An Experimental Study to Analyse the Effectiveness of Programmed Instruction in Educating Agricultural Subject on Affective 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

An experimental study was conducted to explore the potentiality of Programmed Instruction (PI) as an educational method in bringing desirable changes in the affective domain of extension functionaries on new agriculture technology, using Solomon four group research design: before-after with three controls considering 120 respondents. The results revealed that, the PI was more effective at organisation sub-domain (51.00) followed by valuing (42.87), responding to phenomena (39.60), receiving phenomena (38.00) and internalising values (35.33). The overall effectiveness score of affective domain was 41.36 signifying that, the PI is an effective educational method.

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1. INTRODUCTION

The Programmed Instruction (PI) is a self-instructional method in which, new subject matter is presented in a graded sequence and through controlled steps. The learners work with the PI material with a speed based on his ability. At each step, learner is expected to answer the questions and then move on to the next step [1]. Behaviourist Skinner [2] proposed the PI methodology based on the theory, 'Operant Conditioning' which states 'an association is developed between a behavior and a consequence which may be positive or negative for that behavior'.

In PI, subject intended to teach is presented in smaller units called frames. Each frame contains part of information followed by the question/s related to the information provided in that frame. The learner has to answer the question/s before moving on to the next frame. The next frame contains the answer for the previous frame; part of the continued information; and the questions related to that frame. The learner has to answer the question/s and move on to the next frame and the process continues till the last frame. By this stage, learner would have learnt and understood the subject which was intended to teach. The speed of learning depends on the ability of the learner.

There were very few attempts made to utilize this method by the agricultural extension functionaries to educate the farming communities in the past. The traditional methods such as lecturing, discussions, meetings, demonstrations, distance education *etc.*, were the chief methods of instruction generally followed in extension education. The effectiveness of PI was proved in many fields such as medicine, nursing, engineering, mathematics, vocabulary *etc.* 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 affective domain of extension functionaries. The PI method of instruction is of significance in the present day situation, where the number of extension personnel is less as well, they are dispersed in their working area. Huge resources required to conduct educational programmes like trainings, demonstrations, discussion meetings, seminars *etc.*, for these extension functionaries. Hence,

the PI can be employed to educate these dispersed extension personnel effectively at a very less cost.

The affective domain according to Bloom et al. [3], is the manner in which we deal with things emotionally, such as feelings, values, appreciation, enthusiasms, motivations and attitudes. The five major sub domains of the affective domain are (a) receiving phenomena, (b) responding to phenomena, (c) valuing, (d) organization, and (e) internalizing values starting from the simplest behaviour to the most complex. Receiving phenomenon indicates the learner's awareness, willingness to hear, selected attention for the subject matter; Responding to phenomena indicates active participation, attending and reacting to a particular phenomenon on the part of the learners; Valuing indicates the worth or value a learner attaches to a particular object, phenomenon or behaviour; Organization indicates organizing values into priorities by contrasting different values; and Internalizing values indicates a value system that controls the learner's behaviour.

In the present study, sensitiveness of PI in influencing the changes under different sub-domains of affective domains was quantified for its effectiveness.

2. MATERIALS AND METHODS

The experiment was conducted in the Staff Training Unit of University of Agricultural Sciences (UAS), Bangalore during trainings organised to Extension Functionaries *viz.*, Agricultural Officers (AOs) / Assistant Agricultural Officers (AAOs) of the Karnataka State Department of Agriculture (KSDA) during 2013-14. The research design used was Solomon four group experimental design: before-after with three controls. The respondents were the participants of the training programmes. The batches were randomly selected for the experimentation. The sample consisted of four groups with 30 extension functionaries in each group and hence, a total of 120 extension functionaries constituted the sample respondents for the study.

In the present investigation, the PI material was developed using the linear method of

programming on the contemporary subject-climate change, its impact, mitigation and adaptation strategies in agriculture. The developed PI material consisted of 65 frames which was got printed into a booklet form of size 21.5cm X 13.5cm dimension. The readability of PI material was found to be at IX grade indicating that the persons with ninth standard and above can easily read and understand.

In the process of measuring the changes in the affective domain, a scalewas developed and standardised. The scale consisted of five items to measure each of the five sub domains of affective domain and thus, overall, scale contained 25 items.

