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Research Article

Effect of Mastery Learning Strategy on Achievement of Students in Biology

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ABSTRACT

This study was aimed at investigating the effect of mastery learning strategy on achievement of students in Biology. The pre-test and post-test control group experimental design was employed in this study to evaluate the outcomes of the mastery learning strategy and the conventional method of teaching in order to find out the relative effectiveness in producing mastery. The sample comprised 54 secondary school students of class IX. Control group was taught through conventional method and the Experimental group was exposed to mastery learning strategy. Mastery learning strategy with programmed learning material was used to enable the students to attain minimum level of competence. Criterion-referenced tests were used to know the achievement of students and Raven's Progressive Matrices (RPM) was used to measure the intelligence of the students. Content validity was ensured while constructing the criterion-referenced tests for the study. Analysis of the data was done using z-test and t-test. The results showed that the performance of students who were exposed to mastery learning strategy was better than the performance of students who were taught through conventional method of teaching. The findings indicate that mastery learning is possible for students of all intellectual levels provided they are given an opportunity to learn at their own pace. There is a need to develop competence among pre-service and in-service teachers to develop and use self-pacing instructional strategies. Educational Institutions and organisations may develop and use different types of instructional materials for individualising instruction to facilitate students to attain minimum level of competence in various subjects which in turn improves the quality of education.

1. Introduction

The fact that there are individual differences among pupils - physical characteristics, intellectual ability, interests, needs, pace of learning, the degree of retention, etc. - has long been recognised. Though some of these differences may be of no consequence as far as school is concerned, others have important implications for teaching. Educators generally accept the proposition that there ought to be some differentiation in instruction to accommodate individual differences. Unfortunately, in practice most approaches for individualising instruction do not reach the ideal. Most of the techniques used to provide for individual differences are simply techniques by which teachers manipulate course content so that it is easier for some pupils and more difficult for others; give some pupils to progress more or less rapidly than others do.

All students go through a set of experiences designed to produce 'mastery'. The students' attainment of mastery is basically made on summative norm-referenced system. Summative evaluation is also used in decision making. Such evaluation makes group comparison on a normal curve. In this system of evaluation, a group norm is obtained and is then used as a yardstick to identify whether a given student is above or below the group average. Norms are sometimes established before a test is given; at other times norms are identified using the test results as data. Teachers offer 'curve' grades to ensure that a proper ratio of different grades are found in class, and in doing so they are simply comparing students, identifying the above average, average and below average. Bloom (1971) pointed out the shortcomings of using the normal curve or other comparative statistical procedures in evaluating student achievement.

The evaluation is usually based on the historical definition of 'aptitude' in education and psychology which stated that 'some can and some cannot'. The function of evaluation has been to screen out the can'ts from the can's. In rethinking the

notion of aptitude, Carroll (1963) suggested that aptitude is the 'amount of time required by the learner to attain mastery of a learning task'. Bloom (1971) noted: 'Most students (perhaps more than 90 percent) can master what we have to teach them, and it is the task of instruction to find the means which will enable the students to master the subject under consideration. Our basic task is to determine what we mean by mastery of the subject and to search for the largest proportion of our students to attain such mastery'. Mastery learning rests on the fact that most students can learn and that a teacher has the responsibility for working with them until they do learn. If Caroll's definition of aptitude is accepted, careful consideration must be given to the time required for a learning task. In fact, time becomes a variable that is determined by the internal and external needs and capabilities of the learner.

Mastery learning focuses on students' acquisition of specific abilities. In other words, the education programme includes a set of learning objectives that are stated so that their accomplishment can be observed in the form of specified learner behaviours or knowledge. Learning activities are geared to assist each student in acquiring al least the minimum levels of competence. Mastery learning offers a powerful new approach to student learning which can provide almost all students with the successful and rewarding learning experiences. It proposes that almost all students can master what they are taught. Mastery learning produces greater student interest in the subject learned than conventional methods.

