CHAPTER III

DEVELOPMENT OF THE MATHEMATICAL PROGRAMME
Mathetics is an attempt to capitalise upon Skinner's (1954) approach while systematically striving to answer the basic questions: what ought to be taught, how, to whom and when? Indeed, Mathetics has been described as the technology of education, since it systematically plans the course of learning.

Mathetics was conceived by Gilbert (1962), as 'the systematic application of reinforcement theory to the analysis and reconstruction of those complex behaviour repertoires usually known as 'subject-matter mastery', 'knowledge' and 'skill'. The whole approach is based upon the operation of prescribing a mastery repertory'. A matheticist sees the basic problem of programme writing as:

- determining what steps a student must take in order to master a subject i.e. how to control the stimulus configuration present in the situation.
- arranging conditions so as ensure that the student will take these steps (i.e. how to reinforce him).

In essence, it systematises the succession of acts, duties and responsibilities, the sum total of which adds
upto the routine of programming. The principles of mathetics are derivative rather than novel; indeed its actual principles are few in number and they are taken almost literally from the science of behaviour.

Mathetics is not just another point of view about teaching and learning; it is an authoritative scientific technology. Mathetics if applied diligently, produces teaching materials that exceed the efficiency of lessons produced by any known method. Gilbert (1962) compared the mathetical exercises with the best available programmed materials and found that these programmes require twice to ten times as much learning time, five to thirty times as many exercises to cover the same subject matter, and the programmes result in poorer recall. The more difficult the material the greater the advantage gained by mathetics.

3.1. THE PROCESS OF MATHETICS

Mathetics is a production process consisting of five different stages. These are as follows:

- Task Analysis.
- Prescription.
- Development of the Domain Theory.
- Characterisation.
- Exercise Design.
3.1.1. **Task Analysis**

The first phase of writing a mathetic lesson plan, is to define as precisely as possible the real nature of the mastery behaviour that is being sought. In doing the task analysis for the programme to be developed all the elements of the topic are analysed in terms of their criticality to the learning behaviour required.

In the present study, the entire task has been analysed unit-wise, sub-unit-wise, concept-wise and sub-concept-wise. This has been detailed separately for the information and skill content under the captions 2.1, 3.1 and 2.1.3.2 in Chapter II. The tasks for teaching through linear and mathetical styles of programming have been kept strictly identical.

3.1.2. **Prescription**

Prescription is a description of the behaviours that constitute mastery in some subject-matter domain. The only behaviours made explicit in the prescription are those necessary to synthesize mastery performance. The behaviour repertory that the prescription represents is called the synthetic repertory.

The basic unit of the prescription is the operant, which consists of a single act of behaviour (R) together with its associated stimule condition (S). According to
A prescription is developed in a series of approximations. The first approximation (1st Px) describes every detail of the required behaviour, often in operants which are considerably smaller than the operant span. The extremely small size of these units ensures that no detail is overlooked. The 1st Px may be written with or without the help of an expert in the subject-matter.
The second approximation of the prescription is developed from the 1st Px and the details are successively refined by combining or collapsing operants until they approximate the known operant span of the student population. After completing the 2nd Px, the estimates are re-examined by the programmer. The complexity of the domain will determine the number of approximations necessary to produce a confident prescription; this approximation is called the Nth approximation Nth Px) containing sub-chains, multiple discriminations and generalisations.

The Nth Px does not necessarily represent the most efficient structure of mastery performance; more efficient descriptions can be discovered. Usually these are obtained by an analysis of how the tactics of presenting information can lead to a simplification of the task. The resulting analysis called a differential prescription (D - Px), is inserted in the synthetic prescription at appropriate places. For the present study, only the synthetic prescriptions arranged in chains were established by retrogression by the basic exercise model.

3.1.3. Developing the Domain Theory

A domain theory is produced for the purpose of supplying the student with a repertory of selective observing behaviour, a repertory that should increase his ability to generalise across the superficial details peculiar to single problems within the domain. The domain
theory is obtained by examining the synthetic prescription for common properties or generalisable structure. A domain gives context and framework to what has to be learnt, so as to increase the student's observing behaviour and make the new material meaningful. The purpose of this prescription is to:

- foster generalisation by helping the student to see through detail to the essential properties of a situation.
- increase retention by serving as a verbal prompt for the acts necessary to mastery.
- increase reinforcement by shortening the route to mastery.
- relate the behaviour involved in learning to the objectives of the student.

The following procedure given by Gilbert (1962) was adopted for developing the domain theory for the present study:

- All multiples were reduced to a single operant, the synthetic prescriptions were rewritten.
- The description of each operant was restated in its most generalised and non-substitutable form.
- All adjacent operants that had the same description were combined into a single operant.
The new prescription was started with the terminal operant and continued backwards through the chain until all the duplications were deleted.

For writing the statement all these descriptions were used in the final prescription.

The diagrammatic depiction of development of domain theory through synthetic prescription for a segment of MS programme is shown in Fig. 3.2. The figure shows the development of theory for the domain pertaining to 'Determination of Equilibrium Quantity and Equilibrium Price'. All the steps given by Gilbert (1962) starting with synthetic prescription, and going through the steps related with the description of each operant into a generalised form, combining of the adjacent operants into a single operant, crossing out of similar non adjacent operants and rewriting the prescription led to the development of domain theory for the segment in hand.

The same procedure was followed for developing the domain theory necessary for writing the mathematical exercises for other content units also.

