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A Comparative Study on Effectiveness of Programmed Instruction and Lecture Method on Cognitive Domain of Extension Functionaries

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Programmed Instruction (PI) is a self-instructional technique in which learners are presented with new subject matter in a graded sequence of controlled steps. The learners work through the PI at their own pace, and after each step, they test their knowledge by answering a question, and they can identify the right answer immediately. To compare the effectiveness of Programmed Instruction (PI) and Lecture methods in bringing desirable changes in the cognitive domain of extension functionaries on the subject, 'Climate change, its impact, mitigation and adaptation strategies in agriculture', an experimental study was conducted using Solomon four group design: before-after with three controls considering 240 respondents. The mean cognitive domain scores of PI and lecture method of instruction was worked out. The results of ***t*** test revealed that there was a

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significant difference between effectiveness of PI and lecture methods with respect to acquisition of learning on cognitive domain. The overall cognitive domain effectiveness in PI method (45.17) was significantly higher than the lecture method (32.83). In the areas of sub-domains of the cognitive domain too, the effectiveness scores of PI method of instruction was significantly higher than the lecture method. The study's conclusions suggest that the PI materials can be used most effectively to educate extension functionaries on the new agricultural technologies emerging from time to time. Furthermore, PI can be used to educate literate farmers on new agricultural technologies such as protected cultivation, secondary agriculture, and so on, which will eventually drive them to adopt these technologies.

Keywords: Programmed instruction; frames; lecture method; cognitive domain; extension functionaries.

1. INTRODUCTION

Extension education is a continuous educational process to provide knowledge to the rural people about the improved practices in a convincing manner. It is a method of assisting rural residents in being more productive and improving their overall standard of living. Therefore, 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. Extension functionaries equipped with efficient methods, approaches and techniques can better educate the farming community and can expand the agricultural technologies in a pragmatic manner.

While searching for new educational approaches, Programmed Instruction (PI) was found to be unexplored approach in agricultural extension education. The Programmed Instruction (PI) is a method of instruction in which the subject matter which is to be taught to the learners is divided into smaller units and presented in a written form in a sequence. The smaller units are called frames which contains a part of the information followed by the questions related to the information given in that frame. Skinner [1] "based on operant conditioning theory, developed PI as an educational technique. It is characterized by self paced, self administered instruction, which is presented in a logical sequence and with multiple content repetitions. He argued that, learning can be accomplished if the content is divided into small incremental steps, and if learners get immediate feedback, reinforcement and reward". "In PI, the subject to be learned is arranged in a series of sequential steps, usually it moves the learner from a familiar background into a complex set of concept, principles and understanding" Smith and Moore [2]. This educational technology is being extensively adopted in educating various groups such as age, sex, education, physical and mental capabilities, positions in the job, different subjects like science, mathematics, engineering, medicine, nursing, counseling. But, its utility in educating the agricultural subjects to the farming community or the extension personnel is very less. Hence, a comparative study of PI and Lecture methods in influencing the cognitive domain of extension personnel was done.

"Cognitive domain deals with how we acquire, process, and use knowledge. It is the thinking domain" Anderson and Krathwohl [3]. Matlin [4] described that cognitivism refers to the unobservable change in mental knowledge and further stated that cognition meant thinking and awareness. According to Webster's dictionary (2015), "cognition can be defined as the act or process of knowing in the broadest sense; specifically, an intellectual process by which knowledge is gained from perception or ideas".

The cognitive domain according to Bloom [5], "involves knowledge and the development of intellectual skills. This includes the recall or recognition of specific facts, procedural patterns, and concepts that serve in the development of intellectual abilities and skills. There are six major sub domains of the cognitive domain viz., (a) knowledge, (b) comprehension, (c) application, (d) analysis, (e) synthesis, and (f) evaluation starting from the simplest behaviour to the most complex".

1) Knowledge refers to the ability of learners in arranging, defining, duplicating, memorizing, naming, ordering, recognizing, relating, recalling, repeating, reproducing; 2) Comprehension refers to the ability of classifying, describing, discussing, explaining, expressing, identifying,

indicating, locating, recognizing, reporting, restating, reviewing, selecting, translating; 3) Application refers to the ability of applying, choosing, demonstrating, dramatizing, employing, illustrating, interpreting, operating, practicing, scheduling, sketching, solving, using, writing; 4) Analysis refers to the ability of analyzing, appraising, calculating, categorizing, comparing, contrasting, criticizing, differentiating, discriminating, distinguishing, examining, experimenting, questioning, testing; 5) Synthesis refers to the ability of arranging, assembling, collecting, composing, constructing, creating, designing, developing, formulating, managing, organizing, planning, preparing, proposing, setting up, writing and 6) Evaluation refers to the ability of appraising, arguing, assessing, attaching, choosing, comparing, defending estimate, judging, predicting, rating, coring, selecting, supporting, valuing, evaluating. In the present investigation, a comparative analysis of effectiveness of PI over Lecture method in influencing the cognitive domain was analysed.

In the present investigation, an experimental study was conducted to compare the effectiveness of PI and Lecture methods in influencing the cognitive domain of extension functionaries on the agriculture subject, 'Climate change, its impact, mitigation and adaptation strategies in agriculture'.

