Final Draft of the Criterion Test

<table>
<thead>
<tr>
<th>Knowledge</th>
<th>Understanding</th>
<th>Application</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>6</td>
<td>6</td>
<td>23</td>
</tr>
</tbody>
</table>

The final draft of the Criterion Test has been provided in the Appendix-1.

3.5 PROGRAMME WRITING:

A programme was developed on the topic "Trigonometric Ratios" in the linear format given by Skinner (1954). The writing of it was guided by the considerations of structuring, designing and sequencing of the didules (frames).

3.5.1 Structuring of Didules:

A didule is a segment of material which the learner handles at one time. It may vary in size from a few words to a full page or more. Klaus (1961), DeCecco (1970) have given four essential parts of a frame:

1. The stimulus and the stimulus content;
2. The prompts necessary to produce the response reliably;
3. The response(s), the stimulus works;
4. Enrichment material which makes the frame more readable or which recalls previously learned material to facilitate the student response. Another important feature of didule structure is corrule which either reinforces the correct response given by the student or corrects his incorrect response.
In structuring didules, proper attention was paid to the step size. It was ensured that the amount of information in a particular didule was minimum possible for eliciting a particular respule, superfluous material was avoided. The size of the stimule was also controlled keeping in view the complexity of the concept to be taught. Except introductory didules, initial learning didules consisted of small steps followed by large steps as the programme further progressed. Maccoby and Sheffield (1961) found that the short steps were more effective than large steps for initial learning and the progressive lengthening of steps lead to the best performance on the terminal behaviour.

In designing didules, careful consideration was given to -

1. appropriateness of stimule, respule and corrules;
2. the language used in didules;
3. size of the didules so as to avoid boredom;
4. correctness of what is said in the didule;
5. logical ordering of the didules on the basis of the principle from simple to complex or from known to unknown; and
6. the relevancy of the response to the purpose of the didule so as to achieve the terminal behaviour of the didule.

3.5.2 Respule:

There are different modes of responding to a didule, namely overt responding, covert responding and a reading mode response type. In the present programme overt type respule has been
preferred to covert type. In overt type respule the learner is called upon to write the respule. The learner is asked to construct it or choose from true or false type respules.

The programme included both types of respules constructed as well as two-option respules. In a constructed respule the learner is required to construct his own respule, and in two-option respules the learner is required to 'select' a respule out of the two given respules rather than 'construct' a respule. Proper care was taken in the 'two-option' type respules to see that the student wrote the respule in the blank provided for this purpose rather than putting a check-mark (\(\checkmark\)) on one of the options.

The overt respule was favoured over the covert because of its superiority as reported in several studies. Cummings and Goldstein (1962) and Anderson (1967) found that overt respules facilitate learning when the respules are relevant to the content of the lesson. He also found overt respules are relevant to the content of the lesson. He also found overt respules better than the covert ones in the learning of unfamiliar and technical terms. A study by Krumboltz and Kiesler (1965) supported that overt respules facilitate learning depending upon the relevancy of the content. A study by Egen and Margurilies (1963) on the learning of non-sense syllables discovered that the overt respule group learned twice as many of the difficult syllables as did the covert respule group.
3.5.3 Corrule:

Corrule (feed-back) is the condition of establishing the desired behaviour either by confirming the response of the learner or by correcting it. When the learner discovers that his response is correct, he obtains confirmation; when it is incorrect, he receives correction.

Krumboltz and Weisman (1962) found no differences in the test performance of the students who were supplied the correct answer all the time and of those supplied the correct answer only a part of the time. They suggested the importance of knowledge of results in the later stage and in the earlier part of the programme when prompts for the correct responses are withdrawn.

In the present study every didule was supplied with correct responses. The corrule, thus was continuous and not intermittent. Continuous corrule was selected because the learners were to use programmed material for the first time, so giving them correct responses every time could give them psychological advantage. Correct responses were printed just under the or on one side of the didule. Students or learners were advised to cover the correct response till they had responded to the didule in their answer sheets.

