CHAPTER I

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INTRODUCTION
1.1 PROGRAMMED LEARNING: A BRIEF RETROSPECT

Programmed Learning sprang up from a bewildering complex of ideas and research ventures in many different fields. Espich and Williams (1967) define programme learning as 'a planned sequence of experiences leading to proficiency in terms of stimulus-response relationships'. The early exploits of Thorndike (1912), Catechetical form in instruction given by Graves (1914), job-analysis technique given by Allen (1919), behavioural approach to test construction given by Tyler (1932) are well known. Other origins, however have been obscured by the brash inventions of Skinner (1954) and Crowder (1963).

May (1946) and Lumsdaine (1963) examined in some detail the factors influencing the effectiveness of instructional films and made a basic study of stimulus and response functions of associated pictorial and verbal representations of objects. Experimental studies of the effectiveness of the film for training purposes including the use of active response were also carried out by Hovland and Sheffield (1949); while Sheffield
(1961) looked at the presentation conditions affecting the probability of correct responses during the learning of sequential procedures. And whilst others were acclaiming Skinner's (1954) operant conditioning tactics, Gagne (1962) from the military training faction was bold enough to declare that learning theories were irrelevant to the solution of training problem.

Tyler's (1957) contribution was to point out the need for teachers to be explicit about their teaching objectives. Without clearly stated aims it is impossible to assess whether teaching has been successful. He was able to show that the use of objective tests to assess achievement of objective makes it possible to examine what is inadequately learnt and hence, to make adjustments to the contents and the methods of instruction. This is the essential feature of programmed learning that there is feedback to the programmer to improve the teaching situations he has devised.

It was the implementation of Pressey's (1963) 'feedback to learners' notion which made it possible to find defects in teaching as they took place. This idea is two sided. By testing their grasp of short sections of a course it can become clear whether learners are making satisfactory progress. Angell (1949) and Hirsch (1952) found that by informing the learners immediately of their success or failure - and what the
correct answer should be, learning could be significantly enhanced. Thus, active involvement in learning, immediate knowledge of results and feedback to the teacher all contributed to the development of programmed learning. Mager and McCann (1961) worked on Learner Controlled Instruction. Mager and Clark (1963) reported 65 per cent reduction in training time by giving students objectives for a course and allowing them to structure their own course.

Pipe (1966) gave useful hints for practical programme learning. Markle (1969) developed linear programme which contained frames longer in length. Lysaught and Williams (1963) showed many ways in which a linear programme could be modified into multi-path programme.

Gilbert (1962) developed mathematical style of programming. In (1967), Gilbert extended his mathematics approach into a philosophy called Praxeonomy for systematically identifying real training needs by performance analysis. Praxeonomy places greater importance on the students' level of accomplishment. Hartley (1972) directed the attention on programmed instruction (what programme writers do) from programme learning (what learners do).

In India, programmed learning is still in its infancy. A formal association for the development
of programmed instruction named 'Indian Association of Programmed Learning (IAPL) was established by the department of Psychological Foundation in October 1975. Besides this association there are some universities which started centres of programmed learning. The NCERT, the Meerut University, the Himachal Pradesh University and the Baroda University have done a lot of work in different areas of programming.

1.2 PROGRAMMED LEARNING - ITS CHARACTERISTIC FEATURES

Skinner (1954) gave four characteristics of programmed learning which are as follows:

- Small steps
- Active Responding
- Self Pacing
- Immediate knowledge of the Results.

Holland (1961) suggested that programmed learning depended on three principles — gradual progression, control of the student's observing and mediating behaviour and variations in material.

Kulkarni (1967) defined the programmed instructional material in the above context and, 'a teaching material which leads a student by short, logically and psychologically related steps, resulting in a few errors so that he practises correct responses rather than errors and
these are reinforced immediately by the knowledge of results so that he makes successively closer approximations to the response leading to the desired goals.

