In a developing country like India, there are problems connected with quantitative expansion of educational opportunities as well as the qualitative improvement in our educational programmes. We cannot accommodate the explosive student population within the conventional framework of our educational system. We are virtually forced to consider how we can use available resources more effectively and efficiently. In this modern age, technological development and explosion of knowledge will provide a new style of life for pupils. To meet the demands of education, new innovations in education can bring significant changes in our educational system.

The developments in Programmed Learning and Educational Technology are among the important developments in educational field which will increase the effectiveness of education and extension work in schools, colleges, industries, agriculture, etc.

What is Programmed Learning

Programmed learning, as is too well-known, is a pupil-centred approach in which a pupil is allowed to progress at his pace. It recognizes his individual level with the help of the entering behaviour test and allows the
pupil to learn according to his own speed. The pupil is provided with immediate knowledge of result at each and every step. Such a feedback is very essential without which he has to grope in the darkness living much learning to a chance factor.

Programmed learning may be described as a teaching system in its own right with its own science and techniques. Programmed learning is a teaching technique according to which the clear concept of a subject matter are clearly presented one by one. In other words, we can see that programmed learning is a planned process whereby the learner has to pass through certain planned steps of information with which he interacts in order to achieve the objectives of the course.

Mishra defines programmed learning as "a way of anticipating students' responses during the teaching-learning process and predesigning the entire gamut of learning experience to a predetermined set of specific goals or objectives." 17

Lysaught and Williams (1962) stated that "the programming is a process of arranging materials to be learned in a series of small steps designed to lead a student through self-instruction from what he knows to the unknown of new and more complex knowledge and principles." 13

So programmed learning is nothing but a self-study
device. The student has to read the material step-by-step and he has to read the material with his own capacity and he has to confirm whether he is right or wrong and this immediate confirmation is used as a feedback. This will strengthen the learning.

Programmed learning refers to self-instructional devices, through which the content to be taught is analysed and developed into programme, which is designed, taking into consideration a theory of learning, the nature of the student for whom it is designed. It includes capabilities of particular device to be used.

Programmed learning techniques is a very powerful tool for learning. Its logical steps accelerate the learning rate. It is an effective technique because it constantly interacts between student and his learning material.

Programmed learning affects the stimulus by acquainting the students with only one item at a time and by presenting the total number of stimuli in sequence that lead to greater understanding. It governs the response through instant checks of answers and through consistent immediate reinforcement of learning. Similarly, it closes the door to faulty information by denying reinforcement altogether and then helps students to rectify their errors through the medium of programme itself.

Programmed material is specially prepared material in which subject matter to be learned has been arranged
into a series of sequential steps or sections. These sections are known as frames. The content of the topic is divided into a series of units or frames. The learner is required to make response in each frame before he verifies the correct answer and proceeds to the next item or frame.

The form of frame is as under:

<table>
<thead>
<tr>
<th>C</th>
<th>A3</th>
<th>C</th>
<th>A4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response</td>
<td>Unit of information</td>
<td>Response</td>
<td>Unit of information</td>
</tr>
<tr>
<td>No. 2</td>
<td>B.</td>
<td>No. 3</td>
<td>B.</td>
</tr>
<tr>
<td>Question No.3</td>
<td></td>
<td>Question No.4</td>
<td></td>
</tr>
</tbody>
</table>

* Adopted from Poczer, Jerry, *The Theory and Practice of Programmed Instruction*, (1972, p. 55)

From the above, it is clear that each frame is divided into three parts - 'C' part of the frame is the response of the previous question. 'A' part of the frame is the unit of new information to be given to the student and 'B' part of the frame is the question on the section of the subject matter given in the same frame.

