UNIT III

LESSON NO: 03 PROGRAMMED INSTRUCTION/LEARNING

Lesson Structure

3.1 Introduction

Dear students, Programmed Instruction or programmed Learning is one of the most innovative, highly individualized, systematic and very recent type of teaching-learning process. It is often referred as auto- instruction and is extremely useful for self

learning and equally beneficial for class room instruction as well. This type of Instruction actually started during the era of Aristotle and the process of Programmed Learning was for the first time practiced by Plato but this kind of Instruction could not progress due to lack of resources at that time. In 1954 James Howard and B F Skinner developed the Auto instruction Method which fashioned the base for Programmed Learning. For the first time in 1963 NCERT started the preparation of Material for programmed Instruction / Learning and sincere attempts were made for the use of programmed instructions in the class room and in providing programmed study material to the students of distance education. At present suitable self- instructional programmed materials have been prepared for different subjects and grades which are used by different students for self instructional Purpose. Programmed learning is extensively used in the teaching learning process of all those subjects which include practice and drill work and require logical and systematic study.

3.2 Objectives

Dear students, after reading this lesson, you should be able to:

- Discuss the concept and meaning of Programmed Instruction / Learning;
- Discuss the contribution of Skinner, Mager, Gilbert in Programmed Instruction;
- What are the fundamental principles of programmed Instruction;
- Understand different types of programmed Instruction
- Discuss the Research trends in programmed learning;

3.3 Background Information

We cannot understand the present day status of instructional technology without examining its early beginnings and the origins of current practice. Programmed Instruction was an integral factor in the evolution of the instructional design process, and serves as the foundation for the procedures in which instructional technology

professionals now engage for the development of effective learning environments. In fact, the use of the term programming was applied to the production of learning materials long before it was used to describe the design and creation of computerized outputs. Romizowski (1986) states that while Programmed Instruction may not have fulfilled its early promise, "the influence of the Programmed Instruction movement has gone much further and deeper than many in education care to admit" (p. 131). At the very least, Programmed Instruction was the first empirically determined form of instruction and played a prominent role in the convergence of science and education. Equally important is its impact on the evolution of the instructional design and development.

3.4 Origin of Programmed Instruction

Although attempts at processes resembling programmed instruction date back to the 1920s (Pressey, 1926), the actual term is probably derived from B. F. Skinner's (1954) paper, "The Science of Learning and the Art of Teaching," presented at the University of Pittsburgh's conference of Current Trends in Psychology and the Behavioral Sciences on March 12, 1954. Skinner's remarks reflected his reaction to a 1953 visit to his daughter's fourth-grade arithmetic class (Vargas and Vargas, 1992). Skinner (1954, pp. 90–91) argued that schools were unable to accomplish the type of teaching that eventually leads to original thinking because:

- Schools relied on aversive stimulation or control; as Skinner described it, children worked to "avoid or escape punishment."
- Schools did not pay attention to the contingencies of reinforcement.
- Schools lacked a systematic plan for learning skills, or, in Skinner's words, "a skillful program which moves forward through a series of progressive approximations to the final complex behavior desired."
- Schools too infrequently provided reinforcement.

Skinner suggested a systematic plan—or programmed instruction—as the vehicle to accomplish the changes that needed to occur in classrooms, and in his description of that plan he made two statements that illustrate the importance of instructional design and its relationship to technology. He stated that "education is perhaps the most important branch of scientific technology" (1954, p. 93), and "in the present state of our knowledge of educational practices, scheduling [of behaviors and consequences] appears to be most effectively arranged through the *design* of the material to be learned" (p. 94, emphasis added). Skinner was at the forefront in articulating the need to accomplish this scheduling of behaviors and consequences and a program for effective and efficient learning through *operant conditioning.* Operant conditioning is a form of conditioning that reinforces desired behavior and it is this behaviorist theory that forms the basis for programmed instruction.

During the 1950s, educators and psychologists became concerned that the mass schooling precipitated by increasing demands on public education were not meeting an individual's needs for personal attention in the learning process, and they suggested that teaching machines could restore the "important features of personal instruction" (Skinner, 1986, p. 103). Additional teaching machines were introduced in the 1960s, largely as a result of the success of programmed instruction. A variety of simple machines were introduced, including Skinner's teaching machine, the Porter device, the Bell device, the punchboard, the Subject Matter Trainer by Briggs, the Arithmetic Machine by Skinner and Zeaman, and the Polymath by Rothkopf (Ysewijn, 1993).

During the 1970s and 1980s, as the first computers were being placed in the classrooms of many schools, behavioral theories became quite popular. Advances in programming and computer technology also spurred the popularity of programmed instruction by making it possible to teach a wide range of topics and skills. During this period programs for nearly every topic covered in a traditional school curriculum (i.e., math, science, language arts, social studies) were written for a variety of teaching machines (which eventually gave way to the personal computer) (Chen, 2006).

Programmed instruction is now generally considered to be one appropriate instructional approach among many, and most appropriately utilized in conjunction with a variety of other instructional methods.

3.5 Meaning of Programmed Instruction

Programmed instruction / learning simply means learning performed or instruction provided by a teaching Machine or programmed textbooks. In order to understand the meaning of programmed instruction we will through light on some definitions of programmed instruction put forward by different scholars:

Smith and Moore (1962): Programmed instruction is the process of arranging the material to be learned into a series of sequential steps, usually it moves the students from a familiar background into a complex and new set of concepts, principles and understanding.