3.5.4 Error Rate:

A good didule is one which obeys the principle of minimal errors. But this principle is not accepted universally by all. So
researchers do not agree with this principle. Fry (1963) has, however, cautioned against the stringent application of this rule. In the present study to ensure minimum number of errors the following points were kept in view:

- the amount of information was minimum possible to serve the purpose.
- the concepts were developed by using.
- priming and prompting techniques to elicit the desired response.

3.5.5 Types of Didules:

The type of a didule depends upon the nature of purpose for which didule has been prepared. The programme before structuring a didule would decide whether the didule is to introduce new concepts or knowledge, whether it is to test the knowledge or skill of the learner from the material which he has already learnt.

Espich and Williams (1967) defined three major types of didules:

- The set didules.
- The practice didules.
- Terminal or criterion didules.

3.5.5.1 Set Didules: Set didule is that didule which contains the correct response in the data portion of the didule. The learner deduces the response from the data, even though he might not have
seen the respule before. In such didules the student can copy the correct respule from the data of the didules and sometimes such didules are termed as copying didules. Such didules were used at the introductory stage of teaching a new concept or a new idea.

3.5.5.2 **Practice Didules:** Practice didule is that in which the learner rehearses what he has already learnt or discovered in previous didule such didules provide a chance to the learner to practice what he has already learned or discovered previously. They form about 50 to 60 percent of the total number of didules in a programme. The practice didules have no meaning if presented isolated. They are meaningful only when presented along with the set didules.

In the present study, in developing a new concept, or new formula, the set didules were given first to help the respule appear; when once the respule appeared the students were given ample practice through practice didules so that the respule got fixed up.

3.5.5.3 **The Terminal Didules or Criterion Didules:** A terminal or criterion didule is that in which no new information or no practice of the previously learned material is called for, but on the other hand the learner is asked to respond on his own without receiving any prompts. A sequence of constructed respule type of didules progresses from simple to complex. The final didules of the sequence are known as terminal didules, criterion didules or sometimes as review didules.
In the present study 15 to 20 percent of didules were structured in the programme to serve as terminal didules.

3.5.6 Sequencing of Didules:

Sequencing of didules is a great controversial point in programmed learning. Most of the researchers agree on psychological sequencing of didules, that is, that didules which are to teach simple concepts should be placed first and those to teach complex should follow them. Other learning principle that one should proceed from known to unknown is also acceptable to them but they differ whether rules or concept should follow examples or examples should follow rules or concepts.

According to DeCecco (1970), the sequencing depends upon two factors: the description and analysis of the behaviours, the programme intends to teach and the conditions necessary for the learning required by the various tasks. According to Popham et al. (1970), the problem of sequencing centres around the question, "What should I present first?" rather than "What should be learned first?" Though, both the questions are very much interrelated, yet the relationship has never been made explicit.

In the present study, the presentation of the content was decided on the basis of educational objectives which pertained to the different categories of Bloom's Taxonomy. Most of the researches point out that ruleg system (example follow rules) is better
for teaching simple concepts and egrule system (rules follow examples) is better for developing complex or complicated concepts or rules. In the present study both systems ruleg as well as egrule were used depending upon the complexity of the concept or rule to be learnt.

In each sequence, the following order was followed:
- the set didules (for the introduction of any concept);
- the teaching didules (for the development of the concept);
- the practice didules (for the fixation of the concept or rule);
- criterion didules (pre-testing or reviewing the attainment of the concept);

3.5.7 Prompting:

A prompt is a stimulus added to the terminal stimulus to make the correct response more certain which the student is learning. Prompt may be pictorial or verbal. Prompts vary in strength, i.e., in the probability with which they will evoke the correct response from a given population.