Block (1971,), Bloom (1976) Block and Burns (1976) have reviewed numerous studies which indicate that mastery learning procedures can increase the achievement levels of approximately 80 percent of students to the high levels now enjoyed by only 20 percent of students. Many other studies were undertaken which indicate that mastery learning strategy increases the achievement levels of students (Burrows and Okey, 1975; Collins, 1969; Ezewu, 1979 and 1982; Hooda, 1987; Majid and Zahra, 2010; Mfon Effiong and Theresa Maurice, 2014; Patriciah and Johnson, 2008; Sunday Adeyemo and Veronica, 2014). Some studies were also conducted to know the impact of mastery learning on retention and the studies revealed that students demonstrate significantly greater retention. (Anderson etal., 1970, Koul and Chand, 1985, Poggio, 1975, Romberg etal., 1970).

The three important aspects of the learning situation are the cognitive entry behaviours of the students, the affective entry characteristics of the student and the quality of instruction (Bloom, 1971). Mastery learning (Bloom, 1976, Block and Burns, 1976) focuses primarily on student's abilities to understand instruction by attempting to ensure that all students have mastered the previous skill before attempting the next. According to Bloom's research, initial affective characteristics can account for up to one-fourth of the variation on relevant cognitive achievement measures. Mastery learning research on the affective and cognitive domains of school outcomes reviewed by Block and Burns (1976) did show that the approach has not only produced significant positive effects on school learning but also on the affective disposition of the learners. Block (1971) analysed the studies undertaken by Airasian (1967), Bloom (1968), Biehler (1970), Kersh (1970), Kim (1969) and summarised that these studies report significant effect on students' cognitive and affective development and pace of learning.

Mastery learning programme takes many forms, some of which are individual-based and some are group-based. The most typical mastery learning programme in elementary and secondary schools are group-based methods based on procedures described by Block and Anderson (1975). Research on group-based mastery learning has consistently claimed that these methods increase student achievement more than traditional methods (Block and Burns, 1976, Guskey & Pigott, 1988). Corrective instruction for the mastery classes is provided for teaching the subject at hand. (Arlin and Webster, 1983, Wentling, 1973).

Different methods of grouping students have been attempted in an effort to minimise some of the problems inherent in a class with a wide range of individual differences. These types of ability grouping have taken on many forms and apparently have met with varying forms of success. On one end of this continuum is the intra-class grouping on ability grouping within a self-contained heterogeneous class whereby a teacher attempts the herculean task of teaching three or more groups within a large single class of students. On the other end of this ability grouping continuum is the complete ability-grouped homogeneous class which moves together on its special track for a year or two years or even longer. These two types as well as the many degrees of grouping between them have all been attempts to meet the problem of individual differences. Many studies were done on students of different ability levels (Anderson and Reynolds, 1979).

In order for the teacher to cope adequately with the wide range of students' abilities represented in the classroom, it is probably necessary to diagnose the class relative to the skills involved and follow with remediation. However, giving individual attention to each student by the teacher is not practical. With four to five classes each day, with a total of 150-200 boys and girls, a teacher finds it an impossible task to give the individual attention that is needed. Teachers need self-pacing learning materials to individualise instruction to meet the cognitive and pedagogic needs of the learner. Such self-pacing instruction can allow teachers the time for essential one-to-one interactions with students to ensure that they understand the gestalt of the learning experience. Teachers may also help students in seeking unique ways of applying newly acquired knowledge and skills, and they may urge students beyond minimum learning requirements. By having teachers spend considerably more time with students in one-to-one or small group interactions, students and teachers come to know each other. This situation may provide scope for increased attention to the individual student's learning needs.

Programmed instruction has gained recognition in the schools as one of the self-pacing instructions. The major strength of programmed instruction rests on the fact that it is self-instructional. With such instruction, students may learn at their own speed and take whatever time is necessary to complete the learning task. If programmed materials are made available to students both for directed classroom study and for additional use as needed, no student will be held back by his/her classmates nor will he/she in any way restrict the pace at which others progress through the subject matter. A teacher can supervise a study period in a classroom where large number of students are learning, each with his/her own programmed learning material, proceeding at his own pace in constant interaction with the programme. The teacher's presence is required in order to provide personal guidance

when required, and to check frequently on the progress of the students particularly those students who have academic difficulties. All students after completing the programmed instruction may not do equally well in a test that directly tests knowledge of the content of programmed learning material. Some recognition must be made of these differences and some students might do remedial work by redoing parts of the programme where it seems to be necessary. Programmed instruction promises to increase the effectiveness of student learning by offering individual instruction to all students more effectively than a teacher can do as long as the teacher is faced with the problem of producing learning in a large group of students all at the same time. Programmed instruction was found to be more efficient than conventional method of teaching in terms of performance in achievement tests (Hedges & Mac Dougall, 1965, Sharma, 1984), Young, 1968).

