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DIFFERENT FORMS OF PROGRAMMED  
MATERIAL : THEIR NATURE AND  
RATIONALE

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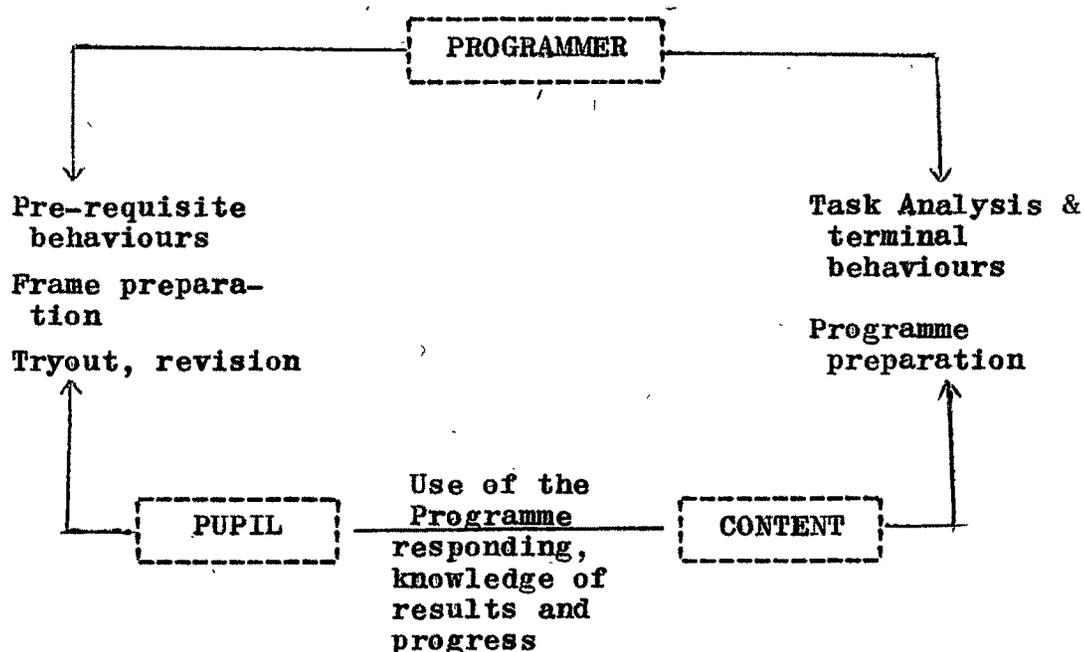
## CHAPTER I

### DIFFERENT FORMS OF PROGRAMMED MATERIAL - THEIR NATURE AND RATIONALE

In a traditional classroom most of us take learning processes for granted, without probing much into pre-requisite behaviours, transitional behaviours and the terminal behaviours of the learner. This happens due to the fact that the entire class is considered to be the unit of instruction, without attending much to the needs and abilities of an individual pupil. It is a truism that such a practice gives rise to frustrating experiences for the teacher and may even lead to sad consequences for the student. Learning the programmed way by its very implication presupposes the individual to be the unit of instruction wherein each student competes only against himself. This creates a need of providing stimuli and demanding responses on an individual basis according to the perceptions, needs and previous knowledge of the individual pupil. Thus, the distinguishing characteristic of the individualized programmes is the active role of the pupil. Wilt (1958) while mentioning the role of the pupil states:

He starts where he is, progresses at his own rate, has instruction according to his developmental and remedial needs, and is involved with the teacher in the evaluation of his own progress.

From the above, it can be seen that programmed learning material involves the programmer, the pupil and the content. Learning is made constructive as it involves the three main planes of interaction between the programmer, pupil and the content as shown below:



#### PARADIGM OF INTERACTION

Programmed learning is a pupil-centred approach in which the pupil is allowed to progress at his own pace. It recognizes his individual level with the help of the entering behaviour test and allows the student to learn according to his own speed. The pupil is provided with immediate knowledge of result(s) at each and every step. Such a feedback is very essential without which he has to gamble in the darkness leaving much learning to chance factors.

