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CONTENTS

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   OBJECTIVES

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JOURNAL AND OTHER ARTICLES

- Schemenner, R.W., Huber, J.C. and Cook, R.L. (1987), "Geographic Differences and the Location of New Manufacturing Facilities," Journal of Urban Economics, Vol. 21, No. 1, pp. 83-104.

CONFERENCE PAPERS

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vi

DEVELOPMENT AND EMPIRICAL VALIDATION OF A LINEAR STYLE PROGRAM ON 'STRUCTURE OF THE CELL' FOR IX GRADE STUDENTS

RAMANJEET KAUR
ASST. PROFESSOR
UNIVERSITY COLLEGE OF EDUCATION
KURUKSHETRA UNIVERSITY
KURUKSHETRA

ABSTRACT

The present study deals with the development of self-learning material on "Structure of the Cell" in science, and its empirical validation in terms of error rate, program density, and sequence of progression on the basis of data gathered through field try-out operation. The investigator found that the students acquire the science concept at a rapid pace while learning it through linear style programming.

KEYWORDS
Linear style programme, self learning, error rate, science teaching.

INTRODUCTION
Improvement in the teaching learning process has always been a matter of priority among the educationists. Due to the explosion in the information availability and development in educational technology, traditional classroom teaching alone is unable to cater the overall demands of the instruction delivery and understanding of the subject on students' end. Population explosion and hence over-crowded classes is another challenge which hinders qualitative improvement. Research in improving the teaching learning process in different subjects is going on in a great pace in all parts of the world. Individualized teaching is the need of the hour in which Programmed Learning is a new path towards individualized instruction delivery.

Programmed learning is a systematic instructional strategy for classroom as well as self- learning. It works wonderfully in case of courses through distance learning. The programme may be of several physical forms. All these programmes can be prepared by experts and put to use for teaching purposes and its results are bound to be positive. It is a learner centered approach which gives emphasis to the method by which material can be presented so as to be auto instructional. Therefore, it has termed as a software instructional technology.

CONCEPT OF PROGRAMMED LEARNING
Programmed Learning is the arrangement of materials to be learnt, in graded steps of difficulty, in such a sequence and in such a manner of presentation that it will result in the most efficient rate of understanding and retention. Smith and Moore (1968) defined Programmed Instruction as the process of arranging the materials to be learned into a series of sequential steps; usually it moves the student from a familiar background into a complex and new set of concepts, principles, and understandings.

Programmed Instruction as conceived by Markle (1969) is "a method of designing a reproducible sequence of instructional events to produce a measurable and consistent effect on the behavior of each and every acceptable student."
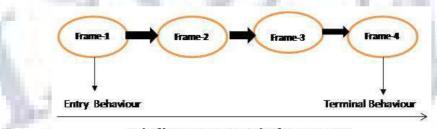
Thus Programmed Instruction is a technique of converting the live instructional process into self-learning or auto-instructional readable materials in the form of micro-sequences which the learners are required to read, make some right or wrong response, correct the wrong responses or confirm the right responses and attain the complete mastery of the concepts explained in the micro sequences, which form a complex subject matter of some wider instructional sequences for unit of instruction.

STYLES OF PROGRAMMING
Various styles of programming techniques have emerged within the last two decades. It is very difficult to have broad classification of the various styles of programming. Basically, programmed material can be presented to the learner either in book form or through teaching machine with the help of following styles:

(1) Linear style   (2) Branching style   (3) Mathetics style

LINEAR STYLE

Linear means proceeding in a straight line. A program in which the information proceeds in a straight line is generally called as "Linear Programming". In this style, the student does every frame in the same order no matter how adequate or inadequate his response is. The sequence of frames and path of learning proceed in a systematic and straight line. It may be diagrammatically represented as follows:

Path of learning in Linear style of programming

As in the above paradigm, in linear style the learner proceeds on a path from entry behavior through the frames to reach the terminal behavior. In a linear format the matter is so arranged in small steps that the learner makes only correct responses throughout the program and receives only positive reinforcement. If a learner responds incorrectly to a particular frame he may have to repeat the frame. In any case he is not allowed to go to the next frame until he responds correctly to the frame in hand.