3.1.4. Characterisation

The characterization is the most technical and difficult process in mathematics. Recognising chains and multiples in the synthetic prescription is not sufficient,
**FIG 3-21 DEVELOPING A DOMAIN THEORY FROM THE SYNTHETIC PRESCRIPTION.**

**Domain:** Determination of Equilibrium Quantity and Equilibrium Price.

### SYNTHETIC PRESCRIPTION

<table>
<thead>
<tr>
<th>S</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Determination of Equilibrium Quantity and Equilibrium Price.</strong></td>
<td><strong>Draw and Label Axes.</strong></td>
</tr>
<tr>
<td>Draw and Label Axes and Curves and measure Variables on Axes</td>
<td><strong>Measure Quantity on X-axis and Price on Y-axis.</strong></td>
</tr>
<tr>
<td><strong>Combine Axes and Curves.</strong></td>
<td><strong>Find out Point of Intersection (P) of Demand and Supply Curves.</strong></td>
</tr>
<tr>
<td><strong>Draw Demand and Supply Curves and Label each.</strong></td>
<td><strong>Find out Equilibrium Quantity and Equilibrium Price on X-axis and Y-axis.</strong></td>
</tr>
</tbody>
</table>

### RESULTS OF STEP-I

<table>
<thead>
<tr>
<th>S</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Determination of Equilibrium Quantity and Equilibrium Price.</strong></td>
<td><strong>Draw the Axes indicating Variables measured on each along with drawing of Curves.</strong></td>
</tr>
<tr>
<td>Draw and Label Axes and Curves and measure Variables on Axes</td>
<td><strong>Draw the Demand and Supply Curves on the X and Y Axes.</strong></td>
</tr>
<tr>
<td><strong>Combine Axes and Curves.</strong></td>
<td><strong>Find out Point of Intersection (P) of Demand and Supply Curves.</strong></td>
</tr>
<tr>
<td><strong>Draw Demand and Supply Curves and Label each.</strong></td>
<td><strong>Find out Equilibrium Quantity and Equilibrium Price on X-axis and Y-axis.</strong></td>
</tr>
</tbody>
</table>

**CONTDD......**
CONTD...

RESULTS OF STEP II

S ----> R

Determination of Equilibrium Quantity and Equilibrium Price

Draw the Axes, Label them, indicate Variables measured and draw the Curves

S ----> R

Combine Axes and Curves

Find out Point of Intersection (P) of Demand and Supply Curves

Draw Perpendiculars on X-axis and Y-axis from point 'P'

Find out Equilibrium Quantity and Equilibrium Price

RESULTS OF STEP III

S ----> R

Determination of Equilibrium Quantity and Equilibrium Price

Draw the Axes, Label them, indicate Variables measured and draw the Curves

S ----> R

Combine Axes and Curves

Find out Point of Intersection (P) of Demand and Supply Curves

Draw Perpendiculars on X-axis and Y-axis from point 'P'

Find out Equilibrium Quantity and Equilibrium Price

CONT D.....
RESULTS OF STEP IV

Determination of Equilibrium Quantity and Equilibrium Price

Find out Point of Intersection (P) of Demand and Supply Curves.

Draw Perpendiculars on X-axis and Y-axis from point ‘P’

Find out Equilibrium Quantity and Equilibrium Price

RESULTS OF STEP V

Determination of Equilibrium Quantity and Equilibrium Price

Draw Perpendiculars on X-axis and Y-axis from Point ‘P’

Find out Equilibrium Quantity and Equilibrium Price
i.e. why more detailed characterising of the actual prescription is necessary. Four kinds of information given by Gilbert (1962) are sought in the characterization of a mastery prescription as detailed below:

**Generalisation Analysis:** It is a specification of those concepts or generalisations that must be established in order to teach the necessary behaviour.

**Competition Analysis:** It is a specification of any existing behaviours in the repertoire of the student which are likely to threaten or compete with the learning and retention of the new material.

**Interaction Analysis:** Competition is not without remedy. There are two general ways in which we can facilitate the strength of a new operant: (a) by induction and (b) by mediation. Facilitation by induction occurs when both the stimule and respule of the one operant possess elements in common with both the stimule and respule of the new operant. If the first operant is brought to strength, the second will gain strength by induction provided the respules are not incompatible.

**Mediation Analysis:** It is an analysis of the initial repertoire of the target population in order to determine what behaviours already exist which can be used to establish and maintain mastery. According to Dodd (1965) and Davies (1972), a good deal of research is now being carried out
in this area and various teaching strategies are now becoming associated with particular kinds of subject structure.

Davies (1972), regards the following statements typical:

**Chain:** The principle of chaining suggests that it is more often effective to teach the student the final or terminal act of mastery first, then the next-to-last act, and so on through the chain. The advantages of this backward or retrogressive teaching strategy, which might at first sight seem highly illogical, lie in the fact that reinforcement for the final act is end product mastery, each act has obvious face validity to the student, and each set is self-completing so that revision and consolidation problems are overcome. It should also be pointed out that retrogressive chaining places smaller strains on the short-term memory than does progressive chaining.

**Multiple Discrimination:** These ought usually to be taught together and not broken down over a series of didules. In this way, the student is forced to
see not only the associations between each stimulus and response, but also to observe the discriminations which are to be made. This type of presentation allows the student to make different, but highly competing responses to different, but closely associated stimuli.

**Generalizations:** These require that two different teaching strategies are adopted, first the student is taught to generalise within a class of stimuli, and then is taught to discriminate between this class and all other classes with which it is likely to become confused.

The net effect of using these strategies is to bring about the greatest behaviour change per unit of effort.

In the present study the following analyses were done after Gilbert (1962):

The generalizations for the content in hand were drawn unit-wise for both the programmes (I & S). The generalizations for the conceptual development of the content were not recorded here. The main thrust was to highlight only those salient generalities which were regarded as vital for the study. The details have been presented in Table 3.1.
**TABLE 3.1**

**GENERALIZATION ANALYSIS**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Generalizations</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Demand curve is negatively sloped.</td>
<td></td>
</tr>
<tr>
<td>- Supply curve is positively sloped.</td>
<td></td>
</tr>
<tr>
<td>I - Equilibrium quantity is determined on the X-axis from the point of intersection of demand and supply curves.</td>
<td></td>
</tr>
<tr>
<td>- Equilibrium price is found out on the Y-axis from the point of intersection of demand and supply curves.</td>
<td></td>
</tr>
<tr>
<td>- Equilibrium Quantity and Equilibrium Price are determined where demand is equal to supply.</td>
<td></td>
</tr>
<tr>
<td>- Demand curve shifts in the upward direction with the increase in demand.</td>
<td></td>
</tr>
<tr>
<td>II - Demand curve shifts in the downward direction with the decrease in demand.</td>
<td></td>
</tr>
<tr>
<td>- Price increases with the increase in demand.</td>
<td></td>
</tr>
<tr>
<td>- Price decreases with the decrease in demand.</td>
<td></td>
</tr>
<tr>
<td>- Supply curve shifts in the upward direction with the decrease in supply.</td>
<td></td>
</tr>
<tr>
<td>III - Supply curve shifts in the downward direction with the increase in supply.</td>
<td></td>
</tr>
<tr>
<td>- Price increases with decrease in supply.</td>
<td></td>
</tr>
<tr>
<td>- Price decrease with increase in supply.</td>
<td></td>
</tr>
</tbody>
</table>

Table 3.1 shows that there are fourteen major generalizations in each programme. The unit-wise distribution of these generalizations is 5, 4, and 4 for the Units I, II and III respectively.
The discriminations were worked out in respect of the following concepts and generalizations:

- Slope of demand curve and supply curve.
- Impact of increase in demand on price and that of increase in supply on price.
- Relationship of decrease in demand on price and decrease in supply on price.
- Equilibrium Quantity versus Equilibrium Price.