There are a number of frames in logical sequence among which the course content should be distributed. The principle behind this is that the knowledge is to be given in parts.
Programmes developed in any style, whether linear or branching have the following characteristics:

1. They are based on definitely planned criteria of entering behaviour and terminal behaviour.

2. They present systematically organized information and require periodical responses from the learners.

3. They provide immediate feedback in the sense that they inform the learner whether his response is appropriate or not.

4. They allow the student to work individually and to adjust his rate of learning and progress according to his abilities, needs and conveniences.

5. They undergo extensive tryouts with individuals as well as with groups.

Psychological Background of Programmed Learning

Programmed learning is a teaching technique. It takes the form of the practical application of laws established in accordance with rules of the scientific method. So, it is not out of the way to give the development of programmed learning since its beginning.

Experimental psychologists have derived a number of laws and theories of learning. The main principle
underlying can be stated in the following terms as principles of association or contiguity, connection of S-R bonds, law of effect, principle of drive reduction or need satisfaction, reinforcement strengthening, law of exercise or repetition or drilling, law of frequency, law of recency, principle of learning by doing or discovery, law of grouping or perceptual organization. These principles have to be operated with full recognition of individual differences, abilities and skills. Each learning theory has used different terminology and stresses for one or the other principle.

Thorndike has given three laws of learning, namely, law of readiness, law of exercise and law of effect. Pavlov emphasised his laws of conditioning, and extinction in his classical conditioning or stimulus learning. Tolman stressed cues in sign learning. Hull advocated for reinforcement in response learning and Skinner did so in his operant behaviour. Most of the behaviourists stress learning by doing, trial and error and discovery which are connected with movements as in S-R learning. Gestalt school emphasised insightful cognitive structure.

Now, let us examine the programmed learning through these psychological principles of learning theories.

The main principles used in programmed learning come from psychology of learning and psychology of individual differences.
Skinner was right in pointing out the constancy of theoretical premises from which programmed learning is derived. The maximum use has been made of the valid laws of behaviour. Any educational practice to be efficient and effective has to implement these principles.

From the analysis of the learning process in programmed learning, it is seen that the new technique in its operation utilizes maximally the three main principles from psychology of individual differences, viz. (1) selecting a response or making a response to a stimulus and thereby establishing connection or association, or in other words learning by doing, (2) principle of reinforcement or strengthening the connection, and (3) recognition of individual needs and individual differences.

Linear programming is a psychological discovery. Inclusion of correct response in the frame immediately following the stimulus question in the programmed learning is a direct application of a psychological principle of reinforcement postulated by Pavlov, Hull, Skinner and other behaviouristic psychologists and is a reformulation of Thorndike's law of effect. Reinforcement is a stimulus that increases the possibilities of recurrence of a response. With a human learner in an immediate knowledge of results of informative feedback after a response has been made is an important feature of linear programming. Correct response is much more helpful to future learning than a
failure or incorrect response. To reinforce correct responses is a psychologically sound for learning. To allow errors and then correcting them by punishment is not helpful for better learning. At the heart of any learning programme lies the practice of reinforcement. There is acknowledgement or reward of some kind to show that an organism has performed satisfactorily. Food and water supplied as reinforcers to lower animals can produce learning patterns among them as conditioned reinforcers such as token which can be exchanged for food, money, grades, prize or even knowledge of being 'right' serve as reinforcers to human learners. In programmed learning, correctness of learning behaves as reinforcers.

The essential nature of linear programming is operant learning. It tries to avoid errors by use of small steps and prompt responses.

**Historical Background of Programmed Learning**

It was in 1920s that S. L. Pressey of Ohio University, began his pioneering work in the field of programmed learning. But his work was not much appreciated at that time. So, the process of learning through programmed instruction did not make much headway until the early 1950s. In about 1954, B. F. Skinner, professor of psychology of Harvard University developed the programmed learning technique. Later on, in about 1955, Norman Crowder of the University of Chicago, was given a contract by the U.S. Air
Force for the training of technicians who were required to find faults in electronic apparatus. He developed branching programme.