Markle (1969) gave three principles of programming. The programmer's task is to create instructional materials which embody the following principles:

- Active Responding.
- Minimal Errors.
- Knowledge of Results.

Leith (1969) in his article, "Second thoughts on Programmed Learning" has emphasised that many ideas were formerly regarded as essentials of programmed learning while others were merely typical of programming. The hitherto recognised features of programmed learning are discussed below in the light of the necessary research evidences.

1.2.1. Programmes contain Teaching Material Analysed into Small Steps

- Step size is governed by many considerations which often lead to the use of large or difficult steps, among them is the point that small steps lead to boredom.
- Step size should be set in such a way that it matches the capacities of the learner.
Homme and Glaser (1959) investigated the effect of size of step upon the frequency of errors and upon immediate and delayed retention. The results showed that smaller the step, the fewer the errors and the greater the retention.

Larkin and Leith (1964) suggested the possible importance of frame size in influencing the effectiveness of frame size in linear programme. There is inverse relationship between post-test scores and step-size.

Maccoby and Sheffield (1961) found that short steps were more effective than large steps for initial learning and the progressive lengthening of steps led to best performance of the terminal behaviour.

1.2.2. Learner should be prevented from making Errors

Skinner's (1954) doctrine rests on scanty evidence. It is not enough, for example, to show that learners who make many errors in programme, learn less than those who make only a few.

Leith and Wisdom (1967) and Leith (1969) carried out experiments designed to elucidate the problem using quasi-programmed, multiple choice problems with feedback. No relationship was found between success of tests and number of errors made.
Elley (1966) concluded that a relationship between mistakes and test performance was absent. Of course avoiding errors was helpful in a rote-learning task.

Leith and Clark (1967) observed that making and overcoming errors sometimes helped learning.

1.2.3. Programmed Learning is carried out at the Learner's Own Pace

Gropper and Kress (1965) concluded that learners worked at approximately the same rate despite the varying difficulty of the programme with which they were working.

Hartley (1974) concluded that self-pacing produces considerable administrative difficulties because even like ability groups spread out enormously in terms of time taken to complete a programme.

1.2.4. Overt Responding is Essential

This requirement was dictated by Skinner's (1954) behaviouristic point of view. Leith (1966) carried out a series of experiments in which he showed that the need for overt responding depends on the type of task involved and the background of the learners. Learning English spelling was better accomplished by writing the
response, while coordinate geometry, probability and the structure of the genetic materials were learnt more successfully if only mental responses were made.

Holland (1965), Leith (1966), Anderson (1967) showed that overt responding was superior when the learners were young children, when the material was difficult, when the programmes were fairly lengthy and when particular (novel or specific) terminology was being taught.

1.2.5. **Programmed Learning is Individual Self-Instruction**

Programmed Learning as a technique is not only at the learner's own pace but it is par excellence individualised (even personalised) instruction. It means the pupils are isolated from each other in individual study booths, thus the consequent absence of social interaction.

Amaria, Biran and Leith (1969) have tried to elucidate some of the factors in cooperative learning. They consistently found that cooperative learning was better than individual work especially for less able subjects.

Hoole (1973) pointed out that programmed instruction may be individualized, the learner may work on his own but the content of what he learns is usually predetermined
by the programme writer. It is not, therefore, completely individual self instruction.

Hartley (1974) pointed out that these researches do not destroy the notion of the importance of individual self-instruction. These results merely mean that individualized programmed learning is not necessarily always the best way of learning and that other methods can be (rather need be) exploited.

1.2.6. Programmed Learning is Self Instructional in that a Teacher is Unnecessary for the Areas Covered by Programmes

Leith & Webb (1968) suggested that learning is most successful when teachers use programmes as an integrated aspect of their teaching. Hartley (1972) reached the conclusion that the teacher and the programme working together provide a more efficient teaching technique than either working in isolation.