Leith (1966): Programmed is a sequence of small steps of instructional material (called frames), most of which require a response to be made by completing a blank space in a sentence. To ensure that expected responses are given, a system of queuing is applied and each response is verified by the provision of immediate knowledge of result. Such a sequence is intended to be worked at the learners own pace as individualized self instruction.

Jacobs and et al (1966): Self-instructional programmes are educational materials from which the students learn. These programmes can be used with many types of students and subject matter, either by themselves, hence the name "self-instruction" or in combination with other instructional techniques.

Espich and Williams (1967): Programmed instruction is a planned sequence of experiences, leading to proficiency in terms of stimulus responses relationship, that have proven to be effective.

Susan Markle (1969): It is a method of designing a reproducible sequence of instrumental events to produce a measurable and consistent effect on the behaviour of each and every acceptable student.

Gulati and Gulati (1976): Programmed learning, as popularly understood, is a method of giving individualized instruction, in which the student is active and proceeds at his own pace and is provided with immediate knowledge of results. The teacher is not physically present. The programmer, while developing programmed material, has to fallow the laws of behaviour and validate his strategy in terms of student learning.

Owing the above definitions we came to the conclusion that Programmed instruction / learning is a systematically planned, empirically established and effectively controlled self-instructional technique for providing individualized instruction to the learner through logically sequenced small segments of the subject matter by using the principles of operant conditioning and schedules of reinforcement.

3.6 Principles of Programmed Instruction

The fundamental principles of a good programmed learning strategy are as under:

1. **Principle of Small Steps:** It is a well known fact that a learner learns better it the content matter is presented to him in suitable small steps. Therefore, in programmed instruction the subject matter is divided into sequenced and meaningful very small steps called frames, which are presented to the learner one at a time for responding.
2. **Principle of Active Responding**: In Programmed Instruction a learner is provided information in frames and he is supposed to be very active in responding to the individual frames as the learner is provided only one frame at a time and is allowed to proceed further only on completing the previous frame, thereby keeping him active and meaningfully busy throughout the programme.
3. **Principal of Immediate Reinforcement:** The learner understands better when he is motivated to learn by receiving the information of the result just immediately after

responding, which is also in accordance with the psychological phenomenon of reinforcement in learning. In programmed instruction it is important to provide immediate results of individual frames so that the learner will get appropriate reinforcement in time.

4. **Principle of Self-pacing:** The concept of programmed Instruction has actually emerged on the concept of providing learners an opportunity to learn at their own pace. The programme should be prepared keeping in view the principle of self-pacing**,** so that the learner can respond and move from one frame to another according to his own speed of learning.
5. **Principal of Student –testing:** In programmed learning as the learner gets the results of his learning while the process of learning which provides him continuous evaluation of his own learning. In this process the learner has to leave the record of his own response because he is required to write a response for each frame on a response sheet. This detailed record helps in revising the programme and acts as a source for studying and improving the complex phenomenon of human learning.

3.7 Types of Programmed Instruction

Programmed Learning / instruction can be broadly divided into following types on the basis of researches and experimental studies in the field of programmed instruction:

1. Linear or Extrinsic Programming
2. Branching or intrinsic Programming
3. Mathetics programming
4. Ruling System of programming

The first three types, Linear or Extrinsic Programming, Branching or intrinsic Programming and Mathetics programming represent the actual Programmed Instruction;

the Ruleg system of programming is just the extension of Linear or Branching programming.

Linear or Extrinsic Programming:

B.F. Skinner (1955), is considered the founder of this type of programmed instruction. It is directly related with his theory of "operant conditioning" and is based on the assumption that human behaviour can be shaped or conditioned gradually, step by step, with suitable reinforcement for each desired response. Consequently, in this programming, the instructional material is sequenced into a number of meaningful small steps, called frames. These frames are presented to the learned in the arranged sequence, one at a time. The learner is required to respond actively at each step. Immediately after responding, the learned is given information about the correctness of his response. It reinforces his behaviour and he may be motivated to learn the next frame in the arranged sequence. By proceeding from one step to another, the learner may be able to acquire the desired learning experiences.

This type of programming is referred to as 'linear' as the sequence of frames and path of learning in this programmed learning is systematic and linear. (As shown in the Fig. 3.1) Here all the learners have to proceed through the same frames and in the same order. The whole instructional procedure is well controlled. However, this control is quite extrinsic exercised by the programmer and so, the linear programming is also referred to as extrinsic programming.