Markle (1969) defines a prompt as "a supplementary stimulus, a hint or bit of assistance that helps the student to come up with a correct response", she has also differentiated between a prime and a prompt. In priming, response is contained in the didule, in prompting it is not. In other words, a prompt is
something which has been added to the terminal response to make the didule easier, and what has been added is not sufficient to produce a response by itself. A prompt is just like a catalyst which accelerates a chemical reaction but cannot start it. Espich and Williams (1967) have differentiated between a cue and a prompt. Cue is a mechanical device or aid that enables the student to make the desired response. According to them, some of the common cues or calling to the student's attention by putting the desired response in capitals, putting the number of blanks equal to the number of letters in the desired response. Some programmers do not make any distinction between the two. Markle et al. (1961) called such cues as "emphasis prompts". According to her (1969), "These types of typographical tricks for attracting the reader's attention are a sub-set of larger set of tricks we might call them 'usual prompts'. "Skinner classified prompts into two major types. Formal prompts provide knowledge about the form of the expected response, such as the number of letters, the initial letter or sound patterns. Thematic prompts depend upon meaningful associations that make it like for a student to give the expected response. Meyer (1960) defined a prompt as "any technique employed to make omission of the correct response more likely".

Prompts play a very important role in learning process, they serve two fundamental purpose. In the first instance, they guide
learner to the correct response without controlling his behaviours, and secondly prompts prevent the learner from making futile or unnecessary errors. Whereas, prompts help the learner to choose the correct responses without making unnecessary errors but at the same time over-prompting can prove harmful to the learner. A common source of over-prompting is the 'copying didules', in which the student is asked to make a response given in the didule. Taber and his associates (1965) believe that over prompted didules are over used by many programmers. Markle (1969) believes that they can be an insult to the learner.

3.5.3 Classifications of Prompts:

Many programmers have attempted classifications of prompts. Skinner (1957) classified prompts into two categories: formal prompts, and thematic prompts. Fry (1963) named two types of prompts - verbal and non-verbal. Callender (1969) classified into as many as six types: formal prompts, copy prompts, sequence prompts thematic prompts, semantic prompts and visual prompts.

Markle (1969) classified them into formal, thematic, multiple-choice, usual and sequence prompts.

Researches have shown that none of the types of prompts is effective for all types of learning situations. In the present programme mixed system of prompting was followed. The decision about the type of prompt to be used in a particular didule was made on the basis of nature and purpose of the didule.
Formal prompts were favoured where the learning situation was simple and understandable, thematic prompts were favoured where the learning situation involved more complex nature of responses. Didules which formed the part of the introductory stage were copying type or in other words the terminal stimulus was highly loaded with prompts. In teaching and practice frames proper prompting was made. In review and testing didules either no prompting was there at all or it was very weak.

3.5.9 Editing:

The next step in the programme development after writing the first draft of the didules is editing. Editing is to be done from three points of view with respect to content, technique and composition.

3.5.9.1 Content Edit: For the success of a programme it is essential to determine the technical accuracies of the content, the material flow and the use of vocabulary in accordance with the mental level of the learner for whom the programme is being developed.

In content editing, the content was placed before subject matter experts for their expert guidance. In the light of their suggestions, content was revised, then the content was broken into concepts, sub-concepts, rules and sub-rules and was arranged in the teaching sequence from simple to complex. This break up of the content was thoroughly discussed with the content experts in Mathematics.
3.5.9.2 Programming Technique Edit:- Editing of programming technique is very important for the success of a programme. If, in a programme either continuity is lacking from item to item or inter-relationship between parts is lacking, it cannot achieve the desired objectives.

In a programme the content should be logically developed leaving no gaps in between with regard to editing of the programme technique. Espich and Williams (1967) raised several issues, namely:

- the continuity of the programme from item to item and from concept to concept;

- inter-relationship between various parts of programme; and

- inter-relationship between sequences.

According to Lysaught and Williams (1963), the editing has to be done primarily with reference to accuracy and relevance of materials, style, vocabulary and content interest.