### Common Features of all forms of Programmed Materials

All programmes, whether linear or branching, presented through sophisticated electronic devices or through simple book formats, whether require overt or covert responding, have the following common features:

- i) They are based on specifically worded and definitely planned statements of entering behaviour and terminal behaviour.
- ii) They present systematically organized information and require periodical responses from the pupils.
- iii) They provide immediate feedback in the sense that they inform the pupil whether his response is appropriate or not.
- iv) They allow the pupil to work individually and to adjust his rate of learning and progress according to his abilities, needs and conveniences.
- v) They undergo extensive tryouts with individuals as well as with groups before the final version is ready.

### Educational Significance of Programmed Approach

One of the difficulties with a classroom teacher is that he cannot put questions on each and every point to each and every pupil. Also, he may not be very successful

in adjusting the lessons to the individual levels of each pupil there, because when he goes to the level of A, then B may find it too simple, while C may feel it awfully boring. All these led to the popularity of the Skinnerian and the Crowderian programmes supplanting, and not substituting the teacher.

In an ordinary classroom it becomes very difficult to provide the pupil with proper and immediate reinforcement. The useful reinforcement given after a terminal test is in the form of returning the answer scripts, probably with certain underlinings and remarks. Such a practice results in a considerable loss in learning which is attributed to the intervening period between the pupil's response and the knowledge of results. Programmed learning, on the other hand, provides immediate knowledge of results and even remedial materials in some cases.

#### Programme Forms

There are mainly two basic forms namely linear and branching programmes. Linear programme is the most frequently used one which displays a fixed sequence of teaching items or frames, and requires all the subjects to go through all the items. Branching form has been suggested as an alternative method which uses a variable sequence of items, allowing each student to branch off to remedial materials when needed. Of course, there are other forms of programming, like mathematics and so on. But programmes written in any form must have the aforesaid features.

## I Basic Linear Theory and Technique

The learning model used in linear programming is basically a conditioning model. It postulates that a desired change in behaviour, defined as learning, can best be brought about by inducing and then rewarding the desired behaviour.

The pupil is confronted with a series of stimuli, which, building from the presumed known or previously learned responses, cause him to emit new responses, the emission of the desired responses is rewarded by the pupil's knowledge of being right. Errors by students on a fully developed programme are so few that their occurrence may be neglected. In linear programming, the student's response is considered an integral part of the learning process; the response is induced in order that it may be rewarded and learning thus occurs.

In the field of programmed learning the work of Skinner stands out as an unique contribution paving a path for further probing into the nature of learning. The nature of reactions to Skinner's views are of two types - one comprising a set of programmers, appreciating the Skinnerian technique and enriching it and the other criticizing the technique and thinking of alternative techniques.

The statement of the Skinnerian technique of programming was produced by Holland in 1960. Holland (1960) suggested eight basis rules for programmers:

- i) Each response must be reinforced immediately.
- ii) Only overt responses, suitably reinforced, are learned.
- iii) Errors have an adverse effect on learning.
- iv) Progress must take place in small successive steps.
- v) Aids to the pupil (cues, prompts) should be withdrawn gradually (the technique called 'fading' or 'vanishing').
- vi) The pupil's observing behaviour should be controlled.
- vii) Extensive discrimination training is needed to establish an abstraction or concept.
- viii) The student must 'write' the programme.

The present day programmers are experimenting with the principles mentioned by Holland, like the role of overt response (rules 2 and 8), the role of small step (rule 4), the necessity of maintaining low error rate (rule 3) etc. The significant outcomes of this way of thinking resulted

in having different programme forms with the following frames:

- a) Covert response modes like 'thinking the answer' as against the overt response modes;
- b) using longer steps than the usual linear steps, and then branching into remedial materials of small steps, if necessary;
- c) being flexible about the occurrence of errors but treating the errors by way of reviews or repeating the missed frames etc.

a) Overt and Covert Responding

Most programmers following Skinner's method demand overt responding. That is to say, at every stage of learning the pupil is called upon to give an active response, either by writing an answer or carrying out some observable action, thus providing the teacher or programmer with feedback.

Leith has done considerable work on overt responding. According to Leith (1966), overt responding will be likely to succeed better than covert responding when

- a) new unfamiliar responses are to be acquired;
- b) difficult discriminations are to be made;
- c) learners are likely to be distracted from their task (e.g., if they must work in a noisy situation); and
- d) the sequence of materials provokes confusion (retroactive interference).

