

PROGRAMMED LEARNING TECHNIQUE: AN EFFECTIVE TOOL IN TEACHING AND LEARNING GENETICS- MENDELISM AND GENE INTERACTIONS AT UNDER GRADUATE LEVEL.

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Abstract - Genetics is an important basic subject in biology. It covers some allied aspects and becomes difficult to learn and remember. Traditional lecture method is difficult to apply while teaching genetics. Students face number of difficulties which are tried to summarize. As a solution Programmed Learning Technique is applied in classroom and found to be useful for teaching mendelism and gene interactions. It is useful to maintain flow in the chunks of information as well as provide the checkpoints to assess students' gain. On the basis of increased performance in post test qualitatively and quantitatively, it found to be effective in teaching these subunits at undergraduate level.

Key Words: Mendelism, Gene Interaction, Programmed learning technique, Undergraduate Level

1.INTRODUCTION

A continuing interest in discovering ways of increasing instructional efficiency and providing suitable materials for independent study prompted the development and testing of programmed materials for use in self-instruction devices or teaching machines in the field of introductory science, psychology, and music etc. The rationale of the teaching machine and its applicability in independent study has been discussed by Skinner (1958); reviews of the present state of the field occur in Galanter (1959) and Silverman (1960); a source book has been prepared by Lumsdaine and Glaser (1960).

Knippels *et al.* (2000) had interviewed biology teachers and ten meaningful problem categories were extracted as far as teaching and learning genetics is concerned. These are abstract nature of subject, complexity, probabilistic reasoning, image in the student's mind, mode of examination, terminology in the subject, symbolizing, background knowledge etc. In the classroom teaching during present work it is observed that genetics is quite difficult to the students at undergraduate level. Basically it seems that the study of genetics requires a good blending of knowledge of other aspects in biology ie pollination biology, cell division and even statistical approach etc. Therefore, it

thought worth to provide stepwise material to students to make their knowledge base sound.

The preparation and evaluation of Programmed Learning Material was found to be effective in terms of achievement of students on various subjects has been the subject of study for many researchers like Bhushan (1973), Dewal (1974), Patel (1977), Sodhi (1977), Sansanwal (1978), Parlikar (1979), Pandey (1980), Trivedi (1980), Man (1981), Choudhary (1985), Gautam (1986), Thaker (1993) and Agashe (1995).

Gautam (1986) conducted a study to find out achievement in relation to creative thinking and level of aspiration, while using programmed instructional material.

Program learning material was found to be as effective as conventional method in terms of achievement of students by Chandrakala (1976) and Govinda (1976). Few researchers conducted studies to find out the achievement level and favourable opinion towards program learning material (Chauhan, 1973, Mavi, 1981, and Davies, 1982).

In case of Mendelian genetics this type of work is carried out by Larson (1964) at high school level where it was an introductory subject. The present paper reports effectiveness of program learning instructions in teaching Genetics – Mendelism and Gene Interactions as whole units at undergraduate level.

2.MATERIAL AND METHOD

The units Mendelism and Gene Interactions are included in B.Sc. I Botany syllabus of Shivaji University, Kolhapur- Maharashtra (India). These units include sub-units mentioned in Table No. 1. It is found to be difficult to understand by students. Therefore, by discussing the students difficult parts in the units were identified. Exact difficulties were also identified and arbitrary difficulty levels were determined. The subunits were taught in the regular classes through lecture method. The students were allowed to study for four days, after which pre-test was conducted. To mitigate the difficulties in learning genetics, programmed learning technique was first introduced to the students followed by provided the frames

(program learning material) to them. Each subunit was again discussed with the help of the frames. Sub unit wise the frames were prepared (Table No.-2). Students tried to learn each frame completely one after another. The frames were organized as per the dependency levels of sub units. Actually meiosis is not included in genetics but thought worth to include because it is one of the important base of genetics. While preparing the frames inclusion of extra information was avoided but connectivity of each frame with previous and later one was purposefully maintained. Then post-test was taken using question paper parallel to pre-test.

The marks obtained by the students in pre-test and post-test were analyzed statistically.

3. RESULT AND DISCUSSION

Genetics is considered as difficult and complex topic because it encompasses related topics in biology like cell division, embryology, evolution etc. It also includes statistics and mathematics up to certain level. During regular classroom teaching it is observed that students cannot easily involve in this topic. Moreover, mere lecture method is very difficult to apply for this topic. Therefore, it is thought worth to teach this topic using programmed learning technique.

Programmed learning technique is also called as programmed instruction method. It is a teaching technique in which a learner is presented with a small chunk of information and is asked to answer the questions after understanding it. Basically it is self passed, self administered process. But in the present piece of work it is combined with regular classroom teaching.

Prior to the implementation of this technique the problems related to learning genetics were collected. Most of the students have difficulties in correlating the subject matter with their previous knowledge. Knowledge of meiosis is important in learning genetics. Either it is not studied well by the students or it cannot be easily correlated with genetics. It is difficult to found the interrelations between meiosis and genetics. Terms like homozygous and heterozygous are somewhat difficult for students to learn. Contrasting characters of pea plant cannot be memorized due to lack of observations. Presentation of laws and other interactions in the form of checker board found to be difficult. Stating the genetic interactions and

presenting them with the help of suitable example is difficult to students. These difficulties with arbitrary levels are summed up in Table No. 1.

Prior to implementation of program learning technique regular teaching of the units was completed using lecture method and pre-test was undertaken.

The students were instructed to paste the frames in blank note book one after another by leaving one or two pages after each plate. During and after discussion of the frames, students were encouraged to write their impressions in their own language. After discussion of all the frames two days were allotted to students to study using the frames. Pre-test and post-test question papers were set by maintaining the same skeleton and difficulty level. Both the papers carried 20 marks each, including match the pairs, answer in short, and answer in detail.