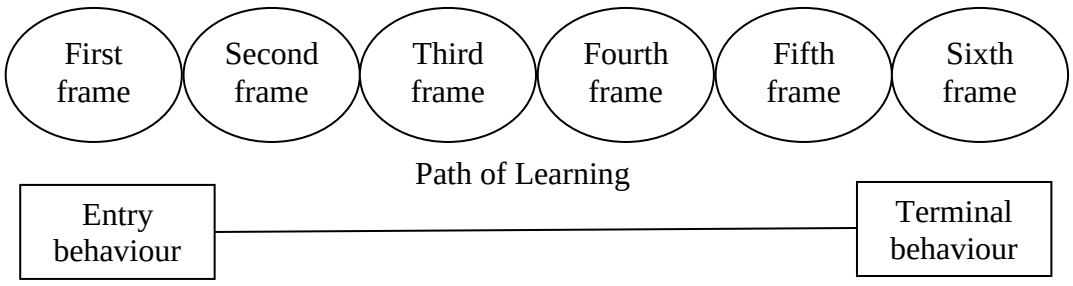

Figure 3.1 Arrangement of frames in liner programming

Normally the learner makes only correct responses and only positive reinforcement, if the learner does not respond correctly to a particular frame, he may be required either to repeat the frame or be acquainted with the correct response. In any case he is not allowed to move to the frame unless he responds correctly to the present frame.

Example: Our Digestive System

Frame 1

The Mouth is an important organ of our Digestive system. The other parts of the system are esophagus, stomach, small intestines, large intestines, rectum and anus. The mouth, and stomach are responsible for digestion of the food, the small intestines help in digestion and absorption of the food and……..are responsible for absorption of water. The rectum helps in temporary storage of ……..

Response: Large Intestines; Wastes.

Frame 2

In addition to the organs of digestive system there are a large number of enzymes that help in the process of digestion, some of them are secreted by mouth, some by ……. and some others by the intestines. Besides there are some hormones which also aid in the process of……

Responses: Stomach; Digestion

In this manner, the students may proceed on their self-learning path by going from one frame to another arranged in a sequential and systematic way.

Branching or Intrinsic Programming:

Norman A. Crowder (1954), an American psychologist is credited for developing the branching programme of programmed instruction. In his own words, branching or intrinsic programming is one which adapts to the need of the students without a medium of an extrinsic device such as a computer, In contrast to linear programming; this style

provides an intrinsic arrangement in the sense that it is not controlled extrinsically by the programmer. Here, a learner is free to make decisions and is able to adapt the instruction to his needs. The basic assumptions underlying this style are as below:

1. When the learning material is presented in its totality or in the form of meaningful components or units, the learning gets better.
2. Learning takes place better if the students are made to learn on the pattern of traditional tutorial methods.
3. Due to the Student's exposure to the new material, basic learning takes place.
4. In a learning process, errors may occur. If an error occurs, it may be detected and corrected before proceeding further on the learning path the biggest advantage of branching programming is that the wrong responses do not necessarily hinder the learning of a correct response.
5. Learning takes place better if a learner is allowed sufficient freedom to take decisions for adapting the instruction to his needs.
6. Learning will be better if each response is used to test the success of the latest communication to the student and the testing is followed by remedial instruction.
7. Multiple-choice items help more in the learning process than the force choice single response items.

Based on the above assumptions, the procedure for branching programme may be outlined in the following way:

1. The size of the frames is quite large in branching programming than that employed in linear programming and instructional material is divided into 'units' of material called 'frames'. Much information, one or two paragraphs or even a page, is provided in a frame.
2. The learner is provided more than one choice while responding to the frames as he is required to respond to multiple choice questions associated with the

learning material of the frame. He has to discriminate and choose one right answer.

3. The learner moves forward if he answers correctly, but is diverted (branched) to one or more remedial frames if he does not. These frames explain the matter afresh, ask him questions to elicit the right answer and reveal his previous mistakes, and then return him to the original frame.
4. This cycle goes on till the learner passes through the whole instructional material at his own pace.

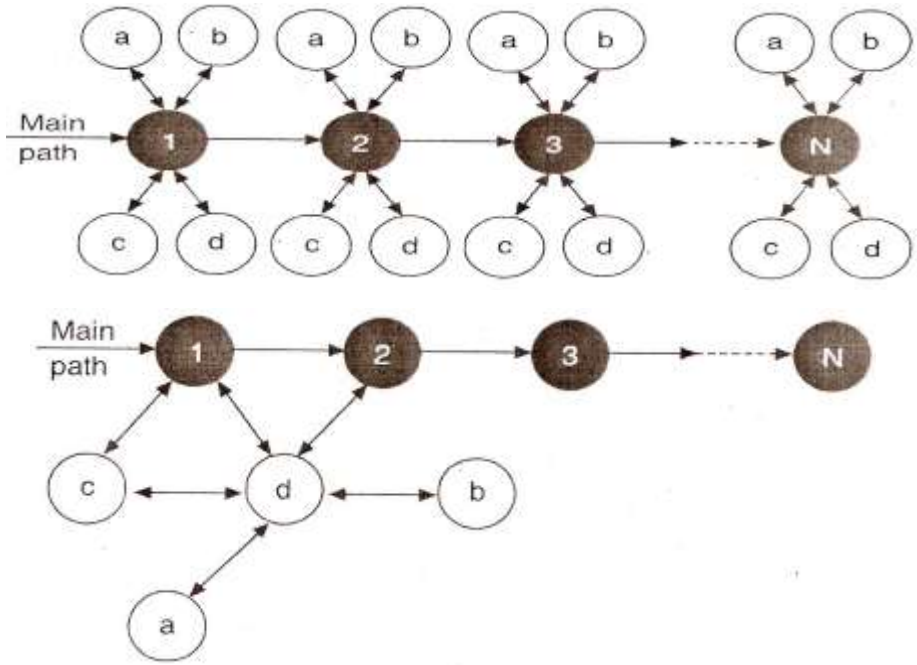

Figure 3.2 A diagrammatic representation of the main path and branching in branching programming.