A number of studies have made recommendations to use mastery learning strategies based on empirical data. Some studies reported that in spite of varying degrees of individual differences, mastery learning strategy was effective in bringing most of the students to a high level of achievement. It was shown by some studies that programmed learning material systematically increased the percent of students attaining mastery.

Programmed instructional materials are used in this study in a mastery learning strategy and this study is an attempt to investigate the effectiveness of mastery learning strategy on the achievement of students in Biology.

Hypotheses of the Study

The purpose of the study was to compare the students receiving instruction under the mastery learning strategy with those under the conventional method in terms of their mastery of the subject under consideration. The following hypotheses were formulated for testing.

1. The Mastery learning strategy and the conventional method of teaching produce significant proportion of masters of learning tasks in biology.
2. The proportion of students of the experimental group mastering the learning tasks is significantly greater than that of the control group.
3. There is no significant difference between the pre-test to post-test correlations with intelligence for the experimental and control groups.
4. There is no significant difference between the proportion of boys and girls mastering the overall learning task in the experimental and control groups.

Objectives of the Study:

The major objectives of the study are:

1. To study the effectiveness of the mastery learning strategy on achievement in biology.
2. To study the relative effectiveness of the mastery learning strategy and conventional method on achievement in biology.
3. To study the appropriateness of the mastery learning strategy and the conventional method for students of different intellectual levels in their achievement in biology.
4. To study the appropriateness of the mastery learning strategy for boys and girls in their achievement in biology.

2. Design and Methodology

2.1 **Sample**

The subjects of this study were 54 students studying in class IX. There were two sections in class IX and both the sections were selected for the study. Section A composed of 29 students, 14 boys and 15 girls and Section B composed of 25 students, 07 boys and 18 girls. The students in both the sections ranged in age from fourteen to fifteen years. There was no significant difference in intelligence between the students of the two sections. One of the methods of teaching was selected randomly by drawing lots and assigned to one of the sections and the other method to the second section. Thus, the mastery learning strategy was assigned to Section A (experimental group), while the conventional method of teaching to section B (control group).

2.2 Development of Programmed Learning Material

Programmed learning material for two units in Biology i.e., Respiration and Excretion was prepared. The steps followed to develop the programmed learning material were i. selection of the topic, ii. formulating broad objectives, iii. specifying objectives in behavioural terms, iv. analysis of objectives, v. analysis of content, vi. development of the frames, and vii. try out of the programme.

2.3 Treatment

Before the experimentation, the investigator had planned with the regular biology teacher, the instructional procedures to be followed during the experimental period. Both the groups used the same textbook and covered the same topics – Respiration and Excretion. These topics were divided into five sequential learning tasks –

1. Respiration in plants and lower animals
2. Respiration in higher animals
3. Mechanism of respiration
4. Excretion in plants and lower animals
5. Excretion in man

Both the groups were not taught these topics before the experimentation. The control group was taught by the regular biology teacher. During the experimental period the control group continued to receive instruction in a more conventional approach. The group received instruction for five hours a week for two weeks of the experiment. During the same hours of instruction, the experimental group was engaged in programmed instruction using the programmed learning material on all the five learning tasks developed by the investigator. The experimental classes were organised and operated on individualised instructional plan through out the experimental period by the investigator. Since, attaining mastery of the learning tasks is the desired goal of a mastery learning strategy, the students of the experimental group were provided with more instructional time during the school hours to pace their learning to attain mastery of the learning tasks.

2.4 Administration and Scoring of Tests

Criterion-referenced tests were used to know the achievement of students and interpreted the scores on the tests

measuring the objectives on each of the learning tasks on a criterion basis. Content validity was ensured while constructing the criterion-referenced tests for the study.

At the beginning of the experiment, the summative test on the five learning tasks was administered to both the groups to assess their overall mastery of the topics. The students' performance on the test was scored with the help of the scoring key and the number of items answered correctly on the test was obtained. The number of students securing 80 percent or more correct responses was used to determine the proportion of masters of the topics under consideration in each group. The analysis of the pre-test results indicated that none of the students in either of the groups was a master.