From the research of Leith and others, it appears that children below eleven years of age tend to learn and retain material better when asked to make an overt response. When pupils have sufficient background knowledge of a subject, overt responding is of less importance. Covert responding tends to be just as effective as overt in conceptual learning. Continuous active responding may, in fact, interfere with the learning process, more particularly with pupils of good academic ability who tend to become bored with continually writing answers when they could be progressing to the next frame.

#### Linear Programmes with Covert Responding

If the aim is to edit a programme in the process of its construction, there is no doubt that we need a record of the responses of students in order to see how far the response control is maintained and how far the student responses follow a particular sequence of learning. But once a standard of workable programme is achieved, one may try the programme without overt responding.

#### b) Other Possible Variations in Linear Programme

Although, usually in a linear programme there is only one path for a learner to go through, many linear programmers also use the techniques of asking students to go back to certain sequence of frames if he fails on some criterion frames. Sometimes students are also asked to skip some

portion of a programme depending on the previous mastery over that sub-topic. This is in a way the effect of branching style on linear programme. (A short account of 'skip programmes' is given in the later pages)

## II. Basic Intrinsic or Branching Programme

Intrinsic programming is not a theory about how education should be conducted. It is a technique for preparing written material that will accommodate quite a range of educational purposes. The technique is based on this simple act. The pupil's choice of an answer to a multiple-choice question (as in the scrambled book) can be used automatically to direct him to new material; the pupil who chooses one alternative can automatically be directed to a different material than that to which a pupil choosing a different alternative is directed.

In intrinsic programming, the questions serve primarily a diagnostic purpose and the diagnosis so made can be promptly utilized to furnish specific remedial material.

Hence, it can be noted that linear and intrinsic programming, while having some similarities, are different in approach, intention, and rationale. In short, the similarities are in terms of goals and the differences are in terms of paths.

a) Backward Branching

Backward branching is based on the principle of 'repeating the missed frames'. The student from frame No.1 of the main stream goes to frame No. 2 of the main stream only if he makes a correct choice. But if he makes a wrong choice, he is led to a remedial frame wherein he is given some more help in understanding the concept. He is then directed to the original frame No.1 so that he can read it again and answer it correctly in the light of the remedial material he has received.

b) Forward Branching

In the forward branching, whether the student makes a wrong choice or correct choice, he will always be going to new pages, thus physically progressing from page to page.

The student making a correct choice will go directly to the next frame of the main stream. But if the pupil makes a wrong choice, he goes to a remedial frame wherein his mistake is fully explained, probably followed by another parallel or identical question.

c) Mixed or Hybrid Programme of Branier Style

The Branier style is nothing but a combination of Branching and Linear styles aimed at providing remedial material in a simpler, step by step form. If the student makes a correct choice, to the multiple choice question

he is led to the next frame in the main stream. If he is wrong, he is led through the linear frames of the same concept. At the end of this linear series, the student is made to respond to another critical question. If he is able to respond here correctly, he is directed to the main stream. If he is still wrong, he is led to the first frame of that linear series again.

a. Skip Programmes

When we apply the principles of branching in the linear programme of small steps, we get another hybrid programme called skip programme.

At the beginning of each concept, one or two frames are given which are followed by a terminal frame. If the student is able, he answers this terminal frame in the light of the limited material presented in the earlier few frames. If the student is correct in this frame, he will go to the next concept, skipping over the further explanation of that point. If he is wrong, he continues through all the frames related to that concept and then takes the terminal frame. Then only he can go to the next concept.

## Illustration of the Format of Skip Programme

1	
2	
3	Question followed by multiple choice (a) . . . . . (b) . . . . .
4	If your answer is <u>a</u> , go to frame no.9. If your answer is <u>b</u> , go to frame no.5.
5	
6	
7	
8	
9	

Thus, as mentioned earlier, 'skips' are the alternative routes through the programme. Subroutes are incorporated to enable the slower student to proceed by means of smaller steps and simplified explanations.

As discussed earlier, the style of programme depends on the topic programmed, population for which it is programmed and other factors. Whether it is presented in a branching or linear style, requiring overt or covert responses, as long as it aims at taking the pupil to the terminal goals, it serves its function.

