

Critical Evaluation of Methodological Aspects in Developing the Programmed Instruction Material on Agricultural Technologies

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ABSTRACT: Extension education is a continuous educational process to provide knowledge to the rural people about the improved practices in a convincing manner. The research in extension education should aim at identifying appropriate methods, tools and techniques for the field extension functionaries who in turn could utilize it for accelerating the change process in the society. The Programmed Instruction (PI) is a self-instructional material, in which learners work through the programmed material by themselves at their own speed and after each step, test their comprehension by answering a question as well, they can find the correct answer immediately. The PI has proved superior method over conventional methods in educating learners of varying groups such as age, sex, education, physical and mental capabilities, positions in the job, different subjects like science, mathematics, engineering, medicine, nursing, counseling. Its utility is unexplored in educating agricultural subject for farmers and extension functionaries. Hence, an attempt was made to develop the PI on agricultural technology, 'climate change, its impact, mitigation and adaptation strategies in agriculture'. On experimentation, the results indicated that, PI is a better method over Lecture method in educating agriculture subject through its influence on cognitive and affective domains of extension functionaries.

Keywords: Programmed Instruction, frames, cognitive domain, affective domain, reinforcement, learning, effectiveness.

INTRODUCTION

Programmed instruction is a method of presenting new subject matter to learners in a graded sequence of controlled steps. Learners work through the programmed material by themselves at their own speed and after each step test their learning by answering a question. They are then immediately shown the correct answer (Crowder, 1964). It is described as both a product and a process. As a process, PI is used for developing instruction systematically, starting with behavioural objectives and using tryouts of the instruction to make sure that it works satisfactorily. As a product, PI has certain key features, such as highly structured sequence of instructional units (frames) with frequent opportunities for the learner to respond via questions, typically accompanied by immediate feedback (Bullock, 1978).

The PI has several uniqueness in its methodology viz., self instruction and self testing; provides the learners, a framework; it provides positive reinforcement in a contingent manner on the accomplishment of each step along the way; provides immediate knowledge of results which facilitates greater amount of learning; maximise the learner's success by thoroughly mastering one step and the learner is optimally preparing for the next; it increases the probability of correct answers and student achievement is not affected by the size of the class. The PI has been used for different purposes viz., educating the students in schools and colleges covering various subjects including science, engineering and medicine; training the practitioners like nurses, doctors, defence personnel, aircraft crew, businessmen and industrial workers etc., and on various categories of people of varying intellectual abilities, age, sex, hierarchial job

positions and races, and proved to be better one compared to conventional methods of education. Donna (1999) in a study to compare the grades earned by incoming MSW learners in traditional classroom-based statistics courses and those taught using software-based content and no regular classes revealed that the learners can learn statistics successfully in a PI on distance education course where as in traditional method, some learners needed additional assistance to learn. A study conducted by Darhyl (2000) to assess the effectiveness of PI and to identify the optimum size of the PI material required to educate the learners of music class in detecting errors of pitch and rhythm. Three forms of PI, each differing in the number of practice frames, were developed and experiment was conducted. The results showed that PI was effective in training error detection skill and the longer forms of the program resulted in greater gains. An experimental study was conducted by Izzet *et al.* (2006) reported from a study that PI performed statistically significantly difference over traditional lecturing in teaching stereochemistry in organic chemistry to the learners. A study was conducted by Uhumuabi Uhumuaybi and Mamudu (2009) to compare the effects of PI and demonstration methods on learners academic performance in science in Esan West Local Government Area of Edo State. The findings indicated that exposing learners to PI method improved performance in science. Darrel (2011) stated that web based PI increased the behavioural vocabulary of the learners. Further, PI maintained learners' interest and helped to maintain their study behaviour. Allamaprabhu (2012) in his study with class VI children found that the book format programmed lesson is a viable means of instruction for teaching general science subjects.

There were very few attempts made to utilize this method by the agricultural extension functionaries to educate the farming communities in the past. Owing to its efficiency and effectiveness in different fields of education, an experimental study was conducted to explore its potential to bring desirable changes in the cognitive and affective domain of extension functionaries.

MATERIAL AND METHODS

In the present study, the methodology as suggested by Skinner (1968) was followed in development of PI material which is as detailed below.

1. *Selection of the subject:* The subject for the development of PI material was 'climate change, its impact, mitigation and adaptation strategies in agriculture'.
2. *Selection of the programming paradigm:* The linear method of programming was followed in the development of PI material due to its simplicity in presentation of the given topic.
3. *Collection of material on the selected subject:* Extensive review of literature was done on the subject

and drafted the contents. As well, discussion with the subject experts was done in correcting the information.

4. *Sequencing of content:* The information collected was categorised into different sub headings. In each sub headings, the subject was sequenced from simpler to complex concepts and principles.

5. *Composition of frames:* The finalised subject content was transformed in the form of frames. In this process, three guiding principles *viz.*, (a) a stimulus which serves to elicit the targeted response, (b) a stimulus context to which the occurrence of a desired response is to be learned, and (c) a response which leads the learner to the terminal behaviour were followed as suggested by Taber *et al.* (1965).