During the experimentation, as per the research design requirement, as a first step, the participants were given orientation on the purpose, method and expected action from the respondents. Secondly, pre testing was done to two groups (G_1 and G_2). Thirdly, standardised PI material was given to two groups (G_1 and G_3) to go through the material and complete the process. As a fourth step, post test was conducted for all the four groups using the

standardised scale. The details of experimentation are given in Table 1.

The effect of treatment/stimulus (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)

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

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

Table 1. Experiment to assess the effect of programmed instruction

Group/batch	No. of respondents	Pre-test (Y_b)	Stimulus/ treatment (X)	Post-test (Y_a)
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

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

$$EAD = \sum_{n=1}^{5} \frac{ARes}{PReS} X100 + \sum_{n=1}^{5} \frac{ARpS}{PRpS} X100 + \sum_{n=1}^{5} \frac{AVS}{PVS} X100 + \sum_{n=1}^{5} \frac{AOS}{POS} X100 + \sum_{n=1}^{5} \frac{AIS}{PIS} X100$$

Where,

EAD = Effectiveness of stimulus on affective domain
AReS = Actual receiving phenomena score
PReS = Possible receiving phenomena score
ARpS = Actual responding to phenomena score
PRpS = Possible responding to phenomena score
AVS = Actual valuing score
PVS = Possible valuing score
AOS = Actual organisation score
POS = Possible organisation score
AIS = Actual internalising values score
PIS = Possible internalising values score

3. RESULTS AND DISCUSSION

The data relating to the effectiveness of stimulus (the true effect of PI after eliminating the sensitisation effect due to pre test, checking the uncontrolled and other natural causes of influences on the respondents) on sub-domains of affective domain are presented in Table 2. The data indicate that the PI had considerable effect on extension functionaries in receiving, responding to phenomena, valuing, organisation and internalising values relating to the technology presented to them. Out of five sub-domains of affective domain, the PI was more effective at organisation sub-domain (51.00) followed by valuing (42.87), responding to phenomena (39.60), receiving phenomena (38.00) and internalising values (35.33). The illustration of the same has been presented in Fig. 1.

The findings of the study revealed that PI was effective at all sub-domains of affective domain in influencing the extension functionaries' mastery on the climate change subject.

The PI method has several advantages over conventional methods *viz.*, (a) provides positive reinforcement in a contingent manner on the accomplishment of each step, (b) has built in mechanism of self-instruction and self-testing, (c) coherence of the programme- mastering step by step, (d) immediate knowledge of the results, (e) increased probability of answering correctly, (f) the learning rate depends on the learners capabilities, (g) suitable for all categories of learners, (h) has no spatial restriction.

There are several classical theories that support to prove the effectiveness of PI in learning. Important ones are (a) cognitive load theory [4] which states that working memory load should be reduced in order to facilitate the changes in long term memory associated with schema acquisition; (b) theory of conditions of learning [5] suggests the subject matter should be arranged from simpler to complex intellectual skills. (c) connectionism theory [6] explains that, connections are more readily established if stimuli and responses are perceived together by the learner. (d) constructivist theory [7] states that a theory of instruction should address four major aspects *viz.*, inclination towards learning, structuring the body of study material, sequencing from easier concepts to the complex

concepts and pacing of rewards and punishments; (e) theory of criterion referenced instruction [8] states that to bring out specific outcomes, comprehensive instructional frame work with criterion reference should be there; (f) minimalism theory [9] suggests that all learning tasks should be meaningful and self-contained activities, after each learning, realistic projects should be given as quickly as possible. There should be scope for self-directed reasoning by increasing the number of active learning activities, the errors should be included in the teaching material in such a way that, the learner should be able to recognise it and correct it; (g) theory of modes of learning [10] proposed that there are three modes of learning: accretion, structuring and tuning. Accretion indicate the addition of new knowledge to existing memory. Structuring means the configuration of new conceptual structures or schema. Tuning means, adjustment of knowledge to a specific task usually through practice; (h) repair theory [11] imply that problem sets or questions should be set in such a manner, to eliminate the bias likely to cause specific mistakes and mistakes are introduced often, when students try to expand procedures further than the early examples provided; (i) script theory [12] indicate that events are understood in terms of relevant previous experiences, scripts, plans and other knowledge structures.