2. MATERIALS AND METHODS

The experimentation was done during 2013-14 in the Staff Training Unit of University of Agricultural Sciences, Bangalore. The respondents were the extension functionaries of the Dept. of Agriculture, Karnataka. Solomon four group research design was envisaged for the study. During training programmes, eight batches were randomly selected. The extension personnel who were trainees in these batches were the sample for the study. The total sample size is 240 extension functionaries, in which, 120 participants each for PI and Lecture methods (four groups of extension functionaries at 30 per group for each of PI and Lecture methods).

In the present study, the researcher has developed the PI material based on the methodology as suggested by Skinner [6]. The new subject selected was *'Climate change, its impact, mitigation and adaptation strategies in agriculture'* which is of contemporary in nature. There are two programming paradigms in the development of PI material namely the linear method and the branched method. In the present investigation, PI was developed using linear method of programming was followed in the development of PI material due to its simplicity in presentation of the given topic. First, the information was through extensive review of literature, the information was edited with the advise of technical expertees, then it was converted in to frames. The readability of the frames was worked out as per the procedure developed by Nanjappa and Siddaramaiah [7]. The worked out 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. Then the PI was pre-tested in the non sampling area and modified based on the suggestions. The final PI material contained 65 frames.

The standardized scale was developed and standardized for measuring the changes in the sub-domains of the cognitive domain namely, (a) knowledge, (b) comprehension, (c) application, (d) analysis, (e) synthesis, and (f) evaluation. For each of the sub-domains five items were included which contained objective type questions consisting of multiple choice questions and fill in the blanks. Thus, overall cognitive domain scale consisted of 30 items.

During the experimentation this standardized scale was utilized during pre-test and post-test for both the treatments *viz*., PI method and Lecture method. For administering PI material, as per the research design requirement, First, pre testing was done to two groups (G_1 and G_2). Secondly, standardized PI material was given to two groups (G_1 and G_3) to go through the material and complete the process. As a third step, post test was conducted for all the four groups using the standardized scale.

In the same manner for administering Lecture method, First, pre testing was done to two groups (G_1 and G_2). Secondly, Lecturing was done to two groups (G_1 and G_3). As a third step, post test was conducted for all the four groups using the standardized scale.

Table 1. Experiment to assess the effect of programmed instruction and Lecture methods

Group/ batch	No. of respondents	Pre-test(Y_b)	Stimulus/ treatment (X)	Post-test(Y_a)
Experiment to assess the effect of programmed instruction				
G_1	30	Yes	Programmed instruction	Yes
G_2	30	Yes	No	Yes
G_3	30	No	Programmed instruction	Yes
G_4	30	No	No	Yes
Experiment to assess the effect of lecture				
G_1	30	Yes	Lecture	Yes
G_2	30	Yes	No	Yes
G_3	30	No	Lecture	Yes
G_4	30	No	No	Yes

The details of experimentation are given in Table 1.

The effect of stimulus /treatment (X) was worked out using the following formula:

$d_1 = (Ya–Yb)G_1 – (Ya–Yb)G_2$ (gives stimulus effect + Sensitizing effect)
$d_2 = (Ya – Yb)G_1 –(Ya – Yb)G_3$ (gives sensitizing effect)
$Z_1 = (d_1 – d_2)$ (gives stimulus effect)
$Z_2 = (Ya)G_3 – (Ya)G_4$ (gives stimulus effect)

$$\textit{Stimulus effect (X)} = \frac{Z_1 + Z_2}{2}$$

Where,

d_1 = difference 1
d_2 = difference 2
Y_a = observations recorded after the treatment
Y_b= observations recorded before the treatment
G_1, G_2, G_3 and G_4 = 1st, 2nd, 3rd and 4th Groups respectively
Z_1 = Stimulus effect 1
Z_2 = Stimulus effect 2

The quantification of effectiveness of stimulus on cognitive domain was worked out using the following formula:

$$\text{ECD} = \sum_{n=1}^{5}\frac{\text{AKS}}{\text{PKS}}\text{X}100 + \sum_{n=1}^{5}\frac{\text{ACS}}{\text{PCS}}\text{X}100 + \sum_{n=1}^{5}\frac{\text{AApS}}{\text{PApS}}\text{X}100 + \sum_{n=1}^{5}\frac{\text{AAnS}}{\text{PAnS}}\text{X}100 + \sum_{n=1}^{5}\frac{\text{ASS}}{\text{PSS}}\text{X}100 + \sum_{n=1}^{5}\frac{\text{AES}}{\text{PES}}\text{X}100$$

Where,

ECD = Effectiveness of stimulus on cognitive domain
AKS = Actual knowledge score
PKS = Possible knowledge score
ACS = Actual comprehension score
PCS = Possible comprehension score
AApS =Actual application score
PApS =Possible application score
AAnS = Actual analysis score
PAnS = Possible analysis score
ASS = Actual synthesis score
PSS = Possible synthesis score
AES = Actual evaluation score
PES = Possible evaluation score

3. RESULTS AND DISCUSSION

The mean cognitive domain scores of PI and Lecture methods of instruction are furnished in Table 2. The results of ***t*** test revealed that there was a significant difference between effectiveness of PI and lecture methods with respect to acquisition of learning on cognitive domain. The results further revealed that, overall cognitive domain effectiveness in PI method (45.17) was significantly higher than the lecture method (32.83). In the areas of sub-domains of the cognitive domain too, the effectiveness scores of PI method of instruction was significantly higher than the lecture method. Fig. 1 illustrated the same.