In India, the movement of programmed learning started in early 1960s. In 1963, the NCERT started working on the development of programmed learning material and took up research studies pertaining to the efficacy of Programmed Learning Materials (PLM). By 1965, the Department of Educational Psychology and Foundation of Education in the NCERT, New Delhi, had already started disseminating the idea to the educationists, teachers, defence personnel, industrial workers, and others by arranging symposia, workshops, sequential training courses, etc.

In 1967, at New Delhi, the association of programmed learning was established. It has been registered as Indian Association for Programmed Learning (IAPL). The association organizes annual conferences on programmed learning at national level.

**Programmed Learning in School Teaching**

The educators believe that in the ideal learning situation all pupils should be actively and continually involved in the learning process. Normal classroom procedures generally do not provide this opportunities to the pupils. Most of the students are only passive learners. Whatever is said or done by the teacher in the class is
accepted wholly or partly by the pupils without any critical thinking or analyzing the information. Moreover, many pupils may be inattentive to what is being said or done in the class by a teacher. Thus, no proper motivation or reinforcement is being supplied. We never give confirmation that the student is right or wrong. On the contrary, we have to reinforce him at every step. In our teaching we compel our student to adopt uniform pace of learning. This discourages a fast learner and frustrates the slow learners. Programmed learning approach can remove many of the defects of conventional classroom teaching.

Many researches comparing programmed learning versus conventional methods of instruction found that programmed instruction is superior to conventional or traditional methods of instruction. Shah (1964), Sharma (1966), Desai (1966), and Mehta (1973) found in their studies that the programmed instruction is superior to conventional methods of instruction. Thus, programmed instruction can be utilized as an effective tool for regular classroom instruction.

The method of programmed learning can be effectively introduced for remedial teaching. In regular classroom instruction, if it is found that the student has trouble with certain topic, the programmed material will be useful for the remedy of his deficiency. There are some researches to support this idea. Joshi (1972) used
programmed material for remedial teaching for the first year degree students at Hyderabad, whereas Shah and Kapadia (1971) used programmed material for underachievers in Algebra among the students of standard VII in a rural area. Both these studies revealed that learning through programmed way helped the students to improve their achievement.

The method gives motivation for homework assignment. Programmes are helpful for the student who is absent in the class. If he is supplied with this material, he can make up the course by himself. Gotkin, through a study, done in Huntington, Long Island, with a spelling programme found that "students working at home, made gains equivalent to those who worked on the programme at school." 9

Programmed learning has been proved a powerful tool for revision work. Kulkarni (1964) and SIE (1970d) reported that: "students using programmed material for revision were significantly better than students who adopted other methods of revision.

Curriculum enrichment can be done by giving programmed material. For example, schools do not have time to give the pupils lessons on 'traffic rules', 'using telephone directories' or the use of 'railway time tables'. Programmed learning can be utilized for such learning.

Kulkarni reported in his article 'Educational
Technology in United States of America" that:

In 1963, 79 per cent of learners were using programmed material in book format, i.e., without any machine. The programmes were used mostly at the junior and senior high school levels and some even below the sixth grade. It is also interesting to note that over 40 per cent of the users tried out programmes with individual students or small groups of students. However, about 70 per cent of schools indicated that they were thinking of using into regular classroom instruction.12

Thus, we can see that programmed learning technique is a powerful tool for different kinds of classroom instructions.

**Types of Programmed Learning**

There are two types of programmed learning, one is the linear and the other is the branching. Skinner is the originator of linear programming and Norman Crowder is the originator of branching programming. Linear programming is the creation of psychological laboratory and the branching programming has been evolved at the time of training the technicians. "Mathetics" is also an other type of programming.

Now, we shall make a brief review of both the main styles.

(1) **Linear Programming**

The linear programme is also known as 'Skinnarian
programme*. This name is given as Skinner developed this type of programme.