These generalizations and discriminations were worked out in instructional sequences necessary for mathematical presentation strategies. The process involved the presentation of the elements into chains which were retrogressive in format, an example of which has been illustrated in figure 3.2 for the synthetic prescription pertaining to 'Determination of Equilibrium Quantity and Equilibrium Price'.

3.1.5. Exercise Design

An exercise is a behaviour unit, and it is defined as all the material designed to establish a single new operant in the chain of mastery. The operant span is the basic element of behaviour change in mathetics, and in behaviour terms the span is a constant unit independent of both content and the repertory of the student. The operant span is the largest gain towards mastery that can
be produced in a single exercise.

Exercise design is the last formal writing task in the mathematical sequence and its aim is to produce as good an exercise as possible. All mathematical exercises have in common a limited and specific aim, their objectives is to:

- produce a new behaviour combination in the student.
- relate new behaviours to all other components of mastery.

Gilbert (1962) contends that students rarely fail to complete an exercise because they cannot make the correct responses; they fail because they cannot make mastery responses on the right occasion.

Although exercise writing is probably one of the most routine aspects of the art of programme writing, nevertheless, exercises must be carefully designed in order to:

- show the student the important things he should look for in a complex situation.
- demonstrate to the student what the master does when he sees these things.
- remind him to notice how he has changed the situation, and what he should do next.
The exercises must also give the students the necessary specialised language of the situation, so that they can use it to remind themselves of what they have to do whenever they become forgetful or confused. According to Pennington (1964) a programmer's job is to 'blend' the course content into an integral programme package.

3.1.5.1. Fundamentals of Exercise Design

The basic exercise model given by Gilbert (1962) for introducing a single operant can be schematised as:

$$(S^0 \rightarrow R^0). \quad S^D \rightarrow (S^I) \rightarrow R.$$  

The $S^0$ is a stimulus for an observing response, designed to get the student to observe the $S^D$. $S^I$ is a stimulus designed to produce the $R$, and it is usually a simple verbal instruction.

The observing stimulus ($S^O$) in the exercise model plays two roles, each representing fundamental properties of perception. $S^0$ directs the student's attention to $S^D$. The two components of $S^O$ are an attention-directing element ($S^a$) and an identifying element ($S^c$).

Suppose we wish to design an exercise to demonstrate a new operant, which we may symbolize $S^D_{n-1} \rightarrow R_n$. Two things
must be done to demonstrate this operant to a student. The elements of the exercise model will be as:

\((S^O - R^O) \cdot S_{n-1}^D\)

The exercise will have some attention getting and explanatory material \((S^O)\) that will lead the student to make the response of looking at and identifying \((R^O)\) the situation or stimulus \((S_{n-1})\) to which he will learn to make a mastery response.

The model of an introductory exercise will be:

\(S^O - R^O \cdot S_{n-1}^D - (S^I) - R_n\)

It indicates, get the student to observe \((S^O - R^O)\) the stimulus \((S_{n-1}^D)\) and instruct him \((S^I)\) to make the proper response \((R_n)\).

In drafting an actual exercise, it seems good practice to begin by designing and drafting the form or topography of the discriminative stimulus \((S^D)\) itself. It is seldom efficient to try to draft the whole exercise at once. As the discriminative stimulus will eventually form the focus of the exercise, it should be placed in a dominant position—often in the centre of the page. Once the \(S^D\) has been located the position and form of the response can be determined.
The observation and instruction stimuli should be kept as simple as possible. Normally they are located to the left and above the $S^D$, so that they are the first thing the student's eyes will fall upon.

Each operant needs to be presented and strengthened in the programme by means of three exercises, each of which has a distinct function and format.

For the present study the basic exercise model was followed in the writing of exercises for information and skill programmes. In the MI programme e.g. for exercise MI-1, $S^I$ i.e. the verbal instruction, designed to produce the response 'straight' is 'OB is not X-axis as it is not a horizontal straight line', observing $S^D$ i.e. 'X-axis is a horizontal straight line' is not sufficient, its identity in this particular context was to be recognised. That was done with the help of $S^O$ (observing stimulus). The attention directing element ($S^A$) of $S^O$ functioned through the blank given and the identifying element ($S^C$) functioned through the statement i.e. OA is X-axis as it is a horizontal straight line.

Similarly for skill programme in exercise MS-1, the $S^D$ i.e. drawing of X-axis and Y-axis and indicating the variables measured on each was observed with the help of $S^O$ which contained ($S^A$) i.e. the blank given with five
dots and a question mark and \((S^C)\) i.e. axes drawn — one in the horizontal direction and the other in the vertical direction. Here instead of verbal instruction, diagrammatic representation was given.

Similarly, other exercises for both the programmes were written taking the components of the exercise i.e. \(S^0\), \(S^D\), \(S^P\) and \(R\).

Demonstration Exercise

This is the first exercise in the sequence. It describes all the essential behaviours of mastery, using the language of the domain theory. Students are requested to follow the examples given and a description is given of the domain in the order or sequence required by mastery. The operant is initially introduced to the student in such a way so as to force him to look at and identify the stimule (i.e. observe) and then to instruct him so that he makes the mastery respule. Thus, proper stimule control is the primary objective of demonstration exercises. For this reason, several aspects of the stimule are treated in a routine way and should always be present in the exercise.