The PI has unique instructional qualities like (a) ensures active participation of the learner by way of answering questions provided in each frame, (b)ensures repeated reading by learner till the contents are perfectly understood before answering the questions, (c) reinforcement on learners occurs twice by answering question/s and cross checking with the correct answer, (d) creates curiosity among the learners leading to enthusiasm to readers till the end of the event, (e) reader can refer back to the information whenever s/he feels so at any point of time, (f) learners feel different learning experience due to avoidance of monotony, (f) provides complete information on the topic and logical sequencing of subject. These attributes of PI will maximise the learners' acquisition of technology at different stages of cognitive domain. All these qualities may not be found in conventional method, lecture. The findings of Venugopal [8] support the findings of this study. He has observed in his study that the PI was superior to lecture method in acquiring and retaining agricultural technology by educated farmers and high school children.

Table 2. Comparison of effectiveness of PI and lecture methods on cognitive domain of extension functionaries

(n=240)

Sl. No.	Sub- domain/ domain	Effectiveness scores		P (T ≤ t)	t value
		PI	Lecture		
1	Knowledge	47.83	32.33	0.0001	4.14 **
2	Comprehension	38.50	25.67	0.004845	2.93 **
3	Application	37.17	29.67	0.031965	2.20 **
4	Analysis	47.00	36.33	0.023647	2.32 **
5	Synthesis	48.17	35.83	0.003344	3.06 **
6	Evaluation	52.33	37.17	0.004638	2.95 **
	Overall cognitive domain	**45.17**	**32.83**	**0.001**	**6.44 ** **

*** Significant at 1 per cent level*

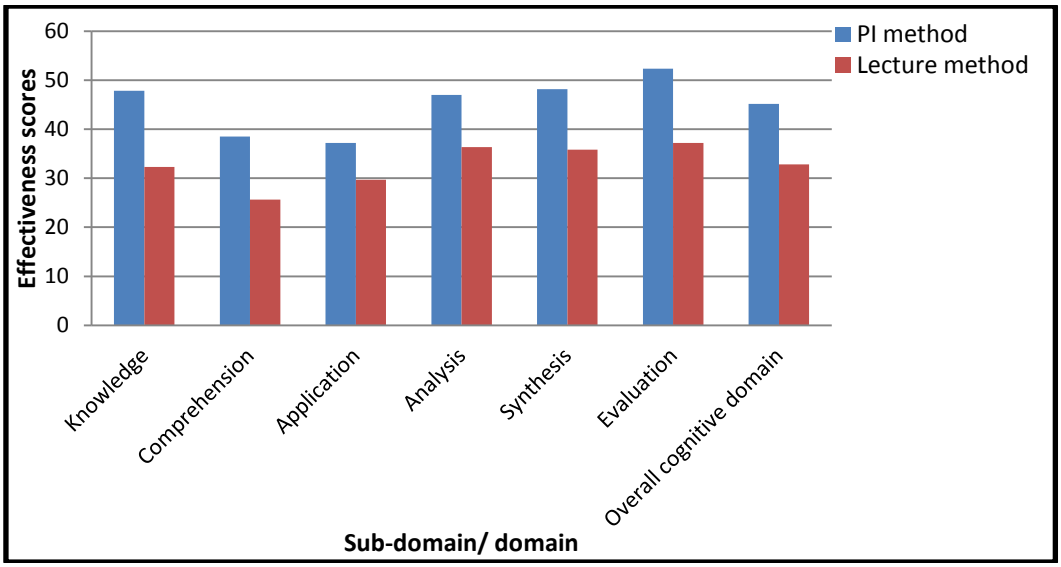

Fig. 1. Effectiveness of PI and lecture methods on cognitive domain of extension functionaries

There were some studies available to indicate the influence of PI over other instructional methods on overall performance of different categories of learners. The findings of Crabb et. al. [9] and Miller [10] revealed that PI was superior to lecture method in acquisition of knowledge.

4. SUMMARY AND CONCLUSION

The comparison of PI and Lecture methods clearly illustrated that PI is superior over Lecture method and has significant effect on the cognitive domain of extension functionaries on the subject - climate change, its impact, mitigation and adaptation strategies in agriculture. Furthermore, it was discovered that PI was successful in learning new technologies across all cognitive sub-domains. Consequently, the optimum use of the PI material is to inform extension functionaries about the sporadic introduction of new agricultural technologies. The employment of PI can also be utilized to influence the literate farmers' intellectual capacities and abilities with regard to new agricultural technologies like protected cultivation, secondary agriculture, etc., which eventually encourages them to adopt these technologies. 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.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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