The programme was edited for its logical and methodological development. It was edited for step-size, for any gaps left between teaching points. Proper care was given to see that the number of set didules, practice didules and criterion didules were enough to serve their purpose satisfactorily. It was also ensured that the line of reasoning in the programme fell within the comprehension level of the learner and the conclusions were the logical derivations from the given premises. The intra-step size was tailored according to the expected student-level of mental maturity. The inter-
relationship between various parts of the programme was checked.

Individual didules were edited for the following:

(i) The relevance of respule was checked against terminal behaviour;

(ii) Respule was checked for its purpose, whether its purpose was identification, defining, discrimination etc.;

(iii) Checked to see that only one concept or its one logical part was presented in one didule;

(iv) Checked for accuracy and inclusion of non-examples in the didules since they were considered necessary for concept teaching and for discrimination;

(v) Didule was checked for prompts. Those frames which were found to be heavily loaded with prompts or under loaded, were revised.

3.5.9.3 Composition Edit: Editing a programme for composition is similar to editing any piece of material for composition.

The programme was checked for language, grammar, spelling, the ability to communicate, aptness of examples and punctuations.

The present programme was checked for its language, spellings, grammatical structures and punctuations and its mechanical aspects.

3.5.10 Validation of Linear Programme:

Having drafted and edited the programmes the next step was, its testing for the strength of programmed material resides not in
the product but in the empirical testing procedures employed in the production. The empirical testing of a programme on a student population is known as validation testing of a programme. Developmental testing procedures were followed at the developmental stage of the programmes and the validation testing procedure was intended to be employed to study as to how the draft programme was successful in teaching the specified population. Espich and Williams (1967) maintain that "the device, or whatever it is, fails to live up to the purpose, for which it was designed if the student does not walk away from its possessing those terminal behaviours that the programme was intended to impart." The success of a programme is measured from the performance of the students on that programme.

The programme in hand was validated against two types of criteria - internal and external. Internal validation was concerned with the diduše analysis of the programme and its error rate. The programme was externally validated on a "80/80 standard".

3.5.11 Stages of the Validation Testing of Programme:

The validation testing of the programme was carried out at three stages: individual testing, small group testing and field testing.

At the first level, testing or the individual testing stage, the programme was administered on a sample of five students
taken one at a time. For this purpose the students selected were little slower than average, because at this stage the main purpose was to find out the stumbling blocks or items in the programme. The decision with regard to the selection of the students who were a little below average was taken on the basis of their performance in previous class tests and of the teacher's ratings.

The programme was presented at this stage to students in the form of serially arranged cards. Each card contained one didule. The student was asked to write the response on the response sheet provided for this purpose. Then he was asked to look up correct response given on the back of the card. In order to check copying the student was asked to read aloud the response while writing it down on the response sheet. In case of wrong responses the programmer asked him the reason for giving wrong and noted all the reasons he gave. In the similar manner each of the five students was administered the programme. When the individual testing was over, revision of the programme on the basis of reasons given by individuals was carried out.

3.5.12 Small Group Testing:

After making revision of the programme on the basis of individual testing, the revised programme was administered to a group of sixteen students. This group consisted of average students. The decision with regard to average students was again based upon
teachers ratings and their performance in class tests. A pre-test was administered to them so as to have an idea of their previous knowledge about these topics. After this, instructions were read out to them about the procedure to be adopted in going through the programme. They were instructed to note down the attempts they made in producing correct response in each case. No instructions or help was offered during the study period. At the end, the post-achievement test was administered. The marks of the post-test were statistically analysed and attempts made by students for elucidating correct response in each didulse were carefully gone through. On the basis of results of the small group, the programme was again modified and was compiled in the form of a test, which forms Appendix-I.

3.6 FIELD TESTING:

After modification on the basis of the small group testing, the programme was presented to a larger group.

Analysis: At each of the three validation stages, the following analyses were done:

- Error rate analysis;
- The 80/80 standard analysis.

