CHAPTER V
CONSTRUCTIONS OF THE PROGRAMMES

Programmed learning involves systematic analysis of the teaching-learning process. Development of programmed learning material (PLM), therefore, is a technical process involving minute scrutinisation of several aspects which, if done properly, will help the learner to achieve the criterion behaviour. Before the programmed learning material takes the final form, it has to undergo some well defined stages. Given below are steps that are to be followed for the development of the programmed learning material. (The tutors books are given in the Appendix).

DEVELOPMENT OF THE PLM

Development Process

A. Selection of the Topic.
B. Entering Behaviour - Pretest.
C. Terminal Behaviour - Post-Test.
D. Task Analysis.
E. Programme Style.
F. Writing Frames.

VALIDATION PROCESS

Individual tryout - Editing - Revision, Group
tryout - Editing - Revision.

The stages mentioned above are discussed in this chapter in the light of the PLM prepared by the investigator for the present investigation.

Selection of the Topic

There are certain topics and subjects which are very difficult to programme. It is not always possible that everything that can be taught can be programmed.

Lysaught and Williams proposed some criteria for selection of the topic as follows:

--- Programmer's own field.
--- Ease of the treatment.
--- Length.
--- Depressed level of learning.
--- Logical order of material.
--- Special students' need.

The investigator tried to fulfil all the abovesaid criteria for the selection of topic.

Programmer's Own Field

The investigator is M. Sc. with mathematics. The investigator is teaching the subject for more than twenty years in colleges and schools. The topics selected for branching programmes are mathematics units from standards
V, VI and VII - arithmetic courses.

Ease of the Treatment

In developing a programme, the programmer should start with as simple and as fundamental approach as possible. If the subject matter contains both simple and complex sub-units, it is desirable to choose one of the easiest at first and proceed with the more difficult ones.

The programmer took proper care of the abovesaid procedure and developed the programmes. The investigator had simplified the matter and one idea was presented in one frame.

Length

While programming a unit, the length of the material should be taken into consideration. It can be broken down into units and programmed as the schedule permits. The short units are desirable in programming. The difficult points should be programmed with moderate length.

The subject matter was divided into a number of parts and one idea was presented in one frame with moderate length.

Depressed Level of Learning

For a number of teachers, one factor that has strongly affected the choice of units to be programmed is
the depressed level of learning shown by many of the students who had been taught by current methods of instruction.

The programmer paid attention in the selection process of those units in his field of knowledge which were difficult to the students without ignoring the criteria of ease and length. The investigator prepared a sequence designed to meet the specific hard nuts in the topics. It was done successfully while preparing the programmes.

**Logical Order of Material**

In this study, the units were from mathematics, so the logical order of material is maintained in the development of the frames. One thing was there that the scrambled book was not smooth as the programmed textbook should be. That was only due to the nature of the material. There were some jumps from one topic to another topic according to the nature of the study.

**Special Students' Need**

Mathematics is considered as a difficult subject. So keeping in mind special needs of the students and difficult concepts, the programmes were developed.

Thus, the investigator has tried to fulfil all the above mentioned criteria for the selection of the topics.
Entering Behaviour (Pre-Test)

Before giving new learning material to the students, it is absolutely necessary for the teacher to know the level of previous learning of the students. Fry asserting the importance of previous learning says, "Previous knowledge influences learning, even though the previous knowledge is only vaguely related to the new knowledge being acquired."² (p. 97).

Entering behaviour is the beginning line from which the terminal behaviour is shaped. Entering behaviour shows the initial position of the students. Dececco described the entering behaviour as "the present status of the students' knowledge and skill in reference to a future status the teacher wants him to attain."¹ The statements of entering behaviour should be written in behavioural terms. So that it is easy to measure the pre-requisite behaviour through the pre-test. The performance of the learners of this test would decide whether they are eligible to take that programme.

In this investigation, the test of the school for the first term was considered as the pre-test. The performance showed by the pupils was the pre-requisite behaviour.