The analysis of pre-test and post-test marks is given in the Table No. 3 average increase in the marks in post test is 6.19 ± 2.41

It indicates that program learning technique is effective as there is increase in the marks in post-test than pre-test. It is quantitative approach. Qualitative analysis of answer sheets is also made. It is depicted in Table No. 4. There is an enhancement in memorization of terms in genetics, contrasting characters as well as reasons for Mendel's success. There is improvement in stating Mendel's laws. Remembrance of gene interactions ratios and example increased satisfactorily. Overall Programmed learning technique by providing program learning material in the form of frames is effective in teaching and learning Genetics (Mendelism and Gene interactions) at undergraduate level. On the basis of class room experience it can be suggested that the frames should be provided and discussed in class room. Students should be encouraged to write their impressions in their own words. It helps in memorizing and recalling the matter.

Table -1: Difficulties faced by the students and difficulty level of individual sub unit in genetics.

Sr. No.	Name of the unit	Difficulties	Difficulty level
1	Introduction of genetics		**
2	Genetics terminology	Number of terms are to be memorize	*****
3	Meiosis	Difficult as it is a stepwise process, get jumbled with mitosis	*****
4	Contrasting characters of pea plant	Lack of actual field observations or diagrams or pictures	**
5	Reasons for Mendel's success	These cover different aspects.	***
6	Mendel's law of Dominance	Difficult to state correctly.	**
7	Mendel's law of Segregation	Difficult to state correctly.	**
8	Mendel's law of Independent assortment	Difficult to state correctly.	**
9	Monohybrid cross and monohybrid ratio.	Presentation in the form of checker board	***
10	Dihybrid cross and dihybrid ratio.	Presentation in the form of checker board	***
11	Back cross	Presentation in	*****

		the form of checker board	
12	Test cross (Dihybrid cross)	Presentation in the form of checker board	*****
13	Introduction of gene interaction	Difficult to imagine that number of genes are expressing at a time and affecting each other.	***
14	Complementary gene interaction	Difficult to state correctly. Example cannot be remembered	*****
15	Supplementary gene interaction	Difficult to state correctly. Example cannot be remembered	*****
16	Dominant epistasis	Difficult to state correctly. Example cannot be remembered	*****

Table: 2. Following frames (Program learning material) were prepared for 'Programmed Instructions' on the subunits of Mendelian Genetics and Gene Interactions.

Sr. No.	Name of the plate / Frame	Content
1	Introduction of genetics	Brief historical account, Mendelian and post Mendelian genetics, Factor to Gene
2	Genetics	Basic terms in Mendelian genetics supported with

	terminology	suitable examples.
3	Meiosis	Knowledge of meiosis is important as a baseline for genetics. Because in punnett square gametes are to be shown.
4	Contrasting characters of pea plant	Dominant and recessive characters of stem, seed, cotyledon, pod, flower color and flower position in pea plant with diagrams.
5	Reasons for Mendel's success	Different reasons for Mendel's success in genetics are discussed. These include suitable characters of pea plant such as its short life cycle, sex organs hidden inside the corolla, possibility of both self and cross fertilization. Mendel's scientific approach, maintenance of up to date record, statistical analysis as well as sincere efforts.
6	Mendel's law of Dominance	Statement of the law with example.
7	Mendel's law of Segregation	Statement of the law with example.
8	Mendel's law of Independent assortment	Statement of the law with example.
9	Monohybrid cross and monohybrid ratio.	Description with example
10	Dihybrid cross and dihybrid	Description with example

	ratio.	
11	Back cross	Definition with example.
12	Test cross (Dihybrid cross)	Description with example
13	Introduction of gene interaction	It is introduced that the phenotype is interactive effect of number of genes. It is synchronized, blended and coordinated activity of all genes. These interactions are called as gene interaction. Also the names of gene interactions are stated.
14	Complementary gene interaction	Verbal description of an interaction with example and punnett square. Phenotypic ratio of the interaction.
15	Supplementary gene interaction	Verbal description of an interaction with example and punnett square. Phenotypic ratio of the interaction.
16	Dominant epistasis	Verbal description of an interaction with example and punnett square. Phenotypic ratio of the interaction.

Table No: 3. Analysis of pre-test and post-test marks.

Number of students - 80	Pre test marks	Post test marks	Increase in the marks
Range	03-17	05-20	
Average	9.38	15.57	6.19
Standard Deviation	3.93	3.75	2.41

Table No: 4. Qualitative analysis of answer sheets

Achievement in terms of	Pre test performance	Post test performance
Memorizing the terms in genetics	Average number of terms memorized – 5 out of 20	Average number of terms memorized – 14 out of 20
Memorizing the contrasting characters of pea plant	Average number of characters mentioned – 2 out of 7	Average number of characters mentioned – 5 out of 7
Memorizing the reasons for Mendel's success	Average number of reasons mentioned – 2 out of 9	Average number of reasons mentioned – 7 out of 9
Stating the Mendel's laws correctly	1 out of 3	2 out of 3
Memorizing monohybrid, dihybrid cross with ratios, back cross and test	0 out of 3	2 out of 3

cross		
Stating the gene interactions correctly	0 out of 3	2 out of 3
Memorizing the ratios of different gene interactions	1 out of 3	2 out of 3
Reproducing the example of gene interaction with accurate punnett square	0 out of 3	2 out of 3

3. CONCLUSIONS

Programmed learning technique is effective in teaching and learning Genetics (Mendelism and Gene Interaction) at undergraduate level.

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