SIGNIFICANCE OF PROGRAMMED LEARNING
The programmed learning has proved to be an effective adjunct to other methods of teaching. However, we have miles to go before our teachers begin to use programmed materials in their day-to-day teaching. In U.S.A. while less than 5 percent schools used programmed learning in 1961, by the autumn of 1962, twenty-three per cent were making use of these materials. In India, in order to test the usefulness of program learning materials and implement it in Indian classroom, various studies have been attempted. Desai (1966), and Kapadia (1972) studied the pupils' intelligence in relation to programmed learning. The first

INTERNATIONAL JOURNAL OF RESEARCH IN COMMERCE, IT & MANAGEMENT   160
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two studies have shown that intelligence did not have much effect on learning through programmed instruction while the study of Kapadia (1972) indicated that higher I.Q. pupil achieve better in programmed learning. Chauhan (1973) developed a programmed text for B.Ed. level to provide auto-instructional material in educational psychology to be used as supplementary material for the course. Bhusan (1973) prepared a liner program in "Educational Statistics" using Hindi as a medium of presentation. The objective of the study was also to prepare a manual for the guidance of the consumers of the program. Gupta (1973) developed a self-instructional program in the basic sentence patterns of English for the undergraduate students and made an empirical study of the program on the basis of field-testing. Govinda (1976) developed a programmed text on "Educational Testing and Techniques of Evaluation" and experimentally validated the effectiveness of the program. Pandey (1980) found that the programmed text is superior to other methods and that the high and low income group students following the program text were distinctively superior to those who had traditional teaching with home assignment and grading. Seshadri (1980) developed a linear program of 2074 frames for mathematics of class IX. She found that the strategy of having Programmed learning Material (PLM) assist major component worked better than the traditional mode of teaching. Mavi (1981) developed a programmed text in physical geography for high school students and covered 18 topics. PLM was tried on an experimental sample of ninth grade students. The programs were in the English language and had a liner format. Chaudhary (1985) prepared programmed learning material in geography for secondary level. He found that after pursuing PLM, students gained significantly as far as knowledge of the subject is concerned. The material was equally effective for both urban and rural students. Desai (1986) developed programmed material on heat in physics for pupils studying in standard XI and found that pupils took active interest in reading and learning through programmed material. Agashe (1995) developed and empirically validated programmed learning material for ensuring mastery in biology for XI and XII students

Keeping in view the usefulness of programmed learning as an instructional mode and the increasing necessity of such materials in school subjects, the investigator developed linear style program material in science for seventh grade students.

OBJECTIVES OF THE STUDY

The objectives of the study are:
1. To develop the self-learning material on the topic of "Structure of the Cell" in science for 9th class students.
2. Empirical validation of self-learning material in terms of error rate, program density and sequence progression on the basis of data yielded through field tryout operation.

POPULATION AND SAMPLE

The target population of the present study consisted of student of 9th class and the experimental sample for the study consisted of 30 students of Green Field Public School, Kurukshetra, studying in 9th class through English medium.

METHODS OF DEVELOPING THE PROGRAM

The development of self-learning materials on the selected topic underwent the following stages.
- Preparation of the program
- Writing of the program in a linear format
- Try out for modification
- Evaluation of the program

Through these phases/ steps the investigator developed a programmed text on the basis of small group tryout and finally the programmed text was administered on the sample of 30 students. Then on the basis of students' response/score, the program was empirically validated in order to test the effectiveness of the program.

EMPIRICAL VALIDATION OF THE PROGRAM

Empirical validation of the program is always done by the programmer for improving the quality of instructional material.The small group and final field try out results are often analyzed in terms of error rates, program densities and flow sequence progression. External evaluation in terms of criteria score is also done by the programmer. The program evolved by the investigator has been evaluated on the basis of final field try-out data, in terms of :
- Error rates
- Program density
- Sequence progression
- Criterion test findings

ERROR RATE

The error rate is applicable mainly in respect of linear and Mathetics style programs. Any frame on which the learner is unable to give a response in accordance with the stipulation of the program is given the name of the error. To calculate error rate, errors committed by all individuals on all the frames are counted and added. The error rate is calculated by applying the following formula:

$$Error\ rate = \frac{Total\ numbers\ of\ errors\ X\ 100}{Total\ number\ of\ responses\ X\ Total\ number\ of\ pupils}$$

Percentage of overall errors of the program is mentioned as below.