The entering behaviour for the present programme was stated as follows:
For Standard V

1. The students can state and recognize commutative law, associative law and distributive law.

2. The pupils know what is the identity element of addition and the identity element of multiplication.

3. The pupil can find factors of a given number.

4. The pupil can know what is composite and prime numbers.

5. The pupil can compute an example of L.C.M. and G.C.M.

6. The pupil can find out the base and index of the exponent.

7. The pupil can define line, line segment and Ray.

For Standard VI

1. The pupil can convert simple fraction into decimal fraction and vice-versa.

2. The pupil can explain percentage in terms of decimal.

3. The pupil can define profit and loss.

4. The pupil can define area of the rectangle and the perimeter of the rectangle.
For Standard VII

1. The pupil can define work, speed and time.

2. The pupil can know the formula for speed, time and distance.

3. The pupil can explain ratio and proportion.

4. The pupil can define partnership.

5. The pupil can explain share, stock and dividend.

Terminal Behaviour - Post-Test

Megar defines the terminal behaviour as, "...that which refers to the behaviour you would like your learner to be able to demonstrate at the time of your influence over him (the learner) ends." 4

The terminal behaviour statements induced the following important aspects:

1. They were stated in behavioural terms describing what the learner would actually do.

2. They describe the conditions under which the learner would be required to perform his action.

3. They specified the minimum level of performance expected from the learner.
The test on the terminal behaviour, known as criterion test or post-test, is devised to know whether the student, after completing the programme, has reached the acceptable standard of performance or not. The items on the post-test were derived from the framework of task analysis.

The items on post-test were based on the following aspects:

1. The stated terminal behaviours were translated into appropriate criterion term.

2. Post-test items were objective based.

3. The criterion item included appropriate instructions regarding the mode of response.

On the following page is given a table indicating the different concepts included in the post-test and the number of questions under each concept. It can be seen that the test items included different aspects, and can be said to have what may be called the content validity, in the language of test construction.
<table>
<thead>
<tr>
<th>Standard No.</th>
<th>Concept</th>
<th>Question No.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>Commutative law of addition</td>
<td>1 (1)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Identity element of addition</td>
<td>1 (2)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Identity element of multiplication</td>
<td>1 (3)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>G. C. M.</td>
<td>1 (4)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>L. C. M.</td>
<td>2 (c)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Fundamentals of exponents</td>
<td>3 (a)</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Basic concepts of line, ray and segment</td>
<td>3 (b)</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Finding out prime factors</td>
<td>2 (a)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Distinguishing between composite number and prime number</td>
<td>3 (c)</td>
<td>4</td>
</tr>
</tbody>
</table>
### TABLE 5.2
Content-wise Analysis of Post-Test of Std. VI

<table>
<thead>
<tr>
<th>Standard No.</th>
<th>Concept</th>
<th>Question No.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>VI 1</td>
<td>Computation of Decimal fraction</td>
<td>1 (1)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 (2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 (4)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Converting simple fraction into Decimal fraction</td>
<td>1 (5)</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Expressing percentage with the help of Decimal</td>
<td>1 (3)</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Profit and Loss</td>
<td>2 (3)</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>Definition of parallelogram</td>
<td>2 (3)</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>Definition of quadrilateral</td>
<td>2 (3)</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>Perimeter</td>
<td>2 (3), 3</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>Area</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

### TABLE 5.3
Content-wise Analysis of Post-Test of Std. VII

<table>
<thead>
<tr>
<th>Standard No.</th>
<th>Concept</th>
<th>Question No.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>VII 1</td>
<td>Work, time and speed</td>
<td>1 (1)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 (2)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Ratio, proportion</td>
<td>1 (3)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 (1)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Share - stocks</td>
<td>1 (4)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 (5)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>
The terminal behaviour of the programmed learning material on abovesaid topics was specified as follows:

Terminal Behaviour for Standard V

After going through the programme, the students would be able:

1. to define commutative law of addition.
2. to give examples of the law.
3. to define identity element of addition.
4. to define identity element of multiplication.
5. to find out G.C.M. and L.C.M. of given numbers correctly.
6. to define the base and power of the exponent.
7. to explain the concept of line.
8. to define line segment and can write with the proper notation.
9. to define ray and write with proper symbol of ray.
10. to find out prime factors of a given number.
11. to give difference between composite number and prime numbers.
Terminal Behaviour for Standard VI

After going through the programme, the students would be able:

1. to compute the decimal fraction.