3.6.1 Error Rate Analysis:

Error according to Markle (1969) is a response unacceptable to the programmer. Error rate is the percentage of unacceptable response to a particular didulse unit, or the programme taken as a
whole. In this study error rate analysis was carried out stage-wise. The Table 3.5 shows the distribution of didules stage-wise:

**TABLE 3.5**

The Distribution of Didules at Different Stages of Programme Development

<table>
<thead>
<tr>
<th>Stage of Programme Evaluation</th>
<th>No. of didules at different stages of development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual Testing</td>
<td>34</td>
</tr>
<tr>
<td>Small Group Testing</td>
<td>50</td>
</tr>
<tr>
<td>Field Group Testing</td>
<td>50</td>
</tr>
</tbody>
</table>

The table 3.5 reveals that the total number of didules increased from 34 to 50 at the small group testing stage, and to 50 at the field group testing stage.

The increase in the number of didules at each stage of the programme development was made on the basis of error analysis of the didules, the results of which are given below:
### Table 3.6

<table>
<thead>
<tr>
<th>Programme Type</th>
<th>Error Rate (%)</th>
<th>Didule-wise Errors</th>
<th>Total</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear</td>
<td>0</td>
<td>1-9, 11-21, 23, 25-27, 30-32</td>
<td>27</td>
<td>Accepted</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>10, 22, 24, 28, 29, 34</td>
<td>6</td>
<td>Revised</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>33</td>
<td>1</td>
<td>Revised</td>
</tr>
<tr>
<td></td>
<td>75</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 3.6 gives the percentage of errors of each unit of the programme during the individual testing stage. The range of error percentage varies from zero percent to 50%. The total number of errors between 25 percent to 75 percent is seven. It may be seen that errors are appearing in the didules which are at the far end of the unit. This shows that students fumbled at the testing stage. Most of the didules on which students made errors were recapitulatory or practice didules. This indicated that proper fixation of concepts had been lacking. The last didules have shown 25 percent to 50 percent error rate. These didules appeared to be very difficult to all the students and required revision. The table 3.6 reveals that 27 frames have error rate of zero percent. So these were accepted as such, since the maximum of errors permissible in a linear programme is 10 percent. All other didules showing error rate above 10 percent were revised. The revision was made in the light of the
following:

- More practice didules were introduced so as to fix up the concepts;
- The concept within a particular didule was made small enough to ensure intelligibility by students;
- The conceptual gap between any two didules was minimised;
- The language of the didule was made simple and more clear than before;
- Prompts were introduced in difficult didules or in those in which there was no prompting previously;
- The sequence of the didules was changed on the basis of empirical evidence;
- Withdrawing of prompts was made more gradual;
- Ambiguous didules were removed.

The revision of the programme was made on the lines given above.

Having made the revision, the revised draft of programme was administered on a small group consisting of 20 students with average achievement. The didule error-wise analysis was made. The results are given in Table 3.7.
TABLE 3.7

Didule-Wise Error Rate at Small Group Testing Stage

<table>
<thead>
<tr>
<th>Error %</th>
<th>Didule-Wise Errors</th>
<th>Total</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00%</td>
<td>1-10, 12-21, 25, 27-28, 31-32, 34-37, 39-43, 45-47, 49, 50</td>
<td>39</td>
<td>Accepted</td>
</tr>
<tr>
<td>8.33%</td>
<td>11, 22, 23, 24, 26, 29, 30</td>
<td>7</td>
<td>Revised and Modified</td>
</tr>
<tr>
<td>16.66%</td>
<td>33, 38</td>
<td>2</td>
<td>Revised and Modified</td>
</tr>
<tr>
<td>33.33%</td>
<td>44, 48</td>
<td>2</td>
<td>Revised and Modified</td>
</tr>
<tr>
<td>Above</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>33.33%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3.7 gives the error rate of each unit of the programme during small group testing programme. The total number of errors ranging between 8.33 to 33.33 percent is eleven. It may be seen that higher error rate is found for testing or recapitulating didules. This was due to lack of proper fixing. These didules were revised and modified. More prompts were provided. Some were revised for language clarity and withdrawing of prompts was made more gradual. There are 39 didules which have error rates of zero percent they were accepted as such.