The focus of evolving the programme format is concerned with different programme characteristics like step size, role of overt response, role of errors etc. Regarding the features of programmes like - small steps, overt response in each and

every frame, knowledge of results on every frames, and the role of minimal errors etc., no final agreement is reached and the debate continues. This debate led to the construction of programme forms which do not have small steps (of course, it is very difficult to define what is really small and what is really large), which do not require overt responses, which do not give 100 per cent knowledge of results and which do not discourage errors and so on.

The thing that requires emphasis is that, whatever the programme format may be, it should be based on specifications of behaviours, tryout process, and evaluation of the programme. Thus, they are to be based on the analysis of entering behaviour, analysis of content and the analysis of tryout data.

A detailed description of the basic programme forms, used in the present investigation is given in the following pages. The investigator prepared and used seven different forms of a lesson on "THERMOMETERS".

DESCRIPTION OF THE SEVEN DIFFERENT  
FORMS OF THE PROGRAMME

In the present investigation the following seven different forms of the programme on "Thermometers" were used as experimental treatments.

- A. Linear Overt Form (Classical Skinnerian)
- B. Linear Covert Form
- C. Response Prompt Overt Form (Copying)
- D. Response Prompt Covert Form (Reading)
- E. Skip-programme Form
- F. Branching Form
- G. Hybrid Form (Branching-Linear Form)

The seven forms have certain commonalities. They are the pre-requisite behaviours, the transitional behaviours and the terminal behaviours, that is, all the seven forms have the same entering behaviour test, the criterion frames (exercises) and the criterion test.

The programme forms, however, differ on the following three main characteristics:

- a) Step size - small step/large step
- b) Route traversed - linear/branching
- c) Nature of response - i) answer given/answer not given  
ii) overt/covert  
iii) construct/multiple choice.

It should be noted here that though the term 'branching' is mostly used as a synonym to Crowderian form of programme, other forms like skip-programme or hybrid form etc., are also branching forms as they allow the pupil to take a route depending on his response to the multiple choice item; branching does not always mean the one with large steps; the principle of small steps can be entirely (skip-programme) or partially (remedial frames in a hybrid form) applied in branching programme.

The difference between the linear and the branching forms disappears if we have the cases of students making correct responses on all the frames thus, traversing entirely through the main stream frames or prime path frames. As this happens to be a rare possibility, the difference between the linear and the branching does exist.

Below is given the table describing the principles of programmed learning applied in the various forms of the programme.

TABLE NO. 4.1

PRINCIPLES OF PROGRAMMED LEARNING AND THEIR APPLICATION  
IN THE SEVEN FORMS OF PROGRAMME

Principles (1)	Applications (2)	Programme Forms (Remarks) (3)
1) Specification of goals	<ul style="list-style-type: none"> <li>a) Terminal Behaviours - Construction of Criterion Test</li> <li>b) Initial Behaviours - Construction of Entering behaviours test</li> <li>c) Hierarchy of the concepts and sequence of learning</li> <li>d) Construction of criterion frames (exercises)</li> </ul>	Common for all the seven forms
2) Individual Differences	<ul style="list-style-type: none"> <li>a) Self pacing</li> <li>b) Branching</li> <li>c) Skipping</li> </ul>	<ul style="list-style-type: none"> <li>a) In the two linear forms and the two response prompt forms students work at their own speed</li> <li>b,c) In the branching form, hybrid form and the skipping form, both the time and routes differ from individual to individual</li> </ul>

- |                          |  |  |
|--------------------------|--|--|
| 3) Active Responding     | <ul style="list-style-type: none"> <li>a) Construct - type of responses</li> <li>b) Multiple choice</li> </ul>             | <ul style="list-style-type: none"> <li>a) Mostly 'construct' in the two linear forms and answers are already given in the two response prompt forms</li> <li>b) Multiple choice in the branching, hybrid and the skipping forms, terminal frames in the skipping form</li> </ul> |
| 4) Spaced Learning       | <ul style="list-style-type: none"> <li>a) Small frames</li> <li>b) Rest pauses</li> </ul>                                  | <ul style="list-style-type: none"> <li>a) Small frames in the two linear, two response prompt, skipping form and the remedial frames of hybrid form</li> <li>b) Rest pauses are allowed in all the forms</li> </ul>  |
| 5) Knowledge of results  | <ul style="list-style-type: none"> <li>a) Immediate knowledge of results</li> <li>b) Telling the correct answer</li> </ul> | <ul style="list-style-type: none"> <li>a) In all the forms</li> <li>b) Correct answer in the two linear, two response prompt, and the skipping form. In branching, the reason is also given</li> </ul>   |
| 6) Shaping the behaviour | <ul style="list-style-type: none"> <li>a) Cueing</li> <li>b) Vanishing</li> </ul>  | <p>In the two linear forms, the skipping form and the remedial frames of hybrid form</p>   |
| 7) Research Orientation  | <ul style="list-style-type: none"> <li>a) Evaluation of the programme</li> <li>b) Editing</li> <li>c) Try out</li> </ul>   | <ul style="list-style-type: none"> <li>a) Common for all the seven forms</li> <li>b,c) Details may differ but the aims are the same</li> </ul>   |