Contribution of Skinner, Mager, Gilbert in Programmed Instruction:

In 1943, Skinner and his two other colleagues started programming by teaching a pigeon to roll a small bowling ball by operant conditioning. By 1954, Skinner and James G. Holland devised the auto instructional methods which have served the present

generation as basis for present work in programmed instruction. In Skinnerian programmed instruction whether mechanized or otherwise the learner is initially asked a question which he can easily answer correctly without any previous study of the particular lesson. The learner is taught by the sequence of questions. He is asked more and more as the lesson proceeds in very small steps.

Robert Mager (1958) gave a new concept known as "Learner Controlled instruction" which is a kind of Socratic dialogue in reverse, in which the learner led the instructor. The instructor remains silent until the learner himself stimulated the instructor with questions that suggested the needed illustrations, demonstrations, practice or some other help.

In 1962, T F Gilbert gave formalized expression of his technology of education called Mathetics. Latter a number of educational experts including Pennington further worked on Mathetics and they devised the methods of preparing lessons on the methatics.

3.8 Development of Programmed Instruction

The development of the programmed instruction material in the form of programmed text or computer-assisted instruction is a highly specialized job. The task involves the following main phases:

1. Preparatory phase (preparation of the programme)
2. Development phase (writing of the programme)
3. Evaluative phase (testing or evaluation)

Preparatory Phase

The preparatory phase occupies a very prominent place, in any scheme of the development of the programmed instructional material. It includes the planning and beginning. The experts of programmed instruction are of the opinion, that almost 25 per

cent time should be spent for the execution of the activities concerning this phase. In general, the following activities or steps are to be executed during this phase:

1. Assortment of the Content / topic or units to be programmed

The primary job of a programmer is that, he should concentrate on the wise selection of the topic or unit for his programming. The selection of the topic or content to be programmed should meet the following criteria

1. Is any programme already available on the topics?
2. What are the difficulties that the topic cannot be taught by other already available methods?
3. Does it allow developing a simple, logical and systematic programme quite interesting useful and suitable from the angle of the learner?
4. Does it suites to the curriculum needs of the learner?
5. Whether the teacher has got the required specialization on the subject.
6. Does it really help in curtailing the teacher's burden?
7. Does it allow for setting the real and useful objectives in behavioural terms and design a criterion test to measure the outcomes of the results of the programmed learning?
8. Is it within the economic conditions of the people concerned.

2. Describing the learners

The programme is meant for the learners. Therefore, a programmer should know and describe the characteristics of the learners in terms of their age, gender, socio-economic and cultural background, intellectual level, interest, general scholastic abilities, aptitudes, previous experience potential of learning, etc. For this purpose, he may take the help of his own experience cumulative record and various other testing devices, interest inventory, aptitude tests, intelligence tests, achievement tests, diagnostic tests, etc. and conclude about the characteristics of the learners.

3. Detecting objectives in behaviour terms

The programmer has to set the definite instructional objectives for deriving the desired results, these objectives should be stated clearly in behavioural terms, or he should state clearly the type and extent of the behavioural changes to be expected from the learners after going through the developed programme. It is this description of the terminal behaviour of the learners that is aimed at in writing the instructional objects. The minimum requirement is this regard are mentioned below.

(i) Initially, the programmer has to select the domain – cognitive, effective or psychomotor of the behaviour for which the behavioural changes are to be sought.

(ii) The programmer has to take decision about adopting a particular approach, such as Mager's, Miller's or R.C.E.M. for writing instructional objectives in behavioural terms. While the Mager's approach serves the purpose of cognitive and affective objectives, the Miller's approach is meant for psychomotor objectives, and the R.C.E.M. approach can serve the objective belonging to all the three domains of the behaviour. Each approach has its own taxonomy (system of classification) of education objectives.

(iii) For writing an objective of a particular domain, suitable action verbs or mental processes are picked up from the list of action verbs or mental processes format in relation to the particular topic or content portion to be taught. The objectives can be written in behavioural terms by combining action verbs (in the case of Mager's or Miller's approach) or mental process (in the case of the R.C.E.M. approach) with the content.

4. Entry behaviour of the learners

The objectives and their statements in behavioural terms point out the finishing point or terminal behaviour of the learners as a result of the given programmed instruction. However, one has to start with something for aiming to end with the terminal

behaviour. This starting point with respect to one's behaviour is called his entry behaviour – the initial behaviour. Before going through the programmed instruction, this behaviour – like terminal behaviour – to be stated in clear terms so that the programmer may be very much clear about the programmed instructional material developed by him. Here, one has to describe the behaviour of the learner in terms of the prerequisite knowledge, skills, interest attitudes, etc. as illustrated below:

Before going through the present programmed the learner is able to ……. Read/write/ define/observe/calculate/……. With ……. Efficiency or in …… circumstances.