The Table 2 reveals that effectiveness of the PI on affective domain of extension functionaries ranged from 35.33 to 51.00. The findings are discussed for each sub domain of affective domain are discussed in the following paragraphs.

The data on *receiving phenomenon* is supported by construction-integration theory of Kintsch [13] which states that memory is created by the process of simultaneous thinking by processing of text by a reader which occurs in cycles, usually clause by clause. it is influenced by (a) previous knowledge of the reader on the topic (b) goals and motivations of the readers (c) readers strategy selection and use, (d) the difficulty, kind and type of the text, (e) constraints of the readers memory with respect to processing and (f) readers ability to learn. Thus, the PI had effectively provided an opportunity to the extension functionaries in receiving the technology related to climate change as revealed by the mean score of 38.00.

Table 2. Effectiveness of PI on affective domain of extension functionaries

(Mean scores)

Particular	Affective domain	Sub-domains of affective domain				
		Receiving phenomena	Responding to phenomena	Valuing	Organisation	Internalising values
G_1: Pre test (Y_b)	25.44	28.00	25.60	24.67	22.93	26.00
G_1: PI + Post test (Y_a)	96.75	97.47	96.93	95.73	98.13	95.47
G_2:Pre test (Y_b)	30.93	26.40	24.13	24.80	25.20	54.13
G_2: Post test (Y_a)	36.00	26.53	37.07	33.47	26.80	56.13
G_3:PI + Post test (Y_a)	59.81	49.73	65.33	59.47	64.80	59.73
G_4: Post test (Y_a)	31.84	23.33	38.53	24.53	26.00	46.80
$d_1 = (Y_a\text{-}Y_b)G_1 - (Y_a\text{-}Y_b)G_2$	66.24	69.33	58.40	62.40	73.60	67.47
$d_2 = (Y_a\text{-}Y_b)G_1 - (Y_a\text{-}Y_b)G_3$	11.49	19.73	6.00	11.60	10.40	9.73
$Z_1 = d_1\text{-}d_2$	54.75	49.60	52.40	50.80	63.20	57.73
$Z_2 = (Y_a\text{-}Y_b)G_3 - (Y_a\text{-}Y_b)G_4$	27.97	26.40	26.80	34.93	38.80	12.93
Stimulus (PI) effect $= Z_1 + Z_2/2$	41.36	38.00	39.60	42.87	51.00	35.33
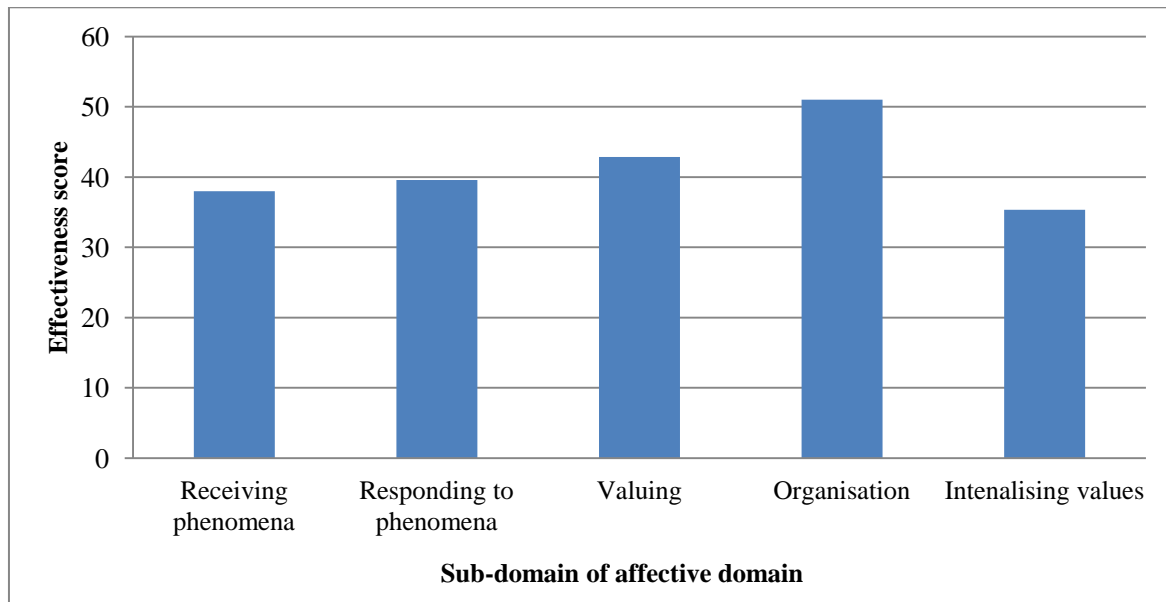
Fig. 1. Effectiveness of PI on sub-domains of affective domain of extension functionaries