The \(S^D\) or discriminative stimule is the actual stimule which produces the required mastery respule. As the \(S^D\) can not always be presented per se, some verbal or pictorial representation of it may be used.
The $S^o$ or observing stimulus leads the student to make the response of looking at and identifying ($R^o$) the critical elements in the situation. The $S^o$ does two functions as discussed earlier.

The $S^i$ or instruction stimulus forces the student to make the correct mastery response to the discriminative stimulus ($S^D$) without making error in the presence of the $S^o$.

On the basis of above points 25 and 30 demonstration exercises were written for the MI (Mathematics Information) and MS (Mathematics Skill) programmes respectively. The number of demonstration exercises for the MI and MS programmes unit-wise is shown in Table 3.2.

**TABLE 3.2**

**DISTRIBUTION OF DEMONSTRATION EXERCISES UNIT-WISE IN MI AND MS PROGRAMME**

<table>
<thead>
<tr>
<th>Programme Type</th>
<th>Exercise Distribution (Unit-wise)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unit I</td>
<td>Unit II</td>
</tr>
<tr>
<td>MI</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>MS</td>
<td>8</td>
<td>11</td>
</tr>
</tbody>
</table>

**Prompt Exercise**

This is the second exercise repeating the performance of the demonstration. The students are prompted to make
the correct mastery respule in the presence of the most distinguishing characteristics of the discriminative stimule. The exercise prompt \( (S^P) \) is a device that makes possible an even clearer connection between two sequential operants, and it can serve as an additional self reminder to the student that one or another respule is correct. Some of the examples of this type of exercise are (MI-1, MI-9, MI-17 etc.) in MI programme and (MS-1, MS-8, MS-12) in MS programme.

**Release Exercise**

This is the last exercise in the sequence and its language is restricted entirely to that of the domain theory. No explicit prompt is given; instead the student's behaviour is freed or released to complete the sequence without help, although he may, of course, prompt himself to make the mastery respule. The number of release exercises in MI and MS is 25 and 30 respectively. The number of release exercises will be equal to that of demonstration exercises in a mathetics programme which in turn will be equal to the number of concepts taught. Some examples of release exercises are (MI-8, MI-16, MI-19) for the MI programme and (MS-7, MS-11, MS-15) for MS programme.

As each single operant is imbedded in a chain of operants, the usual strategy for dealing with a chain is observed, i.e., the chain is taught retrogressively.
This means the first exercise in the programme demonstrates the operant in the chain and prompts the last operant. The third exercise demonstrates the third operant and by definition in a simple chain sequence there must always be two more exercises than the total number of operants to be learnt. Diagrammatically it can be represented as shown in figure 3, for behaviour chain to be learnt
\[ S_1 \rightarrow R_2 \rightarrow S_2 \rightarrow R_3 \rightarrow S_3 \rightarrow R_4. \]

The method of retrogressive chaining was followed for the present study.

3.2. RESPULE DESIGNING

In designing respules for an exercise there are a number of difficulties. There often seems to be a widespread confusion about the actual nature of the respules that are required. However, the problem can be simplified by taking into consideration the properties as given by Gilbert (1962b) for respule designing:

- Respules must consist of either the actual act of mastery, or acts those will directly help establish and maintain this mastery behaviour.
- Respules must require minimal energy. Where covert respules rather than overt respules suffice, these should be preferred.
- Respules must require as little time to complete as possible.
FIG. 3.3 SKELETON OF MATHEMATICAL LESSON PLAN
(After Gilbert, 1962)
For the present study overt respules were asked for from the students which resulted in completion of the mastery act. The programmer preferred these respules as it was possible to observe the behaviour of the students with this type of respules.

3.3. PROVISION OF FEEDBACK

Auto-instruction stresses the importance of the student's checking his answers immediately after making them. It is assumed too uncritically that these answer checks constitute the student's reinforcement. Certainly he is reinforced by evidence that he has made a correct mastery respule.

It is not desirable to design the independent answer checks until all the exercises are in the first draft. There are no set forms which should be followed, but avoidance of distraction, clarity in language and ease of locating the self answer checks should be taken into consideration.

For the present study, the self answer checks for all the exercises were written on the left hand side column just opposite to each exercise.

3.4. EDITING AND EVALUATION OF THE PROGRAMME

According to Davies (1972) the purpose of the first draft is not to ensure that the students will experience success at every step. The first draft consists of
exercises that the ideal target population could seldom negotiate without help. Each operant in the prescription represents an estimate of largest behaviour change our target student is capable of making in a single-well-designed exercise—each operant is an estimate of the operant span. With experience the programmer is in a position to find out whether additional material should be included in an operant or not. It is better to exceed the span than to fall short of it. This is done due to the fact that the try-outs will easily show where the span is exceeded, but if the student negotiates the exercise successfully it is difficult to know how far it is short of the span. Therefore in the beginning, each exercise will include a little too much material. It is part of the function of try-out to indicate how much to shorten the span of an exercise.

3.4.1 Try-Out Procedure

The try-out is a systematic procedure. Since every word and drawing in the exercise has a known function, the purpose of the try-out is to evaluate how well each of these functions is satisfied and to discover any necessary modifications.

An exercise can require modification for any combination of the following reasons:

- The material designed to function as $S^0$, $S^T$, $S^P$ have an effect on the student unlike, and
possibly competitive with the effect desired.

The operant span has been exceeded; the student is required to make too large a step in the direction of mastery.

For all the variety of behaviours that the students will display during a try-out, there appear to be only seven classes of behaviour (Gilbert, 1962). Four of these behaviours (designated Type I) are almost certain indices of defect in the programmes; the other three (designated Type II) do not necessarily indicate important defects but they can be of considerable value in differential diagnosis. The seven indices of defect are:

TYPE-I

(i) Failure to complete a mastery response.
(ii) An erroneous attempt to make a mastery response, and the editor is unable to account for the response that is made.
(iii) An erroneous attempt at a mastery response, and the editor can make a confident judgment that the response is made to some irrelevant property of S^D.
(iv) An erroneous attempt at a mastery response, and the editor can make a confident judgment that the response is to a well established competitive response.
(v) The student evidences hesitation, perplexity, or repetition in reading.

(vi) The student evidences boredom, fatigue, and other signs of loss of interest.