1.2.7. Programmed Learning is Typically Textual mainly given through the Printed Word

Tobin (1968) found that simultaneously given tape recorded programmes in conjunction with visual and practical materials were slightly better than individual tape administration - both being significantly better than individual test and practical work programme.
Wendt (1963) using a random access slide projector for branching programmed instruction with university students concluded that they learnt more if provided with actual tasks to carry out (performance frames). Apter (1967) has also advocated audio-visual methods of programming.

1.3. PROCESS OF PROGRAMMING

The process of programming as discussed by Hartley (1972) has the following main steps:

- The objectives of the programme are specified precisely in a way that can be measured. The objectives of a programme state what it is that the student will be able to do when he has completed the programme.

- The prior knowledge, skills and abilities of the students who are to use the programme are similarly specified.

- The material to be taught and the skills to be acquired by the learner, are painstakingly analysed.

- From these analyses are determined (i) Optimum Teaching Sequences, (ii) Appropriate presentation methods.
The programme is tested on students for whom it is intended.

On the basis of results obtained from empirical tryout, the programme is revised, retested, and revised again until it can be seen to be 'working' satisfactorily.

These steps are depicted in figure 1.1.

1.4. PROGRAMME PARADIGMS

Three types of programmes linear, branching and mathetics are prevalent in the educational scene. Skinner (1958, 1961) not only invented but also eloquently argued for the superiority of the linear programme. In linear programme single track is followed and is based upon the assumption that the learner should learn without committing any error. Crowder (1963) created and stoutly defended the branching programme. It is based on the assumption that learner learns better after committing errors and that a single track cannot suit every learner. Gilbert (1962) gave the idea of mathetics and strongly advocated its superiority over other styles. It is based on the principle of retrogressive chaining through generalization and discrimination.
THE PROCESS OF PROGRAMMED INSTRUCTION (After Hartley, 1972)

Fig. 1.1

The process includes the following steps:

1. Objectives
2. Target Population
3. Task and Behavioural Analysis
4. Course Construction
   - Sequences
   - Presentation Methods
5. Development of Measures of Proficiency
6. Validation
7. Empirical Testing and Evaluation
8. Implementation
9. Revision

The process is iterative, with revisions needed based on empirical testing and evaluation.
In the present study linear and mathematical styles of programming were preferred to branching style because of the following reasons:

- These models appeared economical for teaching of information and skill content embodied in 'Competitive Equilibrium' in the main field of Economics. The content in hand is highly structured. Thus, adoption of a unirather than multiple track was found to be more suitable in a situation like this.

- Another reason for the choice of linear and mathematical styles was to ensure that no errors on the part of the learner were committed during the process of learning.

1.5. TECHNICAL TERMS DEFINED

The technical terms used in the present study are defined as follows:

Didule: It is a segment of information which the student handles at one time.

Stimule: It is the smallest possible information for eliciting a particular respule.

Respule: It is the response that the student makes after reading the stimule.
Correct: It is the condition of establishing the desired behaviour either by confirming the respule of the student or by correcting it.

Operant: It consists of a single act of behaviour (R) together with its associated stimule condition (S). Thus, operant can be represented as (S - R).

Discriminative Stimule (S^D): It is a stimule which produces the required mastery respule.

Observing Stimule (S^O): It is a stimule for an observing respule, designed to get the student to observe the S^D. It directs the pupil attention to S^D.

Instruction Stimule (S^I): It is the stimule which forces the student to make the correct mastery respule to the discriminative stimule without making error in the presence of S^O.

Exercise Prompt (S^P): It is a prompt which serves as an additional self reminder to the student that one or another respule is correct.

1.6. PROBLEM OF STUDY

The problem of the study is concerned with the comparison of Linear and Mathetical styles of programming for Competitive Equilibrium in Economics. So far no such study has been under-taken in India, which would seek to
determine the comparative effectiveness of Linear and Mathetical styles of programming especially with respect to the type of content i.e. skill (diagrammatic) and information.