2. to convert the decimal fractions to simple fraction correctly.

3. to convert the simple fraction to decimal fraction.

4. to explain what is profit and what is loss.

5. to compute examples of profit and loss.

6. to define parallelogram and recognize it.

7. to explain the meaning of perimeter.

8. to compute the examples of perimeter.

9. to work out the examples of area.

10. to explain the difference between area and perimeter.

Terminal Behaviour for Standard VII

The student would be able:

1. to define work.

2. to give formula for work.
3. to give formula for time, \( t = \frac{\text{Distance}}{\text{Speed}} \)

4. to define speed and give formula for speed,
\[ S = \frac{\text{Distance}}{\text{Time}} \]

5. to compute examples of speed, time and work.

6. to explain what is ratio.

7. to explain what is proportion.

8. to compute examples of ratio and proportion.

9. to distribute the amount proportionately among the partners according to the investment.

10. to explain what is share and what is stock.

11. to compute the examples on shares and stocks.

**Task Analysis**

To give description or the list of the task is not sufficient but what students are expected to do, is very essential. The concepts and sub-concepts were listed in order in which they were proposed to be taught, in view of the relations among the concepts.

Popham and Baker said:

"Among the most serious problems facing an instructor is the decision about what he should do to help his students to achieve his desired objectives. Certainly, the statement of explicit behavioural goals is a necessary pre-condition for planning effective instruction."
However, it is clear to any one whoever tried it that the statement of behavioural objectives does not solve the total requirements of the instructional design. A teacher still must have some way of identifying and ordering activities that will optimize his chances of being successful.

Task analysis includes analysis of all the activities that the pupils have to do during the instructional process. The detailed analysis of all the activities that the pupils have to do during the instructional process (the PLM) was done in the form of content analysis. It is presented in the form of a flow chart of content analysis. This flow chart indicates the kind of sequencing and ordering of the learning points and concepts as they would occur in the programme. (The flow charts are given on pages 85, 86 and 87.)

Programme Style

After describing and analysing the task and before writing the frames, it is necessary to decide which programme style will be adopted for the programme.

THE PROGRAMME STYLE ADOPTED IN THIS STUDY WAS "BRANCHING"

Branching Programme

Frame Writing

The present literature could not give any specific procedure about writing the branching programme. But the branching programme can be developed according to the characteristics and format of the branching programme.
The characteristics of branching programmes are as follows:

1. Each frame is of relatively bigger size.

2. A single question, usually of multiple choice type will be most probably asked at the end of a frame.

3. In order to answer the question, the learner has to arrive at an answer by seeing the relationship between one idea and the other and by filling up the gaps not fully expressed in the frame. Then, only he can select the correct alternative from the multiple choice.

4. Branching programme contains multiple choice of items where the student selects the response.

5. According to the alternative selected, the student will be directed to go to a particular page. If his response is correct, he goes to the next concept. If his response is wrong, he goes to remedial page wherein his mistake is partially or fully explained.

6. Errors are anticipated and made the best possible use by diagnosing them and by providing remedial instruction.
The investigator developed the branching programmes by dividing the concepts into manageable frames. One idea was presented in a frame with explanatory sentences. There were more than one sentence ended with a question based on the entire information of the frame.

Firstly, the prime path or main stream frames were written. In the main stream frames which were assumed to be known to the target population was omitted in order to make the frames as small as possible. The alternatives selected were such that the wrong choices could indicate the remedial material to be added. Most of the frames were supplied with two alternatives. Researches reported regarding the development of multiple choice programmes with two alternatives and four alternatives were equally effective. One of the Pressey's students, Servin investigated, "the relative validity of two items and four items responses to multiple choice questions. He found that the mean scores were almost equal in both cases and therefore, no more than two choices were needed, if the criterion for selecting the technique was the amount the student learned."\(^2\)

According to Markle, the prime path frames contained six parts:

1. The answer, the student chooses in the last frame.

2. The feedback or discussion of why the answer
was correct.

3. New information.

4. A question testing his comprehension of the new information.

5. Two or more alternatives answers to select form.

6. Page number to tell him where to go next for each alternative. 5

Thus, beginning stages for constructing a branching programme were the same as for a linear programme but it is more than a linear programme. Branching programme is a linear programme plus something. And this something is to give reason for correct choice or wrong choice. So this frame writing requires a different set of technique.