(vii) The student fails to follow the proper sequence intended for the components of the exercise.

Table 3.3 summarizes the seven indices of exercise defect and the kinds of defects they are typically associated with.

**Table 3.3**

<table>
<thead>
<tr>
<th>Indication of probable Exercise Defects</th>
<th>Factors frequently defective</th>
<th>Factors most frequently defective</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>2.</td>
<td>3.</td>
</tr>
</tbody>
</table>

**Type-I: Mastery Response**

(a) Fails to make mastery response

(b) Unaccountable error in mastery response

(c) Error in mastery response judged to be caused by irrelevant property of sD

(d) Error in mastery response is judged to be a well conditioned competitive response

(Contd. on next page)
Table 3.3 (Contd.)

<table>
<thead>
<tr>
<th>1.</th>
<th>2.</th>
<th>3.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type-II: Other Responses</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(e) Hesitation, perplexity, Repetition in reading and excessive time</td>
<td>$S^A, S^C, S^I, S^P$</td>
<td>LO</td>
</tr>
<tr>
<td></td>
<td>OS, Q</td>
<td></td>
</tr>
<tr>
<td>(f) Prolonged signs of irritation, Fatigue, or loss of interest</td>
<td>Q</td>
<td>OS</td>
</tr>
<tr>
<td>(g) Does not follow intended sequence</td>
<td>$S, Q$</td>
<td>$S^C, LO$</td>
</tr>
</tbody>
</table>

The various symbols used in this table are explained below:

- **LO** = Defective layout
- **OS** = Operant span has been exceeded
- **Q** = Quotation variability (variance associated with temporary factors operating on the student)
- **$S^A$** = A stimule directing the student to attend to $S^D$.
- **$S^C$** = A stimule directing the student to identify $S^D$.
- **$S^I$** = Instruction stimule.
- **$S^P$** = Exercise prompt.
- **R.S.** = Specialised mediators.

For the present study the programmes were tried out at three stages viz., Individual testing stage, small group testing stage and field testing stage.
3.4.2 Individual Testing

The purpose of the try-out was to discover what changes were necessary in the exercises. At this stage both the programmes (MI and MS) were tried over a group of four students (two boys and two girls) selected at random from the T.D.C. Part I Class of Govt. Degree College, Simla. The students were told that they were there to help the programmer evaluate the programme and find ways of making these exercises more effective. No specific instructions about the programmes were given to the students at the outset. The programmes were self instructional. The student was asked to open the programme (MS) and do what it expected him to do. The student was asked to place a sliding paper on the left hand side column as in this column correct respules were given. When the student responded to one exercise, he was asked to slide down the paper and see the answer to that particular exercise. After completing the MS programme, the same student was provided with the MI programme which was written on the cards. Only one card at a time was given to the student. When the student gave the respule on the respule sheet, he was asked to invert the card and see the correct respule. This way
both the programmes were given to all the four students. The order of presentation of MI and MS programmes is given in Table 3.4.

**TABLE 3.4**

**SEQUENTIAL PRESENTATION OF MI AND MS PROGRAMMES AT THE INDIVIDUAL TESTING STAGE**

<table>
<thead>
<tr>
<th>Students</th>
<th>Type of Programme</th>
<th>Type of Programme</th>
</tr>
</thead>
<tbody>
<tr>
<td>One boy &amp; one girl</td>
<td>MS</td>
<td>MI</td>
</tr>
<tr>
<td>One boy &amp; one girl</td>
<td>MI</td>
<td>MS</td>
</tr>
</tbody>
</table>

Table 3.4 reveals that the students who were given MS programme initially, were given the MI programme afterwards and the students who worked with the MI programme in the beginning were provided with the MS programme latter.

The reactions of the students were noted. The details of the mistakes committed by the students are given in Table 3.5.
### TABLE 3.5
Types of Mistakes Committed by the Students in ML and NS Programmes at the Individual Testing Stage

<table>
<thead>
<tr>
<th>Programme Type</th>
<th>Type of Error</th>
<th>Exercises-wise Errors in Units</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>a</td>
<td>TYPE-I</td>
<td>3, 9, 10, 12, 19, 23, 47, 65, 62, 65, 76, 78</td>
<td>152, 163, 169, 172, 184, 192, 199, 240</td>
</tr>
<tr>
<td>b</td>
<td></td>
<td>3, 9, 19, 23, 43, 59, 62, 80</td>
<td>102, 115, 139</td>
</tr>
<tr>
<td>c</td>
<td></td>
<td>10, 12, 47, 65, 78</td>
<td>152, 172, 192, 199, 240</td>
</tr>
<tr>
<td>d</td>
<td></td>
<td>9, 10, 23, 62</td>
<td>172</td>
</tr>
<tr>
<td>e</td>
<td>TYPE-II</td>
<td>3, 9, 19, 23, 43, 59, 62, 80</td>
<td>163, 169, 184</td>
</tr>
<tr>
<td>f</td>
<td></td>
<td>3, 12, 19, 65, 76</td>
<td>152, 192, 199, 240</td>
</tr>
<tr>
<td>g</td>
<td></td>
<td>10, 23, 47</td>
<td>172, 240</td>
</tr>
</tbody>
</table>