5. Developing specific outlines of content

The course content to be covered through the programme are decided on the basis of basic assumptions about the learners, their entry behaviour, objectives to be realized in the form of terminal behaviour, and the courses of study prescribed to them by authorities like Boards of School Education, and Universities. At the planning stage, the programmer is supposed to develop specific outlines of the related course contents. The course content is developed on the basis his own experience and observation of the related course, analysis of the curriculum, and consultation and help from subject matter experts and experienced teacher.

After collecting the content material from the sources, the programmer may go ahead for preparing the outlines. This can be done in two ways: logically or psychologically Whereas logic demands systematic and orderly treatment of the subject, psychology advocates the arrangement that appeals to the basic interests and abilities of the learners. The programmer must try to organize the contents in such a way that it can suit both the purposes, i.e. logical and systematic treatment of the subject, based on the psychological requirement of the learners.

6. Designing the criterion test

At the planning stage, the programmer has to develop a criterion-referenced test to be administered at the completion of the programme for measuring its effectiveness in

relation to the realization of the specific instructional objectives. The criterion-referenced tests are not the same as the traditional achievement or non-referenced tests. Whereas the traditional achievement tests are designed to measure individual differences and aim at comparing individual performances, the criterion-referenced tests are designed to ascertain the effectiveness of programme or instruction by measuring the learner's performance on clearly defined educational tasks. Through the criterion tests, the terminal behaviour of the learner reached after the completion of the unit of a programme is assessed for ascertaining the extent to which the set objectives have been realized. While designing the test one should keep in mind:

(i) instructional objectives defined in behavioural terms should be well addressed in the test.

(ii) As far as possible, there should be at least two to three items for each instructional objective.

(iii) The programmer should acquire desirable competency and skill in the preparation of the objective test items. use the objective-type question is obligatory for make a test item.

(iv) The programmer has to see that items are free from any ambiguity or language and content and possess reasonable discrimination power as well as internal consistency It helps in avoiding repetition and elimination of useless or less useful items.

(v) The items as well as the accompanied instructions of the test must be able to create the necessary conditions or situations calling the demonstration of the students or terminal behaviour for the assessment of the realization of instructional objectives.

(vi) The programmer should try to establish the reliability and validity of the test. Reliability refers to a faith that can be put into a test and it can easily be verified through the test-retest method. The test may be repeated, and the extent to which the results are the same for the same individuals, the

test is said to be reliable. Validity refers to the accuracy behaviour of the test. A valid test should always measure what it aims to measure. Validity of the test can be achieved by carefully going through item analysis, seeing that every item serves the purpose for which it is being constructed and comparing the results of the test with some already well-established valid tests or criterion.

Development Phase

The development phase covers the actual writing of the programme. In writing the programme, besides taking decision about a particular style of a linear, branching or mathetics programme, the programmer takes all help from what is being done at the preparatory phase. The assumptions about the learner, his entry behaviour, the instructional objective fixed in the form of terminal behaviour, the outlines of the contents chosen, all are given due consideration while engaging in writing programme.

The writing of the subject matter as programmed instructional material differs much from the ordinary textbook writing. Here, the programmer has to follow the spirit and principles of programmed learning. The instructional material is to be broken into logically sequenced suitable small steps or segments of the subject matter called frames. These frames are so designed and sequenced that the learned remains meaningfully busy and active by responding to them, one at a time, faces minimum or no failure, gets immediate reinforcement by receiving information of the result immediately after responding, and is able to respond and move from one frame to another according to his own speed of learning.

In practice, the task of programme writing involves three steps, namely designing of the frames, sequencing of the frames and editing of the programme.

Designing of the frames

A frame represents the basic smallest unit of the instructional material that is to be presented to the learner at a time. It varies in size from a few words to a full page or more

(as in the case of branching programme). It has three different components, namely stimulus (for information presentation), response (for responding by learner) and reinforcement (knowledge of result in the form of answer) as illustrated:

Cement and lime used as building material are obtained from the mines. These are called minerals. The marble used in the construction of building is also obtained from the mines. The marble is a ……

In writing the frames for developing a particular programme, the programmer has to make use of certain special techniques like priming and prompting for helping the learner respond correctly and proceed successfully (with minimum error rate) from one frame to another.

Priming:

In the priming technique, attempts are made to pour the information into the minds of the learner for active responding in the way we pour in some water for drawing out water from a dry water pump. Let us now illustrate this technique with examples:

1. Cement and lime used as building material are obtained from the mines. These are called minerals. The marble used in the construction of building also is obtained from the mines. Kota stone also is obtained from the mines. Kota stone is a …..

   Response: mineral

2. The heavenly bodies once part of the Sun and now revolving around it on account of its gravity are called planets. The Earth, Mars and Jupiter are such heavenly bodies that were once the part of the Sun and now are revolving around it. These are called planets. Mercury and Saturn also are such separated heavenly bodies that are revolving around the Sun. These also are called …….

   Response: Planets

In the form of an extra stimulus is provided in the frame for helping the learner to respond correctly. Their use helps the learners in getting additional helping stimulus for responding to a given programmed material frame. It can be illustrated well through the following examples:

1. Cement and lime are such building materials that are obtained from the mines. These are called minerals. The marble used in the construction of building also is obtained from the mines. The marble is ……. Mineral.