The main variables of the study are the programming styles and the content - each of which is studied at two levels. The styles pertain to Linear and Mathetical formats of the auto-Instructional Programme. The content has been envisaged in the light of information and skills required in the domain of the Competitive Equilibrium in Economics. Sex as a classification variable has also been studied in view of the possible sex differences in learning information and skill through two different styles of programming.

The problem in specific form is stated as under:

"Performance of the College Students in Linear and Mathetical Styles of Programming at Information and Skill levels of Content"

1.7 JUSTIFICATION AND SIGNIFICANCE OF THE PROBLEM

Behaviour analysis approach is the latest arrival in the world of pedagogy giving a new look to the entire process of teaching and learning. Based on the principles of imparting information in small steps, ensuring active
responding by the students, immediate knowledge of the results and self-pacing, the technique of programming provides to the students an opportunity to learn the things by interacting with the written or printed material. The study was necessitated by the empirical and logical considerations which have been highlighted in the succeeding subheads according to the variables of study.

1.7.1. **Styles of Programming:**

The style of programming plays an important part in programming. Style is the presentation of teaching material in a particular pattern. The commonly used styles of programming are 'Linear', 'Branching' and 'Mathetics'.

Gilbert (1962) compared the mathematical exercises with the best available programmed material and found that these programmes require twice to ten times as much learning time, five to thirty times as many exercises to cover the same subject matter and the programmes result in poorer recall. The more difficult the material, the greater the advantage gained by Mathetics.

Davies (1972) pointed out that retrogressive chaining places smaller strains on the short term memory than does progressive chaining.
In the light of the contentions of Gilbert (1962) and Davies (1972) it was considered worthwhile to conduct a study on the comparative effectiveness of the two styles of programming - one using the progressive chains and the other using the retrogressive chains - in the Indian setting where empirical evidence for the superiority of these two styles over each other has been badly lacking.

1.7.2. **Content Forms**

DeCecco (1970) gives different instructional steps for different types of content. Skills, Verbal Associations, Concepts, Principles, Problem solving, Creativity and Discovery Learning are designed each in a different instructional sequence for making the content intelligible to the learners. The variable of content in the present study has been viewed differently for diagrammatic skills and information. The content of information has been considered in the light of teaching of both the concepts and the rules. Skill content has been viewed as the teaching of the same concepts and rules, as have been taken up for the information content, with the help of diagrammatic sequencing.

Fitts (1962) identifies three stages - the cognitive, the fixation, and the autonomous - through which the student passes in learning a complex skill.
In the cognitive stage, the learners, attempt to intellectualize the skill. Miller, Galanter, and Pribram (1960) suggested that the task should be done by learners in terms of the developmental plans guiding the execution of the skill. Fitts (1962), however argued in favour of the performance of the task by both the instructor and the students. In the fixation phase, the correct behaviour patterns are practised until the chance of making the incorrect responses is reduced to zero. This is done by linking together the basic units of the chain. The autonomous phase is characterized by increasing speed of performance in which it is important to increase accuracy to the point at which the errors are unlikely to occur. Fitts (1964) referring to a study by Grossman (1959) emphasized a long cycle of practice for reaching this stage.

The present study is an attempt to break up the concepts into subconcepts and then establish a chain of sub-concepts, concepts and rules with the help of skill programming in the form of diagrammatic depiction of the content on the one hand and information — programming on the other. The investigation can lead to some interesting generalizations on the broad issue of the presentation of content through diagrams alone or information alone.
1.7.3. **Sex Differences**

Sex has been included as another variable in the present study since it was thought to have an important bearing on learning through different styles of programming.

The psychologists and educationists have conducted many studies on sex differences in relation to school achievement as well as differential ability and personality patterns. Hicks & Hayer (1938) secured data on subjects most liked and least liked by 102 boys and 148 girls in a junior high school, grades 7 to 9. Boys more often than girls preferred mathematics, science and social studies (History, Civics and Geography); English was far more popular with girls.