**Total** 48, 33, 25, 106

(Contd. on next page)
<table>
<thead>
<tr>
<th>Programme Type</th>
<th>Type of Error</th>
<th>Exercises-wise Errors in Units</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>TYPE - I</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>5, 7, 13, 23, 30</td>
<td>36, 39, 48, 52, 54, 65, 65, 65</td>
<td>68, 70, 84, 92, 95</td>
</tr>
<tr>
<td>b</td>
<td>23, 30</td>
<td>36, 48, 65</td>
<td>68, 70, 95</td>
</tr>
<tr>
<td>c</td>
<td>5, 7, 13</td>
<td>52, 54, 65</td>
<td>84, 92, 95</td>
</tr>
<tr>
<td>MS</td>
<td>d 5, 23, 30</td>
<td>36, 52, 54, 65</td>
<td>70, 95</td>
</tr>
<tr>
<td>TYPE - II</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e</td>
<td>13, 23, 30</td>
<td>48, 52, 65</td>
<td>70, 92</td>
</tr>
<tr>
<td>f</td>
<td>5, 7, 23, 30</td>
<td>36, 39, 48, 65</td>
<td>70, 95</td>
</tr>
<tr>
<td>g</td>
<td>13, 23</td>
<td>52, 54</td>
<td>84, 92</td>
</tr>
<tr>
<td>Total</td>
<td>22</td>
<td>25</td>
<td>12</td>
</tr>
</tbody>
</table>
Table 3.5 shows that the students committed Type I as well as Type II, errors in the MI and MS programmes at the Individual testing stage. Exercises 3, 9, 10, 12, 19, 23, 43, 47, 59, 62, 65, 76, 78, 80, (Unit I); 81, 87, 90, 92, 102, 115, 117, 139, 145, 147 (Unit II) and 152, 163, 169, 172, 184, 192, 199, 240 (Unit III) of the MI programme showed Type I errors. Here the students showed their inability to make the correct mastery resolute. The programmer tried to find out the reason for giving incorrect mastery resolute. In certain exercises it was due to irrelevant property of SD[^Exercises showing Type I (c) errors] and in some it was due to a well established competitive resolute[^Exercises showing Type I (d) errors]. In the exercises showing Type I (b) errors, the programmer was unable to account for the resolutes which were given. Out of the exercises showing Type I error, the exercises 3, 9, 12, 19, 23, 43, 47, 59, 62, 65, 76, 80, of Unit I; 81, 87, 90, 92, 102, 115, 117, 139, 145, 147 of Unit II and 152, 163, 169, 172, 192, 199, 240 of Unit III showed Type II errors. In the exercises showing Type II errors, the students indicated the signs of boredom and fatigue.

The exercises showing Type I and Type II errors were modified for defective lay-out. The operant span was reduced by increasing the number of exercises in different units for MI programme.
In MS programme, the exercises 5, 7, 13, 23, 30 of Unit I; 36, 39, 48, 52, 65 of Unit II and 68, 70, 84, 92, 95 of Unit III showed Type I and Type II errors. The distribution of errors for Type I (a, b, c, d) and Type II (e, f, g) is shown in Table 3. The exercises were modified for $S^A$, $S^C$, $S^T$ and $S^P$ for making corrections in the defective layout. The number of exercises was increased for reducing the operant span.

3.4.3. **Small Group Testing**

After making changes at the individual testing stage, both the programmes (MI and MS) were given to students at the small group testing stage. The number of exercises was increased from 80 to 97 for Unit I; 70 to 83 for Unit II and for Unit III, the number of exercises remained same i.e., 90, for MI programme. In the case of MS programme the number of exercises remained the same for Unit I and in Unit II it increased from 35 to 37 exercises, for Unit III, the increase was from 30 exercises to 38 exercises. The sample at this stage consisted of six boys and six girls of T.D.C. (I) Class of Govt. College, Simla.
At this stage the programme was given in cyclostyled form. Three boys and three girls selected at random from a sample of these twelve students were provided with the MI programme. And the other six students (three boys and three girls) were provided with the MS programme. The students were required to proceed according to the instructions for both the programmes. When the students completed the MI and MS programmes they were given the respective criterion tests. The order of presentation of the programmes and criterion tests was reversed after the completion of the post-test at this stage to ensure that every student worked with both the programmes (MI and MS). The details of the sequence of presentation of programmes and criterion tests is shown in Table 3.6.

**Table 3.6**

<table>
<thead>
<tr>
<th>Sex</th>
<th>Programme</th>
<th>Post-test</th>
<th>Programme</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys (3)</td>
<td>MI</td>
<td>CI</td>
<td>MS</td>
<td>CS</td>
</tr>
<tr>
<td>Girls</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys (3)</td>
<td>MS</td>
<td>CS</td>
<td>MI</td>
<td>CI</td>
</tr>
<tr>
<td>Girls (3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 3.6 shows how the programmes and the criterion tests were administered to the students at the small group stage of testing. To start with six students (three boys and three girls) were given the MI programme. At their completion of this programme, they were given the criterion test in information. Afterwards, they were given skill programme and were post-tested in skill content. The other group which also consisted of six students (three boys and three girls) was first given the MS programme and was tested for the skill content. This was followed by the administration of MI programme and then by the criterion test in information. Thus each of the two groups was instructed in both the forms of content, but the order of presentation of programmes was different. The criterion test were administered in accordance with the form of the content taught to the students.

Out of these twelve students only ten students (five boys and five girls) completed both the programmes and criterion tests. These programmes were evaluated by the investigator on the basis of the error analysis of the exercises. This error analysis is given in Table 3.7 for both MI and MS programmes.
TABLE 3.7
TYPES OF MISTAKES COMMITTED BY THE STUDENTS IN MI AND MS PROGRAMMES AT THE SMALL GROUP TESTING STAGE

<table>
<thead>
<tr>
<th>Programme Type</th>
<th>Type of Error</th>
<th>Exercise-wise errors in Units</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td><strong>TYPE - I</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>4, 7, 25, 30, 32, 80, 92, 95</td>
<td>101, 113, 115, 145, 158, 168, 169, 174, 179</td>
<td>192, 201, 210, 235, 242, 265, 269</td>
</tr>
<tr>
<td>b</td>
<td>92, 95</td>
<td>145, 158, 179</td>
<td>192, 242, 265</td>
</tr>
<tr>
<td>MI</td>
<td>c 4, 7, 30, 32, 80</td>
<td>101, 115, 145, 168, 174, 179</td>
<td>201, 210, 235, 269</td>
</tr>
<tr>
<td>d</td>
<td>4, 25, 80</td>
<td>145, 179</td>
<td>192, 210, 265</td>
</tr>
<tr>
<td><strong>TYPE - II</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e</td>
<td>80, 92, 95</td>
<td>145, 158, 174, 179</td>
<td>192, 242, 265</td>
</tr>
<tr>
<td>f</td>
<td>4, 25, 30</td>
<td>145, 168, 174</td>
<td>210, 235, 265, 269</td>
</tr>
<tr>
<td>g</td>
<td>7, 30, 32, 80</td>
<td>113, 115, 158, 168</td>
<td>201, 242, 269</td>
</tr>
<tr>
<td>Total</td>
<td>28</td>
<td>31</td>
<td>27</td>
</tr>
</tbody>
</table>

(Contd. on next page)
Table 3.7 (Contd.)