The learning model used in the linear programme is the conditioning model. The desired change in behaviour can take place in the best way if the response is induced and then the desired behaviour rewarded. The linear programmes present a sequential development of the material. The material is presented in a very short frame with a blank or short question along with the adequate cues or prompt, to which a learner has to respond overtly. The correct response is presented to be marked and then to be tallied with learner's own response. If response is found to be correct he feels rewarded and thus the material is strengthened. Errors on frames are considered irrelevant and undesirable and their occurrence is restricted to a negligible number. This implies that the number of frames should be increased, all related concepts should be included, repetition should be done and adequate cues should be provided, Lysaught and Williams state: "a basic assumption of linear programme is that each stimulus should be designed to elicit the correct response by the students and that his own consideration of responses is an integral part of learning situation."13 The characteristic of linear programme is a single path sequence and in which all students read and respond to same material.

The basic elements of Skinnarian programme are:
1. Stimulus.
2. Response (likely to be correct).
3. Reinforcement (by learning correct responses).
4. Very small size of step from frame to frame.
5. Sequence of items which will, because of its gradual progression, be suitable for all students.

(ii) Branching Programme

This type having its roots in differential psychology, is primarily interested in using the students' responses to control the course of the programmed material presented to that particular student. This type is interested in the student's responses as the primary datum required to operate a branching programme.

In this style, the material is presented in a comparatively large size of frame, followed by a multiple choice question, with two or more alternatives, along with the page numbers written against them. After having selected the alternatives the learner is required to turn the page number given against the alternative where he is told whether he was correct and why he was correct. Then, he is presented the next bit of information. The learners may be directed to different streams according to their individual requirements. A bright learner with adequate prerequisites may finish the programme much earlier, by going through the main stream whereas a slow learner may be
branched to different remedial materials wherever he fails to respond correctly. At the end of remedial instruction, the student is instructed to return to the original question page to try once again. The student does not go to new learning material until he chooses the correct answer.

The 'serambled book' or 'tutor text' is the device to presenting the branching programme. It has its own speciality. The pages are randomly arranged, that is, page number given with answer choices and not consecutive or in obvious way. The advantage of this format is that the student cannot cheat by seeing the correct answer prior to selecting his own answer.

The basic elements of branching programme are:

1. Stimulus.

2. Response, which may be correct or incorrect.

3. Reinforcement is response followed by:

   (a) if student response is correct, reference to following item.

   (b) if student response is incorrect, additional stimulus/response leading to (i).

4. Relatively large size of step from frame to frame, with greater amount of new information in each frame.
5. Sequence of items, which, by allowing for points of difficulty within it, enables different students to follow a different path in learning the same material.

What is Diagnosis

According to Educational Dictionary by Good:

(a) Diagnosis is the procedure by which the nature of a disorder whether physical, mental or social, is determined by discriminating study of the history of the disorder and of the symptoms present.

(b) The determination of the characteristics and problems of individual students being counselled, not restricted to the pathological disorder or 'problem cases'.

Brueckner and Melby define educational diagnosis in the following words: "Diagnosis is the procedure used to identify or to determine the nature of deficiency or weakness."

In education, diagnosis starts with some educational backgrounds or difficulties which can be traced to some organic defect or improper teaching methods or low intelligence or other environmental factors such as economical, poor home environment, absence from school for many days, etc. In the second step causes of backwardness or educational difficulties are located and third step is remedial teaching.

McCall expresses the same view in the following
words: "The function of detailed diagnosis of the particular defects of classes or pupils is to locate the underlying causes of defects and to guide corrective measure."15

**Diagnosis in Classroom Teaching.**

Pupils differ in learning capacities and there are individual differences in the abilities and skills. Now, if a pupil is weak in a particular area of the subject, it will be difficult for him to progress further. The classroom teaching fulfils the needs of average students and bright students up to some extent. It is not possible to meet the needs of each and every pupil in a heterogeneous class. We are measuring the students by different methods such as traditional examinations, oral tests or achievement tests but we are not pointing out the weaknesses or weak points of the students. We are not able to inform students of the causes of weakness.