While preparing the wrong answer frames or remedial frames, it was assumed that the student failed in a genuine attempt to understand the concept and was entitled to further explanation.

In remedial frames, the remedial information was provided and the reason why the answer was wrong, was carefully explained for eliminating the misunderstanding.

Most of the pages of the scrambled book were divided into two parts A and B and the pages were scrambled
within the concepts.

**Editing**

The editing of branching programme is not the same as linear programme. The edit codes of linear programme were not applicable here. The editing of branching programme was done keeping two things in mind. First, a single idea developed in each frame and second the language level of the students kept in mind. And moreover, the remarks made by Peter Pipe regarding the nature of the questions at the end of frame were also followed in the editing process.

According to Peter Pipe, the question at the end of information should:

"(a) require the student to demonstrate his understanding of idea presented,
(b) contain the alternatives which represent reasonable choice,
(c) not test a possible misinterpretation.
(d) not centre around some trivial points."

In this study, after completing the draft, the investigator got them edited by an expert of the field, keeping above said principles in mind. Then, the matter was checked by the subject expert.

**Validation Process**

This process gives accounts of the programme that is successfully imparting the intended instruction. This process is divided in three chronological stages,
such as (a) the individual testing, (b) the group testing, and (c) field testing. But, the material prepared for this study had not passed through all these three stages, except the last stage.

The reasons are as follows:

1. The learners had already learnt the matter. There were no new concepts which they had to study.

2. The investigator was very careful for the language level of the students. There were six/seven words in a sentence. The explanatory sentences were quite simple.

3. The content was divided logically into small steps, one idea was produced in the frame.

Thus, the student can read the material that had to produce for diagnostic purpose and remedial material was supplied through branching frames.

While distributing the scrambled books to three classes, proper instructions were given. Throughout the experiment, there was no difficulty about reading of the subject matter. These scrambled books were successfully used as the instructional material.
References


FLOW CHART OF ARITHMETIC STD. V

COMUTATIVE LAW
NUMBER MULTIPLICATION OF ADDITION G x B = B x A.
ASSOCIATIVE LAW
G x (B + C) = (G x B) + C.
IDENTITY ELEMENT OF MULTIPLICATION 1 x A = A
IDENTITY ELEMENT OF ADDITION A + 0 = A.

COMPOSITE NO. DIVIDED BY 1, BY ITSELF AND BY ANY OTHER NUMBER NOT PRIME.

IDENTITY ELEMENT OF ADDITION IS 0 BUT NOT 1.

FACTORIZATION
12 = 2 x 2 x 3
1, 2, 3, 4, 6, AND 12 ARE FACTORS OF 12.

COMPUTATIVE LAW IT IS WRONG BUT IT IS ASSOCIATIVE.

ANSWER DISTRIBUTIVE.
EXPLANATION GIVEN FOR CORRECT ANSWER.

COMPUTATIVE LAW 1 x A = A.

MISTAKE IN FACTORIZING.
210 = 3 x 7 x 10.
CORRECT ANSWER IS EXPLAINED.

MISTAKE IN USING INDEX.
120 = 2^3 x 3 x 5.
CORRECT IS 2^2 x 3 x 5.

MISTAKE IN COMMON FACTORS.

A NUMBER WHICH EXACTLY DIVIDES A NUMBER IS A FACTOR. A NUMBER WHICH IS EXACTLY DIVISIBLE IS THE MULTIPLE.

LEAST COMMON MULTIPLE.
THE LEAST OF ALL THE COMMON MULTIPLES, WHICH IS DIVISIBLE BY GIVEN NUMBERS.

L.C.M. BY DIVISION METHOD IS GIVEN.

MISTAKE IN COMMON FACTORS IS.
NO = 10.

LEAST COMMON FACTORS IS.

MISTAKE IN CALCULATION.
WRONG ANSWER.

H.C.F. IS A NUMBER WHICH IS NOT DIVISIBLE BY ANY OTHER NUMBER.

MISTAKE IN THE CONCEPT.
H.C.F. FACTORS OF THE NUMBERS TO BE FOUND OUT.