   Response: a
2. The Earth, Mars and Jupiter, once happened to be a part of the Sun, are now seen revolving around it. These are called planets of the Sun. Mercury and Saturn also are similar heavenly bodies that revolve around the Sun. These are called the planets of the …… Response: Sun

Sequencing of the frames

The task of arranging the frames is some systematic order (on the basis of logical and psychological principles) to lead a learner form his entry behaviour to terminal is termed as sequencing of the frames. Usually, the following three approaches are employed for the sequencing:

1. Matrix approach
2. Ruleg approach
3. Egrul approach

In the **Matrix** approach, a matrix is prepared by putting the learning points and a major concept including sub-concepts, minor concept information points, etc. on one axis and the frames of the programme that lead to the behavioural change to the learner on the other axis. Thus, a glimpse on this matrix may reveal everything aimed and systematically covered through the frames.

In the **Ruleg** (rule + example) approach, deductive reasoning is employed in sequencing the frames. The fames putting or emphasizing rules or principles are given first. These are followed by examples frames depicting the meaning and application of the rule or principle.

In **Egrul** (example + rule) approach, inductive reasoning is employed in sequencing the frames. The frames employing examples are presented first, these are followed by the frames depicting rules or principles generalized through the previous example frames.

Editing of the programme

The first draft of the programme developed in the form of sequenced frames is subjected to a thorough review and editing process. This work is done at the following three levels in a hierarchical order:

1. Technical accuracy editing
2. Programme technique editing
3. Composition editing

In *technical accuracy editing*, the programme is thoroughly reviewed for the purpose of removing any technical inaccuracies in the subject matter. The help of some subject experts and the audio-visual or methodology experts may be taken for this purpose.

The *programme technique editing* is performed with the help of some experts in the field of programmed instruction, for removing any deficiency and inaccuracy in the technique of programme development including designing and sequencing of the frames, style and format of programming, and so on.

In *compositing editing*, the help is taken from some language expert to remove any inaccuracy and weakness from the language and composition point of view such as grammatical mistakes, spelling errors, inappropriateness of the language, and punctuation forms. The language of the instructions given to the learners in the programme should

also be checked and, similarly, the other important aspects such as length of the blanks, uniformity of the numbering system, placement of example and illustrations also should be thoroughly checked as to remove any discrepancies from the point of view of composition.

Evaluative Phase

The last phase of the development of the programmed instruction material, evaluative phase, is related with the try-out and evaluation of the edited programmed material available in the form of sequenced frame. With the help of activities undertaken in this phase, the programmer tries to test the efficiency and effectiveness of his programme and in the light of its results; he further tries to bring proper modification and improvement in his programme. The main activities undertaken in this phase are:

(i) Individual try-out, (ii) Small group try-out, (iii) Field try-out or testing, and

(iv) Evaluation.

Individual try-out

In this, the programme is administered to a few learners, say four (representatives of who9m the programme is written) by taking them out at a time. In practice, the learner is presented with the material of the frames one by one, and asked to write down his responses on a separate sheet of paper, and then tally them with the correct responses written on the back page of the frames. The learner is clearly told that he is not going to be tested but his help is being sought in the modification of the programme. Therefore, he has to provide free and frank suggestions for improving the content, sequences or organization of the frames. Here the information face-to-face contact with a single learner, at a time, provides a valuable opportunity to the programmer to study the reactions of the learner regarding the difficulties he faced and the inadequacies of the programme. Consequently, based on the results of the tryout at individual level, the programmer tries to bring necessary improvement and modifications in the draft of the programme.

Small group try-out

The modified programmed instruction draft (on the basis of the individual try-out is then tried on a small group of learners, say five to ten. Here, with a proper rapport and in a informal environment, the learners are persuaded to render proper help in testing the appropriateness and effectiveness of the programme. They are provided with the copy of the programme along with a blank sheet to record their responses, point out difficulties and give suggestions for modifications and improvement. The time taken in completing the programme is also carefully noted. Pre-test before proceeding on the programmed instruction and post test after completing the programme also are conducted. The differences in the attainment scores of pre-test and post-test are them employed to ascertain the effectiveness of the programme.

Field try-out or testing

One the basis of the finding of the small group try-out, the programmer brings necessary structural changes in the programmed draft and goes a step further for testing its validity of the field, i.e. real setting. Field testing differs from the small group try out in the sense that it represents a full and final try-out of the programme and is undertaken by the teachers and instructors instead of the programmer with the real students in real learning situations. However the method of testing is similar as practiced in small group try-out. The difference found in pre-test and post-test attainment scores of the learners, the difficulties faced, and the suggestions received and responses analyzed on the basis of findings of the field testing provide **v**aluable cues and keys for testing the validation and appropriateness of the developed programming material.

Evaluation

The results of field try-out in the form of data are properly analyzed through the process of evaluation for testing the validity and improving the quality of the prepared programme. The validation is carried out on two fronts: one on internal criteria and the other on external criteria. Whereas the internal criteria of the evaluation is concerned with

internal features strength and weaknesses of the programme, the external criteria provides support for the validation of the programme by giving evidence in favour of its effectiveness.

Evaluation based on internal criteria: Here, the data of field testing may be evaluated in terms of (i) error rate, (ii) programme density, and (iii) sequence progression.