DeCecco (1970) held the view that girls had usually surpassed boys in actual school performance. According to him the girls obtained better school grades, in all the subjects such as language, literature, science, history and so on.

Anastasi (1958) gave several reasons for the superior school performance of the girls. Two of the reasons are given below:

- superior ability of the girls.
- more docility of girls than boys.
Clark (1959) compared boys and girls in grades 3, 5 and 8 on California Achievement Tests. At all three grade levels, girls were better in spelling. Girls out-scored boys in mechanics of English at the 5th and 8th grade levels and in Arithmetic Fundamentals at the 8th grade level.

Terman and Tyler (1954) found out that in standardized achievement tests, what differences there are tend to favour girls. Often, however, such studies have shown that boys score higher on some sub-tests. Girls typically excel in English, Spellings, Writing and Art and boys in Arithmetical reasoning, History, Geography and Science.

Book (1922), Colvin and MacPhail (1924), Livesey (1942) separately reported the same sex differences in subject preference at the high school level. In all these studies, the boys named Science, Mathematics and History or Social studies more frequently than did girls, whereas girls more often listed English, Commercial studies or languages as preferred.

Sharma (1975) found that the girls are significantly superior to boys in the segment of Hindi Grammar under study.
Sethi's (1975) findings reveal that the girls are superior to boys in performance pertaining to programmed presentation through auditory and visual media.

In view of the conflicting research evidences in different research areas, particularly with regard to social sciences, in respect of the performance of boys and girls, sex as a variable of study was taken into account. It could lead to some interesting generalizations for the attainment of concepts and skills in the domain of Economics.

1.8. OBJECTIVES OF THE STUDY

The following objectives have been formulated for the present study:

- To compare the effectiveness of linear and mathematical styles of programming for different levels of content (Information, Skill and Information+Skill) with regard to the pupil-response on the respective criterion tests.

- To work out the sex differences in pupil performance on the criterion tests at three levels of content — Information (I), Skill (S), and Information + Skill (I + S) for the linear format.
To find out sex differences in pupil-performance on the criterion tests at different content levels for the mathematical paradigm.

To study the effectiveness of sex across linear and mathematical styles for the content of information, skill, and information plus skill.

To find out the interaction effects of styles and sex at three different levels of content.

1.9. HYPOTHESES

On the basis of the objectives of the study, the following hypotheses were formulated:

- The pupil performance on the criterion measures at all the three levels of content will be significantly better for the pupils taking programmed content through the mathematical style of programming than through the linear style.

- Boys will perform significantly better than girls in information content whereas girls will do better in skill content in each of the two styles of programming.

- Sex will interact with style to yield significant results at all the three levels of content.
1.10. **DELIMITATIONS OF THE PROBLEM**

The present study has been delimited in respect of variables of study, content, tools and techniques at various stages:

- The variable of styles has been studied at two levels — Linear and Mathetics, whereas the variable of content has been confined to the main areas pertaining to information and skill.

- The content has been drawn from Micro Economics and is restricted to 'Competitive Equilibrium' covering the following areas:
  - Determination of Equilibrium Quantity and Equilibrium Price.
  - Effect of Increase/Decrease in Demand on Price.
  - Effect of Decrease/Increase in Supply on Price.

- The tools for the study pertained to the development of Linear and Mathetical programmes separately for information and skill content.

- The criterion test, used for validating the information programmes prepared in both the styles, included short answer, multiple choice, matching and completion type of items. The criterion test meant for measuring skill-performance contained the items pertaining to
drawing, labelling, completing of diagrams, and denoting the same by letters.

The foregoing description clearly outlines the scope of the study, its focus and theoretical framework. It would be now worthwhile to present in the two subsequent chapters the detailed account of the development of programmes in the two styles under study.