6. *Evaluation and revision:* The PI material was sent to 20 subject matter specialists to seek their suggestion in content, sequencing and formulation of the frames.

7. *Working out readability of the PI material:* The readability of the finalised PI material was worked out using the procedure developed by Nanjappa and Siddaramaiah (1996).

8. *Pre testing:* The PI material developed was pre-tested by administering it to 30 extension functionaries in non sample area.

9. *Final PI material:* Based on pre testing, suitable corrections were incorporated in the PI material and finalised material consisted of 66 frames, which was printed in the form of booklet.

RESULTS AND DISCUSSION

The results and discussion regarding the process of development of PI material is presented in the paragraphs below.

1. Selection of the subject. Lysaught and Williams (1963) stated that the PI development process should begin with a determination of what subject or topic is to be taught. In the present investigation, the subject selected was climate change, its impact, mitigation and adaptation strategies in agriculture. This subject was selected for two reasons *viz.*, (a) its importance in recent times and (b) to serve as a new subject to test the impact of methods on cognitive and affective domains of learners.

2. Selection of the programming paradigm. There are two programming paradigms in the development of PI material namely the linear method and the branched method. Ellington (1987) describes that the linear programmes allow learners to advance through the instructional process in a particular order as they provide correct answers. Learners are provided with specific pieces of information in a series of frames and asked to recall or apply this information during frequent tests in each frame. Branched programmes involve the use of several possible paths through the sequence of frames, with the so-called remedial frames and remedial loops being included in order to correct misconceptions identified from learner responses to individual steps and

offer learners a variety of paths through a curriculum. According to Luckerman *et al.* (1962), the efficacy of both linear and branched programmes is same. Hence, in the present study, the linear method of programming was followed in the development of PI material due to its simplicity in presentation of the given topic.

3. Collection of material on the selected subject. As a first step, extensive literature on the subject climate change, its impact, mitigation and adaptation strategies in agriculture was collected, synthesized and prepared a draft technical material. Secondly, in consultation with the subject experts, the final technical material was prepared. This was then translated to the local vernacular *Kannada* language for further use.

4. Sequencing of content. Skinner (1961) suggested that one of the ways that the PI helps with teaching is through the orderly presentation of the program, which in turn is required to be constructed in orderly sequences. Smith and Moore (1962) stated that the material should move from familiar concept, principles and understanding to the complex ones in the PI. Considering these suggestions, the selected subject in the study was divided into six parts and is arranged in the order of familiarity to complexity in the sequential order of (a) concept of climate change, (b) impact of climate change, (c) climate change mitigation strategies, (d) climate change adaptation strategies, (e) India's policies concerning climate change mitigation, and (f) summary.

5. Composition of frames. In the process of composition of frames, three guiding principles *viz.*, (a) a stimulus which serves to elicit the targeted response, (b) a stimulus context to which the occurrence of a desired response is to be learned, and (c) a response which leads the learner to the terminal behaviour were followed as suggested by Taber *et al.* (1965).

Accordingly, the first frame had two parts namely, (a) information on a concept and (b) question relating to information given in that frame. The subsequent frames had three parts namely, (a) The correct answer for the previous question on the right side top corner, (b) sequenced technical information, and (c) the question relating to the information given in that frame. The draft PI material had 84 frames.

6. Evaluation and revision. With a view to avoid errors in content accuracy, inappropriateness, irrelevance, difficult writing styles and understanding, Markle (1969); Lysaught and Williams (1963) suggested to use external reviewers such as subject matter experts to assist with initial program editing. Accordingly, the draft PI material was evaluated and revised in two stages.

In the first stage, 20 subject matter specialists were given with draft material to assess and modify the technical content for its coverage/ completeness, sequence, bifurcation of subject into frames, content load in each frame, simplicity in presentation, readability, appropriateness of questions and answers *etc.* Based on the experts judgment, the technical content in each frame

was finalised. In the second stage, the finalised frames were given to 20 senior level education technology experts to assess each frame for its appropriateness to meet the PI principles. Based on their suggestions, the PI material was modified. The modified PI material had 66 frames.

7. Working out readability of the PI material. Since, the PI is a self-learning technique, the PI material supplied to the respondents should be self-explanatory. Hence, it should meet the readability standards as applicable to the respondents. Readability is concerned with rapid comprehension of what is read. It is said that readability always go with understandability. To measure the readability of frames of the PI material, the procedure with three steps namely, (a) working out sentence length, (b) calculation of word complexity for 100 words, and (c) working out grade level was followed as suggested by Nanjappa and Siddaramaiah (1996).

Working out Sentence Length: Number of words per frame and number of sentences per frame were counted and then the average sentence length was calculated by dividing number of words by number of sentences in that frame.

$$\text{Average Sentence Length(ASL)} = \frac{\text{No. of words in a frame}}{\text{No. of sentences in that frame}}$$

Calculation of word complexity for 100 Words: In the construction of a word in *Kannada*, letters and syllables play a significant role. But both are interrelated. Basically, there are two types of letters in *Kannada* words a) the letters requiring short breath and b) the letters requiring long breath for their pronunciation. These two types of letters are found in different combinations in a word. Time taken to pronounce a letter is referred to as *Mathre*. All letters in a word will either require one *mathre* time or two *mathre* time to pronounce them. The letter requiring short breath is called *laghu* and the letters requiring long breath to pronounce are called as *guru*.