In this text, we will discuss the first two, i.e. error rate and programme density

(i) *Evaluation in terms of error rate:* The error rate is computed on the basis of the learner's responses obtainable on each frame of the programme. If the learner is not able to respond correctly on a particular frame, it is considered as an error. This task of error detection is carried out for each frame and for all the learners who are tested in the field try-out. The errors detected are then used for computing two types of error rate: (i) the error rate of the total programme or a particular unit of the programme, and (ii) the error rate of a particular frame. The formulae used for the computation of these are:

$$\text{Programme error rate (in percentage)} = \frac{\text{Total no. of errors X 100}}{\text{Total no. of responses in frames X No. of learners}}$$

$$\text{Frame error rate (in percentage)} = \frac{\text{Total no. of errors made on the frame X 100}}{\text{Number of learners}}$$

The interpretation of error rates in terms of the evaluation of the programme should be made very cautiously. A lower error rate does not always ensure the effectiveness of the programmes. It may be the result of an easy programme or excessive priming or prompting used in designing the frames. However, the errors, especially the higher error rate, provide red signal to the programmer for making necessary modification in the programme.

(ii) *Evaluation in terms of programme density*: The computation of programme density helps in the measurement of the difficulty level of a programme. It is usually measured in

terms of a hypothetical ration known as **type token ratio (TTR).** This ratio is calculated with the help of the following formula:

$$TRR = \frac{N_d}{N_t}$$

Where N_d = the total number of different types of responses and N_t = the total number of responses required in a programme.

For example, if in a particular programme, the learner is required to respond in 30 different ways out of 70 total number of responses required, its programme density can be computed as:

$$TRR = \frac{30}{70} = 0.428$$

Since TTR is a ratio, its range lies between 0 and 1. Its value signifies the relative difficulty level of the programme. If the value is one, the programme density will be the maximum. The learner will be required to respond differently to each frame of the programme and hence the programme will be termed as the most difficult. Similarly, if every response that is required of the learned consists of the same word, the programme will be termed to save minimal density. The computation of TTR, thus, can serve very useful purpose in Pointing out its difficulty level. In an ideal programme, the range of TTR is said to be between 0.25 and 0.33 and consequently, every programme should try to maintain this level of TTR in the development of the programme.

Evaluative measures based on the external criteria: Under this, the programmer can evaluate his programme in terms of: (i) Criterion test, (ii) gain ratio, and (iii) learner's attitude.

Let us discuss these measures one by one.

(i) Evaluation in terms of criterion test:

Evaluation of the levels of performance of the learners under this test is done at the preparatory stage of the programme. Its results may reveal the extent to which the behaviour potential (from entry to terminal behaviour) is raised Thus, the units or whole of the programme may be evaluated in terms of the realization of the set objectives.

(ii) Evaluation in terms of gain ratio:

The effectiveness of a programme can properly be measured with the help of a concept known as gain ratio. It is defined as the ratio between the amount learned and the am9ount could be learned. For a particular programme, it can be computed with the use of the following formula:

$$\text{Gain Ratio} = \frac{\text{Mean of (Post-test scores — Pre-test scores)}}{\text{Mean of (Full marks of post-test scores — Pre-test scores)}}$$

(iii) *Evaluation in terms of the learner's attitude*:

For this purpose, the programme is required to develop and administer an attitude scale. The use of a three-point attitude scale can serve the purpose well by making the attitude-linked statements as *yes*, *no* and ? (agreeing, disagreeing, and can't say). With these attitude-demonstrable responses of the learner, the programmer can be acquainted with their reactions, liking and disliking for the content, style of programming, difficulty level, language, the design and sequencing of the frames, instructions, illustrations, and other such features of the programme. For objective evaluation, the programmer can go ahead with the task of computing the attitude coefficient with the help of the following formulas:

$$\text{Attitude coefficient} = \frac{f_{\text{yes}} - f_{\text{no}}}{f_{\text{yes}} - f_{?} - f_{\text{no}}}$$

Where f_{yes} = the total of the frequencies of responses marked as 'yes'; f_{yes} = the total of the frequencies of responses marked as 'no'; and f_{no} = the total of the frequencies of responses marked as '?'.

3.9 Review of Research trends in programmed learning

Programmed Instruction has become the field of interest for researchers all over the world and thousands of studies have been conducted on this topic. As such, many compendiums and substantive reviews of programmed instruction research are available, including Galanter (1959), Lumsdaine and Glaser (1960), Stolurow (1961), Hughes (1963), Meirhenry (1964), Taber et al. (1965), Glaser (1965), Ofiesh and Smith and Smith (1966), Hartley (1974), Lockee et al. (2004), and to name a few primary references. The following section provides an overview of the key research topics and studies related to programmed instruction.

Learner Variables in Programmed Instruction

This type of research includes how learner variables such as ability and attitudes affect learning from programmed materials. Several studies reported that there was little or no correlation between ability level and achievement on programmed materials (Detambel and Stolurow, 1956; Ferster and Sapon, 1958; Porter, 1957). Studies designed to gauge *learner attitudes* toward programmed instruction of learners at all levels and in a variety of settings found a very positive attitude toward this instructional approach (Eigen, 1963; Engelmann, 1963; Jones and Sawyer, 1949; Smith, 1962; Smith and Smith, 1966; Stolurow, 1963).