<table>
<thead>
<tr>
<th>Programme Type</th>
<th>Type or Error</th>
<th>Exercise-wise errors in Units</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>TYPE - I</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>5,7,21,23,24,</td>
<td>36,42,48,52,65</td>
<td>92,93,102,104</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b</td>
<td>5,21,30</td>
<td>42,48</td>
<td>92,102,104</td>
</tr>
<tr>
<td>MS</td>
<td>21,23,24,30</td>
<td>42,48,65</td>
<td>92,93</td>
</tr>
<tr>
<td>d</td>
<td>5,7,21</td>
<td>36,42,65</td>
<td>92,102,104</td>
</tr>
<tr>
<td>TYPE - II</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e</td>
<td>21,23,24</td>
<td>42,65</td>
<td>92,104</td>
</tr>
<tr>
<td>f</td>
<td>5,7,24,30</td>
<td>36,52,65</td>
<td>93,102,104</td>
</tr>
<tr>
<td>g</td>
<td>24</td>
<td>48,52</td>
<td>92,93,102</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

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Table 3.7 indicates that 24 exercises of MI programme showed Type I(a) errors for the three different units. Here the students could not complete the mastery respules. In eight exercises showing Type I(b) errors, the students tried to give mastery respules but these were wrong. The programmer was unable to account for the incorrectness of the respules which were made. Fifteen exercises showing Type I(c) errors and eight exercises showing Type I(d) errors for MI programme revealed the fact that wrong mastery respules were given due to irrelevant property of \( S^D \) and due to well established competitive respules. Type II (e, f and g) errors were made in ten, ten, and eleven exercises respectively for MI programme. Here the students did not follow the proper sequence intended for the components of the exercise. Table 3.7 shows that eighty six exercises of the Mathetics information programme depicted Type I and Type II errors. These exercises were revised and modified for defective layout by changing and rearranging \( S^C, S^A, S^P, S^I \). The number of exercises was increased in the Units I, II and III of the MI programme for reducing the operant span.

The later half of the Table 3.7 shows the mistakes committed by the students in MS programme at the small group testing stage. Fifteen, eight, nine
and nine exercises of the MS programme showed
Type I (a), (b), (c) and (d) errors respectively.
Type II (e), (f), and (g) errors were committed in
seven, ten and six exercises respectively of the
MS programme. TotaL number of all these sixty four
exercises was revised and modified for defective
layout. The number of exercises was increased for
all the three units of the MS programme so as to
shorten the operant span for getting correct mastery
repules.

3.4.4. Field Testing Stage

After modifying the exercises at the small
group testing stage, both the programmes were
presented to a group of forty students of T.D.C.
Part I Class of Govt. Degree College, Simla. Ten
boys and ten girls selected at random from this
group were provided with the MI programme and the
other group of twenty students (10 boys and 10
girls) handled the MS programme. Table 3.8 shows
the sequence of presentation of programmes and
criterion tests at the field testing stage.
Table 3.8 shows that in the first instance all the students were provided with the criterion tests (I and S). When the students completed these tests ten boys and ten girls were selected at random to be provided with the MI programme. It was called group A. When the students of group A completed the MI programme, they were tested for it by providing the CI. After the completion of CI, group A handled the MS programme and was finally given the CS. The other group B, consisting of ten boys and ten girls, after completion of both the pre-tests took the MS programme which was followed by CS for this group. After completion of both MS and CS, this group was given the information programme (MI)
followed by post-test (CI). Out of forty students thirty completed the full set of programmes and criterion tests.

Table 3.9 shows the number of exercises in both the programmes at each validation stage.

**TABLE 3.9**

**UNIT-WISE DISTRIBUTION OF EXERCISES IN BOTH THE PROGRAMME SETS AT EACH VALIDATION STAGE**

<table>
<thead>
<tr>
<th>Programme sets</th>
<th>Stage of programme evaluation</th>
<th>Total exercises in Units</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>Individual Testing</td>
<td></td>
<td>80</td>
<td>70</td>
</tr>
<tr>
<td>MI Small Group Testing</td>
<td></td>
<td>97</td>
<td>83</td>
</tr>
<tr>
<td>Field Testing</td>
<td></td>
<td>109</td>
<td>88</td>
</tr>
<tr>
<td>Individual Testing</td>
<td></td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>MS Small Group Testing</td>
<td></td>
<td>30</td>
<td>37</td>
</tr>
<tr>
<td>Field Testing</td>
<td></td>
<td>35</td>
<td>39</td>
</tr>
</tbody>
</table>
As it is clear from the Table 3.9 the number of exercises for the MI programme increased from 240 to 270 and then to 295 as we proceeded from the individual testing phase to the small group testing phase and finally to the phase of field testing. Similarly for MS programme the increase was from 95 to 105 and then to 118 exercises as the validation advanced through the aforesaid stages of programme development.

The number of errors committed by the students at the field testing stage is shown in Table 3.10.

At the field testing stage in the MI programme, twenty four exercises of Unit I, twenty exercises of Unit II and twenty five exercises of Unit III showed type I and type II errors. As is clear from the Table 3.10 certain exercises showed both type I as well as type II errors. Out of sixty-nine exercises for which wrong responses were given by different students, twenty exercises, showed type I(a) errors. Here the students showed their inability to complete the mastery responses. It was due to inappropriate $S^I$ and $S^P$. These exercises were revised for Instructional stimuli and prompts. The stimuli directing the students to attend
TABLE 3.10

TYPES OF MISTAKES COMMITTED BY THE STUDENTS IN MI AND MS PROGRAMMES AT THE FIELD TESTING STAGE

<table>
<thead>
<tr>
<th>Programme Type</th>
<th>Type of Errors</th>
<th>Exercises wise errors in Units</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>MI</td>
<td>a</td>
<td>14,19,25,42,57,97,103,108</td>
<td>137,142,155,191,194,195</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>25,57,103</td>
<td>191,194</td>
</tr>
<tr>
<td></td>
<td>c</td>
<td>14,19,42,97,108</td>
<td>137,142,155,191,194</td>
</tr>
<tr>
<td></td>
<td>d</td>
<td>19,97</td>
<td>191,195</td>
</tr>
<tr>
<td>MI</td>
<td>e</td>
<td>25,57,103</td>
<td>142,191,194</td>
</tr>
<tr>
<td></td>
<td>f</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>g</td>
<td>57,97,108</td>
<td>137,142,191</td>
</tr>
<tr>
<td></td>
<td></td>
<td>24</td>
<td>20</td>
</tr>
</tbody>
</table>