Below is given a short account of each programme form. Sample frames are given at appropriate places in order to illustrate the characteristics of the frames. There may be slight variations from frame to frame of the same programme form, but consistency is maintained in a particular form to the maximum extent possible.

#### A. Linear Overt Form

It is the traditional Skinnerian programme containing frames of small steps and having blanks or questions. The response would be of construct type or of requiring the student to select one of the alternatives provided. The student is expected to write down his answer.

#### Illustration of Form A

13	Heat level or temperature of a substance can be measured scientifically using a thermometer. The instrument used to measure the _____ of a substance is called thermometer.
temperature	

#### B. Linear Covert Form

It is just the linear form described above, but it requires the student to think about the answer without writing it down.

Illustration of Form B

13	Heat level or temperature of a substance can be measured scientifically using a thermometer.
temperature	The instrument used to measure the _____ of a substance is called thermometer

C. Response Prompt Overt Form (Copying)

It is the same linear programme with answers given in the blanks so that the pupil is prompted with the answer(s) rather than required to construct the answer(s). The pupil is expected to copy down the word or answer given in the blank.

Illustration of Form C

- 
- 5 (a) Temperature indicates the heat level of a substance.
- (b) When the heat level is high, we say that the temperature is high.
- (c) When the heat level is low, we say that the temperature is low.
-

#### D. Response Prompt Covert Form (Reading)

This response prompt form differs from the one described above in the sense that the pupil would silently read the frames with answers, instead of doing any overt response like copying the answer(s).

#### Illustration of Form D

- 
- 5 (a) Temperature indicates the heat level of a substance.
- (b) When the heat level is high, we say that the temperature is high.
- (c) When heat level is low, we say that the temperature is low.
- 

#### E. Skip Programme Form

In this form each sub-concept starts with a terminal frame. If the pupil's response is appropriate, he will skip over some frames in between and will go to the next sub-concept. If his response is wrong, he is led to further elaboration of that point through the regular frames and then goes to the next sub-concept.

Forms A, B, C, D and E all contain small frames of linear type whereas form E, in addition, contains some frames like....

"If your answer is YES, go to frame No.68

If your answer is NO, go to frame No.72"

.... in order to direct the pupil according to his response.  
In this way skip programme form directs the pupil to branch  
off according to his response.

Illustration of Form E

17	Can Ram know the accurate temperature of a substance using a thermometer?  _____ (Yes/No)
18	If your answer is <u>Yes</u> , go to frame No. 20  If your answer is <u>No</u> , go to frame No. 19
19	Heat level or temperature of a substance can be measured scientifically using a thermometer.  The instrument used to measure temperature the _____ of a substance is called thermometer.
20	To measure the temperature of a substance we use an instrument called _____ .

F. Branching Form

This is the typical branching programme advocated by Crowder. Each concept is elaborated in a paragraph or two of about ten lines, and is followed by a terminal question of multiple-choice type. Each alternative is provided with a different page number which should be followed by the pupil according to his choice. If his choice is not right, he is led to remedial information and then asked to re-read the original page again. Here the pupil is expected to write down his choice.

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Page 6-A

Your answer was:

Ram concluded that by touching water in the beaker B, its exact temperature could not be known. You are right.

By touching we can just know whether a substance is hot or cold. But its exact temperature cannot be known. To measure the temperature of a substance scientifically we need a thermometer.

Can we know the accurate temperature of a substance by using a thermometer?

	Page
Yes	3
No	7-A

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Page 7-A

Your answer was:

The accurate temperature of a substance cannot be known using a thermometer. Is it really so?