Total no. of errors	=	60
Total no. of responses	=	59
Total no. of pupils	=	30

Error Rate = 3.4%
Percentage of success = 100 – 3.4 = 96.6%
The error rate of the program is less than 5%, the criterion suggested by Skinner to check the validity of an effective linear program.

PROGRAM DENSITY

Another measure to evaluate the effectiveness of a program is to calculate its density. The term 'density' has been borrowed here from physics where it represents mass per unit volume. Density is an independent measure of the difficulty level of the program. It is used to see whether the program is of high, medium or low density. To calculate the density of a program, a tally is made of the number different responses required. The tallies are of programmer's confirmatory responses and not of pupil's responses.

A program would have a density 1.00, if every response required by the program were different. Hence the formula for calculating density of a program is

$$\text{Density of programme} = \frac{Nd}{Nt}$$

Where,
Nd = Total number of different types of responses required in a program.
Nt = Total number of responses required in a program.
Green (1962) has mentioned two types of densities.

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INDEPENDENT DENSITY

This is the density of a single frame or a group of frames comprising a part of section of a program. Density of each section is independent of one another. The program is therefore divided into section of equal number of frames.

CUMULATIVE DENSITY

Cumulative density is the density of the entire program taken as a whole. The entire program is considered as a single section and the total number of different types of responses appearing on the entire program frame is divided by the total number of responses required on the whole program. Cumulative density of the program is an indirect measure of the difficulty level of the program. Hence cumulative density is calculated by:

Cumulative Density = Nd/Nt

Here,   Nd = 34

Nt = 59

So, Cumulative Density = 34/ 59 = 0.58

INTERPRETATION

Cumulative density reveals that the programme has medium density hence it has reasonable difficulty level. It can be easily comprehended by IX graders

SEQUENCE PROGRESSION

A program is usually analyzed in terms of progression of sequence. It is considered an important indicator of the authenticity of the program. Sequence progression chart helps the programmer to evaluate the logical arrangement of the parts of the program. A study of sequence progression is made by the programmer by recording the errors made by all the students on each frame. For this purpose a flow chart was prepared. The chart consists frame numbers on vertical line. The frame on which each learner has made an error is shown by marking (x).

Flowchart gives us the information concerning the location and relative frequency of errors. The flowchart for the criterion test revealed that students obtained 98.8% of success on criterion test of the program.

CRITERION TEST FINDINGS

The program has also been evaluated on the basis of student's performance on the criterion test.

The error rate of the criterion test and overall percentage of success was calculated as follows:

$$Error\ rate = \frac{Total\ numbers\ of\ errors\ X\ 100}{Total\ number\ of\ test\ items\ X\ Total\ number\ of\ pupils}$$

In criterion test:

Total no. of test items   =   30
Total no. of Pupils   =   30
Total no. of errors   =   70

Hence percentage of error in criterion test was: 7.7%

Percentage of success in criterion test = 100-7.7 = 92.3%

The percentage of success on the criterion test was 92.3%. Success on criterion test shows that students are able to acquire the science concepts at a rapid pace while learning it through linear style programming.

MAIN FEATURES OF THE FINAL DRAFT AND DISCUSSION

Linear style has been followed at the time of developing the program and the investigator selected the topic from his area of interest. After writing the objectives in behavioral terms, the criterion test was prepared.

The program was edited by the subject expert, programming technique expert and language expert; the program was also modified on the basis of individual try-out and small group try-out. The program at the end of second try-out consisted of 59 frames.

The program was then administrated on the sample of 30 students. On the basis of students' responses and scores on the criterion test, error rate and program density were calculated and sequence progression charts were prepared to inspect the flow of information. Study of sequence progression chart revealed that the flow of information through the frames was quite smooth.

EVALUATION

The error rate of the entire program comes to 3.4%; cumulative density is 0.58. The percentage of success on the criterion test comes to be 92.3%.

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