H.C.F. AND L.C.M. IS.

L.C.M. BY DIVISION METHOD IS GIVEN.

MISTAKE IN CALCULATION.
WRONG ANSWER.

PRINT IS UNDEFINED.

NOTE: ☐ = main stream. ☐ = remedial frame.
**FLOW CHART OF ARITHMETIC STD. VI**

- **Percentage Out of Every Hundred**: In a ratio with 100 as a consequence, the antecedent shows the percentage.
- **Percentage is that Fraction of which the denominator is 100/12 Fraction with Two Decimal Places**.
- **Convert Percent in to Simple Fraction. A Means out of Every Hundred by 12/100**.
- **Decimal In to Simple Fraction and Simple Fraction In to Decimal Fraction 10/100 Are in Denominator**.
- **The Number in the Numerator is not the Decimal Fraction, Correct Thing Is 8 Placed**.

**One Decimal Place, 10 in Denominator, Two Decimal Places, 100 in Denominator Etc.**

**Multiplication of Two Decimals, Multiply as the Total Number of Decimal Places of the Multiplier and Dividend, Put the Decimal Point from Right to Left**.

- **0.039 Is Not 39/100. Explanation for Decimal Places**.
- **Mistake in Putting Decimal Point, the Procedure Explained**.

**Division of Two Decimals. While Dividing, the Antecedent Places of the Dividend is to be 000 Tracked From Decimal Places of the Divisor**.

- **Set Price (L.P.) Selling Price (S.P.) Profit or Loss = S.P. - L.P. Profit and Loss in Percentage**.
- **Mistake in Putting Decimal Place Like 0.3.90 = 0.39**.

**Area of Rectangle AS X BS. Meters, Perimeter of Rectangle AS BS (L.M.) Units**.

**Concept of Quadrilateral: Concept of Parallelogram Opp Sides Equal, Opp Angles Are Equal**.

**Rectangle Opp Sides Are Equal and Angles Are of 90° While in Parallelogram Angles Are Not of 90°**

**NOTE: 12 = main stream. @ = remedial frame.**
FLOW CHART OF ARITHMETIC STD. VII

WORK DONE IN PARTICULAR TIME-TIME TAKEN FOR A PARTICULAR WORK.
WORK GIVEN IN TERMS OF DAY EXAMPLE.

SPEED = D/T EXAMPLE BASED ON THE FORMULA, D = DISTANCE T = TIME.

MORE THAN ONE PERSON IN PARTNERSHIP PROFIT OR LOSS DIVIDED ACCORDING TO THE INVESTMENT.

DISTRIBUTION OF PROFIT AMONG THREE PARTNERS EXPLANATION, EXAMPLE.

CORRECT METHOD OF CALCULATION OF THE GIVEN EXAMPLE.

IN EXAMPLE, RATIO OF THE INVESTMENT IS NOT CORRECT MISTAK IN CALCULATION CORRECT METHOD OF EXAMPLE.

A SPEED PER HOUR IN EXAMPLE MINUTE IS NOT CHANGED IN HOUR CALCULATION OF THE EXAMPLE.

WRONG CALCULATION NOT CLEAR FOR HOW MUCH WORK HE DOES IN ONE DAY, CALCULATION.

IN CO-OPERATIVE SOCIETY, AT LEAST 10 MEMBERS, IN JOINT STOCK CO. LIMITED MEMBERS FIXED AND LIMITED.

IN JOINT STOCK CO. WHEN PRICE OF THE SHARES IS FULLY PAID SHARES CAN BE CONVERTED INTO STOCKS STOCK CAN BE SOLD OR PURCHASED IN FRACTION.

EXPLANATION OF DIVIDEND DIVIDEND IS TO BE GIVEN ON THE FACE VALUE OF A SHARE.

FOR INVESTMENT MARKET VALUE IS TO BE CONSIDERED.

STOCK IS CONVENIENT TO SHARE AS IT CAN BE SOLD/PURCHASED IN FRACTION BUT IT IS NOT THAT IT SOLD OUT QUICKLY.

HERE INCOME IS TO BE FOUND OUT USE THE FACE VALUE GIVEN CALCULATION OF THE EXAMPLE.

NOTE: 1. = main stream. 2. = remedial frame.