By touching, we cannot know the exact temperature of substances. In order to know the exact temperatures, we have to use a thermometer.

Study the material on page 6-A.

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G. Hybrid Form - (Branching Linear Form)

Here the pupil who commits an error branches off to a series of linear frames wherein the concept is elaborated and explained. These remedial frames are just the regular frames of the linear overt form and the student would be answering each and every frame. The remedial sequence terminates with a direction leading to the next concept. This form also requires overt response i.e. writing down the answers.

Illustration of Form G

Page 6-A

Your answer was:

Ram concluded that by touching the water in the beaker B, its exact temperature could not be known. You are right.

By touching, we can just know whether a substance is hot or cold. But its exact temperature cannot be known. To measure the temperature of a substance scientifically we need a thermometer.

Can we know the accurate temperature of a substance by using a thermometer?

	Page
Yes	3
No	7-A

Page 7-A

1 By touching the tap water, Ram \_\_\_\_\_  
(could/could not) know its exact  
could not temperature.

2 Heat level or temperature of a  
substance can be measured scienti-  
fically using a thermometer.

The instrument used to measure the  
temperature \_\_\_\_\_ of a substance  
is called thermometer.

---

3      To measure the temperature of a  
 thermometer      substance we use an instrument  
 called \_\_\_\_\_ .

---

4      Can Ram know the accurate temper-  
 ature of a substance using a  
 thermometer?  
 \_\_\_\_\_ (Yes/No)

---

Write your answer and then read  
 the next frame.

---

5      If your answer is Yes, go to  
 Page No. 3.

If your answer is No, read the  
 above frames once again

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Forms A, B, C, D, E and G consist of frames of  
 small step (in G they are the remedial frames).

Forms A, C, E, F and G require overt responses i.e.  
 Writing down the answer while B and D require just think-  
 ing or reading the frames. And forms E, F and G consist  
 of branches according to the response made.

Below is given a comparative analysis of the seven  
 programme forms revealing the similarities and differ-  
 ences in terms of step size, nature of stimuli, nature of  
 response, role of errors, nature of knowledge of results  
 etc.

COMPARATIVE ANALYSIS OF THE SEVEN TREATMENTS

TABLE NO. 1.1.2

Sl. No.	Programme Forms	Step size	Construct/ Multiple choice	Mode of response	Expectation of errors	Knowledge of results	How errors are handled
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	Linear Overt	Relatively small	Mostly construct	Writing	Less errors	Only correct answer	Just correct answers shown; he then goes to the next frame
2	Linear Covert	Relatively small	Mostly construct	'Mentally thinking'	Less errors	Only correct answer	Just correct answer shown; he then goes to the next frame
3	Response-Prompt Overt Form (Copying)	Relatively small	Blanks filled, questions answered	Copying	Theoretically none	Only correct answer	Just correct answer given; he then goes to the next frame
4	Response-Covert Form (Reading)	Relatively small	Blanks filled, questions answered	Reading	Theoretically none	Only correct answer	Just correct answer given; he then goes to the next frame

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
5	Skip-programme	Relatively small	Mostly construct, multiple choice on criterion frames	Writing	Errors permitted to some extent	Only correct answer	At criterion frames, correct answer makes the pupil to skip some frames; wrong answer leads to further elaboration of the point
6	Branching Form	Relatively large	Multiple choice	Writing	Maximum use of errors	Correct answer + reason why it is correct or wrong	Remedial frames and back to original page/question
7	Hybrid Form	Large in main stream and small in remedial frames	Multiple choice in main stream and construct in remedial frames	Writing	Maximum use of errors	Only correct answer in remedial frames; correct answer and its reason in main stream	Remedial frames of linear type and forward to next main stream point

From the above descriptions and comparisons it is clear that the programme treatments are not very discrete variations, but rather points on a scale of simplex-complex dimension.

To sum, the seven different forms compared in the present investigation have been described in detail with illustrations. These seven different forms were used as the experimental treatments (independent variables) in the present investigation. It is thought that such a comparison of the relative effectiveness of different forms of programmed learning material in the Indian context would be a valuable addition to the existing stock of studies done in the field in India and abroad.

In the next chapter an attempt has been made to provide an overview of studies completed in the field.

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