(Contd. on next page)
<table>
<thead>
<tr>
<th>Programme Type</th>
<th>Type of Errors</th>
<th>Exercises wise errors in Units</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>a</td>
<td>12, 24, 34, 35</td>
<td>37, 41, 59, 77</td>
<td>104, 111, 117</td>
</tr>
<tr>
<td>b</td>
<td>24, 34</td>
<td></td>
<td>37, 41, 71</td>
</tr>
<tr>
<td>c</td>
<td>12, 34, 35</td>
<td></td>
<td>37, 41, 59</td>
</tr>
<tr>
<td>d</td>
<td>12, 24, 34, 35</td>
<td></td>
<td>37, 41, 71</td>
</tr>
<tr>
<td><strong>TYPE - II</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e</td>
<td>34, 35</td>
<td></td>
<td>41, 59, 71</td>
</tr>
<tr>
<td>f</td>
<td>24, 34, 35</td>
<td></td>
<td>41, 71</td>
</tr>
<tr>
<td>g</td>
<td>34, 35</td>
<td></td>
<td>71</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>20</td>
<td>19</td>
</tr>
</tbody>
</table>
to $S^D$ were also taken note of. Eight exercises showed type I(b) errors. These exercises were revised and modified for defective lay-out and changes in the stimuli directing the students to attend to $S^D$ were also made. Fourteen exercises showed type I(c) errors and seven exercises depicted type I(d) errors. These exercises automatically got revised while revising the exercises for type I (a & b) errors as $S^I, S^P$ and $S^A$ were modified which were responsible for Type I (a, b, c and d) errors. Nine exercises showed type II(e) errors and eleven exercises were revised for type II(f) errors. None of the exercises showed type II(g) errors.

In the MS programme as the Table 3.10 indicates eleven exercises showed type I(a) errors. Out of these exercises certain exercises depicted type I(b) errors, others indicated type I(c) errors and a few were found unsuitable since the students gave responses to these exercises as they were obviously used to make Type II errors were shown in twenty-exercises. Seven exercises showed type II(e) errors, eight exercises
represented type II(f) errors, and five exercises depicted type II(g) errors. The MS programme was finally revised for defective layout and changes were made in \( S^A, S^C, S^I \) and \( S^P \) to remove type I and type II errors.

### Table 3.11

<table>
<thead>
<tr>
<th>Type of stage of programme</th>
<th>Percentage of Type of Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TYPE-I</td>
</tr>
<tr>
<td>Individual Testing</td>
<td>a 13.30 b 5.83 c 6.25 d 3.90 e 5.83 f 7.08 g 2.91</td>
</tr>
<tr>
<td>MI+ Small Group Testing</td>
<td>8.88 2.96 5.55 2.96 3.70 3.70 4.07</td>
</tr>
<tr>
<td>Field Testing</td>
<td>6.77 2.71 4.74 2.37 3.05 zero 3.728</td>
</tr>
<tr>
<td>MS Small Group Testing</td>
<td>14.28 7.61 8.57 8.57 6.66 9.52 5.714</td>
</tr>
<tr>
<td>Field Testing</td>
<td>9.32 6.77 6.77 7.62 5.93 6.77 4.230</td>
</tr>
</tbody>
</table>
Table 3.11 depicts the percentage of the types of mistakes committed at the Individual testing, small group testing and field testing stages for MI and MS programmes.

The percentage of a particular type of mistakes is showing the decreasing trend in the MI and MS programmes as we move from the individual testing to the small group testing and then to the field testing stage. In MI programme for type II(g) errors the percentage of mistakes committed by the students increased from 2.91 to 4.07 as we crossed from individual testing to small group testing stage. It can be attributed to chance factors alone as this percentage further got decreased to 3.728 at the field testing stage.

The decreasing trend of error-percentage in MI and MS programmes for Type I (a,b,c and d) and Type II (e,f and g) at three stages of validation is shown in figures 3.4, 3.5, 3.6, 3.7, 3.8, 3.9 and 3.10 respectively.

After making necessary modifications in the programme-sets for elimination of the errors in making the mastery respule, both the programmes were tried out again on a sample of thirty students of both the sexes of Govt. Degree College, Simla. The percentage of the types of mistakes committed by the students in MI and MS programmes is recorded in Table 3.12.
FIG. 3.4  TYPE I(a) ERROR PERCENTAGE IN MI AND MS PROGRAMMES AT THREE STAGES OF VALIDATION.
FIG. 3.5 TYPE I(b) ERROR PERCENTAGE IN MI AND MS PROGRAMMES AT THREE STAGES OF VALIDATION.
FIG. 3.6  TYPE I(c) ERROR PERCENTAGE IN MI AND MS PROGRAMMES AT THREE STAGES OF VALIDATION.
FIG. 3.7 TYPE I(d) ERROR PERCENTAGE IN MI AND MS PROGRAMMES AT THREE STAGES OF VALIDATION.
FIG. 38  TYPE II (c) ERROR PERCENTAGE IN MI AND MS PROGRAMMES AT THREE STAGES OF VALIDATION
IT - INDIVIDUAL TESTING
SGT - SMALL GROUP TESTING
FT - FIELD TESTING

ERROR PERCENTAGE

FIG. 3.9 TYPE II(1) ERROR PERCENTAGE IN MI AND MS PROGRAMMES AT THREE STAGES OF VALIDATION.
FIG. 3.10 TYPE II ERROR PERCENTAGE IN MI AND MS PROGRAMMES AT THREE STAGES OF VALIDATION.
Table 3.12 reveals that the error percentage for the various sub-types of type I and type II errors is quite low. The modifications made in the exercises thereafter didn't, therefore, warrant any repetition of the try-out cycle.

The programmes, thus developed, were used as tools at the experimental stage of the study and have been given as Appendices A_j and A_k respectively.