The weakness of the individual student can be traced out by the proper diagnosis and it can be removed by remedial teaching.

The process of diagnosis may be thought of in the following five steps:

1. Locating the pupils who are backward.

2. Locating the errors which pupils make in a particular subject.
3. Locating the causes of pupils' errors or weakness.

4. Suggesting the remedies to remove the weakness of the pupils.

5. Suggesting measures to prevent the errors.

**How Branching Helps in Diagnosis**

We have discussed, the nature of branching, and how it works in the process of learning. It makes assurance of learning by 'how and why' method. This technique is most effectively used for diagnostic and remedial purposes.

Now, let us see how it helps in diagnosing. We have divided the diagnosis procedures into five steps. Let us now correlate those five steps in the light of branching style.

Our first step is to locate the students who are backward.

The branching is one of the styles of programmed learning technique. Programmed learning is the self-study method in which we have to supply materials or 'serambled book' to each and every student while working with this material. While advancing, the student can know himself that he knows the thing or not. He can find out the difficult points for him.
The second step of diagnosis is locating errors which pupils make in a particular subject.

In intrinsic programming, it is assumed that the student will learn material from the programme because it is carefully broken down into logically ordered steps. Student response, therefore, primarily becomes a diagnostic tool rather than a learning device. So, at the time of selecting the alternative, the selection becomes diagnostic. It locates the error which pupil makes in a particular subject.

The third step in diagnosis is locating causes of pupils' errors or weaknesses.

In intrinsic programming, if the student selects wrong answer, he is directed to a particular page which is already written against the alternatives. There, he is supplied with the material showing why he is wrong. All the explanations are given for 'why' he is wrong. So the student finds causes for the errors which he has made.

So, we can see by above that diagnosis can be effectively done with the help of branching style.

**How Branching Helps Remedial Measure**

The fourth step is to suggest the remedies to remove the weakness of pupils.

In branching programme, if a student makes a wrong choice, he is led to a remedial frame wherein he is given
some more help in understanding the concept and in solving the problem by a better logic. Then, he is directed to original frame or main stream so that he can read again and answer it correctly in the light of remedial material, he has received. So the student who has committed error goes through the same frame twice, once before the remedial material and once after the remedial material.

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

The student who has made a wrong choice goes to remedial frame wherein his mistake is fully explained probably followed by another parallel question, from which he goes to next frame of the main stream. So, eventhough, he is wrong, physically he does not return to the original frame but progresses to a remedial frame which is more logical and simpler and joins the main stream. So, by backward and forward branching the remedial material is supplied.

Fifth step of diagnosis is suggesting measures to prevent the errors.

In branching programme, the student will be allowed to make a logical error, then, he will be told why his response was wrong and where he becomes confused. Then, he is presented with the problem-solving situation once more and asked to try again. In this manner, most of the logical errors are brought to the notice of the students. By this
way one can prevent the error.

Norman Crowder writes in his article "Intrinsic and Extrinsic programming" that:

When we focus attention on the students' response as the primary datum need to be operated our branching programme, rather than as a part of the learning process as such, we become aware that the question in our programme may serve a variety of different functions that require different types of questions. A routine question on a routine step in the programme should serve:

1. To determine whether the student has learned the material just presented.
2. To select appropriate corrective material if the student has not learned.
3. To provide desirable practice with the concept involved.
4. To keep the student actively working, and
5. To fill a desirable motivation purposes.

If we compare the steps of diagnosis and statements of Crowder, we can easily say that they are similar. Thus, we can say that branching programme is a fully developed system for the diagnosis and remedial tool.

References


22. SIE (Gujarat): To Find out the Effectiveness of Programmed Instruction as Revision Lessons, 1970a.