Elements of Programmed Instruction

Many studies compared elements of the programmed instruction model, such as the mode of presentation, the effects of overt vs. covert responding, prompting,

sequencing of content and contingencies, step size (level of difficulty of content presented in a frame), error rate, and type of response options:

- ***Mode of presentation.*** Researchers found no significant difference in the amount of learning between linear and branching programs (Anderson, 1967; Coulson and Silberman, 1960; Holland, 1965; Leith, 1966; Roe, 1962; Silberman et al., 1961), with the exception of one study by Coulson et al. (1962), who found branching programs to be superior. In general, branching programs saved significantly more time in instruction than linear programs (Anderson, 1967; Coulson and Silberman, 1960; Holland, 1965; Leith, 1966).
- ***Overt vs. covert responses.*** Overt responses are those that require the student to *do* something (for example, writing or speaking an answer), whereas covert responses are those that involve thinking about or reading the material and are therefore not able to be observed. Holland and Porter's research (1961) indicated that if responses were not overt (public), they often ceased.
- ***Prompting.*** Holland (1965) defined a prompt as a cue given prior to an opportunity to give an overt response that can be reinforced (e.g., leaving blanks in a sentence to be filled in by the learner). A few studies that analyzed the advantages of prompting vs. non-prompting in a program sequence found no significant difference (Cook, 1961; Cook and Spitzer, 1960), but Angell and Lumsdaine (1961) found that programs should include both prompted and non-prompted components. This particular component of PI is evident in modern instructional techniques—for example, in the use of completion problems as guided problem-solving models (van Merriënboer and de Croock, 1992; van Merriënboer and Krammer, 1990). Such strategies assist learners in focusing on key features of the problem scenario and ease transfer of learning to real-world application.
- ***Sequence.*** One of Skinner's major tenets was the "construction of carefully arranged sequences of contingencies leading to the terminal performance" (1953, p. 169). Research comparing results on logical, ordered program sequences vs.

nonlogical or random sequences provides mixed results. Many studies indicate that the effectiveness and efficiency of ordered sequences is significantly better than unordered (Gavurin and Donahue, 1960; Hickey and Newton, 1964; Miller, 1969). Other research studies comparing ordered and random program sequences do not support Skinner's principle of ordered sequences (Duncan, 1971; Miller, 1965; Neidermeyer et al., 1968; Wager and Broderick, 1974).

- ***Size of step.*** In studies comparing small step size (fewer concepts to a frame of instruction) to large step size (more concepts to a frame of instruction), the majority of research found that smaller step sizes produced significantly fewer learner errors (Evans et al., 1959; Gropper, 1966), especially for lower ability students. Results from several other studies, however, warned that programs using very small steps could introduce a "pall effect" (Rigney and Fry, 1961, p. 22) in which boredom was induced by the material, particularly with brighter students (Briggs et al., 1962; Feldhusen et al., 1962).
- ***Error rate.*** A major tenet of programmed instruction was to present a sequence of instruction that had a "high probability of eliciting desired performance" (Taber et al., 1965, p. 169); thus, care was to be taken in designing the difficulty of that sequence so as to avoid the possibility of errors. Many studies support the concept of low error rate (Holland and Porter, 1961; Keisler, 1959; Melaragno, 1960; Meyer, 1960). Gagné and Dick (1962), however, found low correlations between error rate and learning.

3.10 Let Us Sum Up

Programmed learning / Instruction is one of the important innovations of the twentieth century in the teaching –learning process. It is technique of teaching in which learners get individualized instruction or learning experience through self instructional materials. Here the self instructional material or the learning experience is logically sequenced into small segments with self corrective instructions.

Programmed Instruction is a bone to the slow learners and it has solved the problem of individual differences in the class room. The teacher usually face a large amount of difficulties while teaching in a heterogeneous class in traditional teaching – learning environments and the complexities get multiplied with the increase in number of learners in the class. The programmed learning is characterized by initial behaviour, small steps, and active participation of the learner, terminal behaviour, immediate feedback, and self evaluation by the learner.

3.11 Check Your Progress

1. What do you mean by Programmed Learning? Discuss the nature of programmed instruction?
2. What are the different types of Programmed Learning? Discuss in detail any one of them?
3. Discuss the basic assumptions of branching programming?
4. What are new research trends in Programmed Learning?
5. Write a detailed note on evaluation phase of the development of programmed instruction?

3.12 Suggested Readings

Arendset, R.L. (et al.), 1997 "Handbook for the development of instruction modules"

Aggarwal, J. C. "Principals Methods and Techniques of Teaching" (Second revised Edition) Vikas Publishing House Pvt Ltd. New delhi.

Cruickshank, D. (1985). Profile of an effective teacher. *Educational Horizons*, 90-92.

Green, Edward J.,(1962). The learning process and Programmed instruction New York:

Holt Rinehart Winston. *Teachers make a difference*.

Rosenshine, B., & Stevens, R. (1986). Teaching functions. In M. Wittrock (Ed.), *Handbook of research on teaching* (3rd ed.) (376-391). New York: Macmillan.

S K Mangal and Uma Mangal (2009) "Essentials of Educational technology".

Taber, Julian, I., Robert Glaser, and Halmurth H. Schefer, Learning and Programmed Instruction. Reading Mass: Addision Wesley 1965.

****