For the letters in the frames, *guru*, *laghu* letters were identified. Then, the *guru* letters were multiplied by two and added to the number of *laghu* letters to obtain total number of *mathre*'s in the frame. The word complexity was calculated by using the formula.

$$\text{Word complexity (WC)} = \frac{\text{Total no. of mathres in a frame}}{\text{No. of words in that frame}} \times 100$$

Working out Grade Level: The grade level of the frame in the PI material was worked out using the formula,

$$GL = -7.4232 + 0.6509 \text{ ASL} + 0.0177 \text{ WC}$$

Where, GL= Estimated grade level of a frame

ASL= Average sentence length in words

WC= Word complexity per 100 words in *mathre*'s

After assessing the grade level for each of the frames from 1 to 65, the average was worked out for them. The 66th frame contained only the answer for 65th frame. The grade level was rounded off to the nearest whole number, when there was a fraction. Worksheet used for determining the grade level of PI material is given below.

Grade Level

Sr. No.	Item	Value/Number				
		Frame-1	Frame-2	Frame-3	Frame-65
1.	No. of words in a frame					
2.	No. of sentences in a frame					
3.	No. of <i>Mathre's</i> in the frame (<i>Laghu + Gurux2</i>)					
4.	Average sentence length in words (divide 1 by 2)					
5.	Word complexity per 100 words (divide 3 by 1 and multiply by 100)					
6.	Multiply average sentence length by the constant 0.6509 (multiply 4 with 0.6509)					
7.	Multiply word complexity / 100 words by constant 0.0177 (multiply 5 with 0.0177)					
8.	Constant	-7.4232	-7.4232	-7.4232	-7.4232	-7.4232
9.	Grade level scores (add 6, 7 and 8)					

To workout the average grade level of the PI material, the averages of the 65 frames was calculated. The average grade level of the PI material was found to be grade IX indicating that the persons educated up to ninth standard and above can easily read and understand the developed programmed instruction material.

1. Pre testing. The PI material developed was pre-tested by administering it to 30 extension functionaries in non sample area. The extension functionaries were asked to indicate the relevancy, aptness and completeness of subject, ability to understand, time required to complete the process *etc.* PI material was thus finalised based on their response.

2. Final PI material. The finalised PI material on climate change, mitigation and adaptation strategies in agriculture, which was synthesised at IX grade (persons with ninth class pass can read and understand) was got printed into a booklet form of size 21.5cm × 13.5cm dimension. The final PI material consisted of 66 frames covered under six categories *viz.*, (a) concept of climate change, (b) impact of climate change, (c) climate change mitigation strategies, (d) climate change adaptation strategies, (e) India's policies concerning climate change mitigation, and (f) summary. In the preface of booklet, introduction to PI and instructions for its use was described.

3. Utilising PI material for experimentation. Utilising the PI as stimuli / treatment, the experiment was to study the impact of PI on cognitive and affective domain of extension functionaries of Dept. of Agriculture, Govt. of Karnataka. Solomon four group research design was employed in experimentation. The study was conducted in the Staff Training Unit of University of Agricultural Sciences, Bengaluru during 2013-14. One hundred and twenty extension functionaries of the Karnataka State Department of Agriculture who were the participants of the week long foundation training programme were the respondents for the study. The out come of the experiment was a) the effectiveness of PI with respect to acquisition of learning by extension functionaries at all the six sub-domains of the cognitive domain was found

to be significant; b) the PI had significant influence on extension functionaries' learning at all the five sub-domains of affective domain; c) the PI was found to be effective in influencing the overall learning at cognitive and affective domains of extension functionaries.

CONCLUSIONS

PI has the multitude of positive effects. The reinforcement of learning occurs twice in the process of learning in PI through answering the questions and by the correct answer provided for cross checking. By using PI the individuals can learn the subject matter in their own place and the speed of learning depending on their ability. Therefore, the uniform learning occurs among individuals having varying abilities. PI can indeed be very beneficial to education for both learners and teachers. Therefore, it can be developed and used as an effective tool teaching all categories of learners and for several circumstances. The findings of the study will be helpful to the Developmental Departments, State Agricultural Universities, Krishi Vigyan Kendras, Commodity Boards and NGOs, to educate the staff working in their organisations and their clients by transforming technical literature/implementation procedures *etc.*, into the form of PI material. Due to limitation of time and resources, PI material has been developed on one agricultural technology on climate change, its impact, mitigation and adaptation strategies in agriculture. Hence, the results cannot be generalized in the same way for the other subjects. The investigation has been conducted on the extension functionaries and therefore, the results cannot be generalized for the other users of PI.

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Conflict of Interest. None.

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