Having made the revision of the programme. It was taken for the field-testing.
At the field testing stage, the programme was administered on a sample of thirty students of IX class of the higher/high schools of Chandigarh.

The error-analysis at the field testing stage is given in Table 3.8.

### TABLE 3.8

<table>
<thead>
<tr>
<th>Error %</th>
<th>Didule-Wise Errors</th>
<th>Total</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00%</td>
<td>1-21, 25-32, 34-37, 39-43, 45-47, 49-50</td>
<td>43</td>
<td>Accepted as such</td>
</tr>
<tr>
<td>3.33%</td>
<td>22, 23, 33, 38, 44, 48</td>
<td>6</td>
<td>Accepted as such</td>
</tr>
<tr>
<td>6.67%</td>
<td>24</td>
<td>1</td>
<td>Accepted as such</td>
</tr>
<tr>
<td>13.33%</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

It is seen from Table 3.8 that the error rate for most of the didules is below 10 percent, at field testing stage. 43 didules have error rate of zero percent, 6 didules have error rate of 3.33 percent, 1 didule have error rate of 6.67 percent. No didule had error rate of 13.33 percent. Since there were no didules which were modified after field testing stage, so it was not considered necessary to repeat the field testing operation. Table 3.9 gives the error percentage at all the three stages of the programme development.
Table 3.9 gives the error-percentage at the three stages of the programme development. The error rate percentage at the three stages of development is 5.88, 3.17 and 0.51 at individual testing, small group testing and field testing stages respectively. The figures indicate that there is a gradual decrease in error rate from individual testing stage to field testing stage. The figures of error percentages at various stages show that the error percentage has decreased with every revision of the programme for revalidation.

3.6.2 Test Analysis - The "80/80 Standard" Analysis:

This analysis was made to see whether the specific objectives of the programme have been attained. In this analysis '80/80 Standard' was taken to mean that 80 before oblique meant that class mean was 80 or more and 80 after oblique meant that every objective was achieved by 80 percent of students.
The analysis was done at two stages - small group testing stage and the field testing stage of the programme development. At individual testing level it was considered necessary to carry out analysis as at this stage programme was quite raw. Tables 3.10 and 3.11 present the analysis on the basis of 80/80 standard at small group testing and field group testing stages respectively.

3.6.2.1 "80/80 Standard" at Small Group Testing: Table 3.10 given below gives the analysis of responses at small group testing stage:

<table>
<thead>
<tr>
<th>No.of students</th>
<th>80% of the students</th>
<th>No.of items</th>
<th>80% of the items</th>
<th>Item Mean</th>
<th>Group Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>16</td>
<td>23</td>
<td>18</td>
<td>15.00</td>
<td>16.90</td>
</tr>
</tbody>
</table>

From Table 3.10, it can be observed that 80 percent of items in criterion meant to test objectives is 18 which is greater than group mean. So the programme is falling below the '80/80 standard'. In order to bring the programme to this level of measurement on the criterion test, modifications were required programme.

The programme was modified and revised accordingly and criterion test was again administered at the field testing stage.
to see the efficacy of the programme in accordance with the standard. The analysis of the criterion test carried out at field testing stage is given in the Table 3.11.

<table>
<thead>
<tr>
<th>No. of Students</th>
<th>80% of the students</th>
<th>No. of items in the test</th>
<th>80% of the item Mean</th>
<th>Group Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>32</td>
<td>23</td>
<td>18</td>
<td>33.80</td>
</tr>
</tbody>
</table>

From the Table 3.11, it can be seen that the class mean 33.80 of the programme is more than 32 (80% of 40). This satisfies the first condition of "80/80 standard" that the class mean should be eighty percent or more. The Table also reveals that group mean is more than 80 percent of the marks obtained by students on test items. This satisfies the other condition of the "80/80 standard" set for the programme validation against an external criterion measures.

The programme thus validated has been given in Appendix-I. This has been used as one of the treatment variables in the experiment.