The mean score obtained with respect to the second sub-domain of the affective domain, *responding to phenomena* was 39.60. This outcome of learning emphasizes compliance in responding, willingness to respond, or satisfaction in responding (motivation). The mental model theory by Gunning [14] lend support to this sub-domain. The theory states that, the learner creates a mental model of circumstances in which the character finds him or herself. The structure of the PI is such that the learner has to give response to the question/s given at the end of the frame. It compels the learner to immediately respond to the stimulus given in the frame. Thus, the PI could influence significantly at this sub-domain.

The third sub-domain, *valuing* is expressed in the learner's overt behaviour and is often identifiable. The expectancy-value theory by Fishbein and Ajzen [15] states that, most of the individual do not wish to choose the task or to continue with the existing task when they expect to fail. Value refers to the various reasons by which, individuals might engage in the task. It has three basic components namely, belief, value and expectations. Further, the double loop learning theory by Argyris [16] states that there are four basic steps in theory of learning: (a) discovery of espoused and theory-in-use, (b) invention with respect to new meanings, (c) producing new actions, and (d) generalizing the results. In double loop learning, assumptions of current views are questioned and publically

hypotheses about behaviour tested. The end result is increased effectiveness in decision making and better acceptance of failures and mistakes. It was possible for extension functionaries to assess the worth or value of technology presented to them in PI material. Therefore, the significant influence of PI (42.87) was demonstrated at this sub-domain.

The highest mean score of 51.00 was observed with respect to the *organisation* sub domain. The proposition theory by Gunning [14] states that a Learners through processing the text, develops a capacity to construct a main idea or macrostructure. The ideas are organized in hierarchical manner in such a way that, the most important things are the highest priority to be memorised. The very nature of PI material having information arranged in a sequence, noting similarities and differences between or among entities, grouping and labelling entities on the basis of their attributes, sequencing entities according to a given criterion and changing the form, but not the substance of information. Thus, PI had maximum influence at organisation sub-domain.

The fifth sub-domain of the affective domain is *internalising values*. This behaviour is consistent, pervasive, predictable, and most importantly, characteristic of the learner. Instructional objectives are concerned with the learner's general patterns of adjustment (personal, social,

emotional). Constructivist theory of Brunner [7] stated that the learner relies on cognitive structure for selecting and transforming information, constructing hypothesis and making decisions. The cognitive behavioural theory by Beck [17] says that individuals form self concepts which may be positive or negative which affect their overt behaviour. The PI has provided opportunity for the extension functionaries to acquire selected information and ignoring others, structuring their technical needs and establishing the direction for the use of technology had provided an opportunity for them to internalise the values relating to the technology presented to them. Thus, PI had significance influence (35.33) at this sub-domain.

4. CONCLUSION

The PI demonstrated positive and significant effect on all the sub domains of affective domain as well, overall affective domain of extension functionaries in acquiring new subject, climate change, its impact, mitigation and adaptation strategies in agriculture. Hence, PI can be used for modifying the feelings, values, motivations and attitudes of the literate persons on new technologies emerging from time to time. Further, PI can be a better instructional method to bring desirable attitudinal changes in the learners even in the situations where, the frequency of meeting of teachers and the learners are less such as in distance education and in the situations, where there is scarcity of teachers, such as isolated schools in the hilly areas. PI can be used for modifying the intellectual abilities and skills of the literate farmers also on new agricultural technologies like protected cultivation, secondary agriculture *etc.*, which intern drive them towards adoption of these technologies.

In the present investigation, the PI was developed through linear approach. As a future line of work, It may be interesting to evaluate the effectiveness of different programming approaches like branching also. The PI material can be digitised and presented in the form of teaching machines using ICT tools and this may be evaluated for its effectiveness.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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