At the beginning and end of instruction of each learning task, a formative test on the learning task was administered to both the groups. The test was scored and students were informed of their performance. The same procedure was followed for all the five learning tasks. The proportion of masters of each learning task in both the groups was obtained.

At the time of the experimental period, the summative test was again administered to both the groups. The procedure for scoring and determining of the proportion of masters of the overall task followed in the pre-test was followed for the post-test also. The results are presented in the table in the analysis and interpretation section.

The students' intelligence was measured through Raven's Standard Progressive Matrices (RPM). The intelligence was measured because in comparing the effectiveness of mastery learning strategy with the conventional method of teaching, it is possible that one method might be more appropriate for above average intelligent students.

3. Data Analysis and Interpretation

From the data relevant to each hypothesis, the required statistics such as percentage of masters, standard error of proportions and standard error of difference between proportions were computed. The z-score was used to determine the statistical significance of proportion of masters of the learning tasks from the experimental and control groups and to establish the significance of the difference between the proportions of masters from the two groups. The t-test was used to study the significance of correlations between the pre-to post with intelligence for the two groups and the difference between pre-to post-test correlations with intelligence of the experimental and control groups.

3.1 Percentage of Correct Responses in Formative and Summative Tests of Treatment Groups

The study is predicted on the hypothesis that mastery of the subject studied is lacking in many students under conventional method of teaching and as a consequence, individualised instructional strategy is needed to promote mastery. To test this hypothesis, a formative test analysis of each of the five learning tasks and summative test analysis of the total task was made. The analysis consisted simply of determining the percentage of correct responses for each formative test and summative test by treatment. The results are shown in table -1.

The data in table - 1 reveal that the experimental group has mastered each of the learning tasks and the total task better than the control group. While the mastery learning strategy has enabled the students to answer 80 percent or more questions in each of the formative tests and summative test, the students taught through conventional method of teaching could respond to 54-68 percent of questions.

Table–1: Percentage of correct responses by test and treatment

Test	Learning Task	Percentage of correct responses	
		Experimental Group (N:29)	Control Group (N:25)
Formative Test - 1	Respiration in plants and lower animals	85	59
Formative Test - 2	Respiration in higher animals	90	62
Formative Test - 3	Mechanism of respiration	84	60
Formative Test - 4	Excretion in plants and lower animals	86	54
Formative Test – 5	Excretion in man	84	58
Summative Test	Respiration and Excretion	80	68

If the minimum level of proficiency that is expected to be attained is 80 percent or more, the mastery learning strategy seemed to meet this requirement. However, the conventional method of teaching is far from being an effective tool. The levels of mastery that are shown in the above table reflect a competence which is less than that which is expected and are to be taken as evidence that conventional method of teaching does not meet the requirements of all students.

Further analysis was made to determine the effectiveness of methods to develop mastery at different objective levels in the learning tasks for both the groups. The percentage of correct responses in each learning task at each of the objective levels - knowledge, understanding and application - for the experimental and control groups are reported in table - 2.

A comparison of percentage of correct responses for the experimental and control groups revealed that the percentage of correct responses in each learning task at each of the objective levels for the experimental group was higher than the corresponding percentage of correct responses for the control group.

The percentage of correct responses in the learning tasks at different objective levels did not differ significantly for the experimental group. There was no relationship among the percentage of correct responses at different objective levels in all the learning tasks for the control group.

Table-2: Percentage of Correct Responses in Formative and Summative Tests by Objective Levels and Treatment Groups

Test	Learning Task	Group	Objective Level		
			Knowledge	Understanding	Application
Formative Test - 1	Respiration in plants and lower animals	Experimental Control	92 58	86 63	87 54
Formative Test - 2	Respiration in higher animals	Experimental Control	97 84	90 46	81 56
Formative Test - 3	Mechanism of respiration	Experimental Control	90 71	79 52	84 60
Formative Test - 4	Excretion in plants and lower animals	Experimental Control	83 55	86 55	88 50
Formative Test – 5	Excretion in man	Experimental Control	89 66	85 62	74 36
Summative Test	Respiration and Excretion	Experimental Control	92 82	58 54	79 58

The percentage of correct responses in the summative test and the formativ e test 3 i.e., Mechanism of Respiration was high at the knowledge level and low at the understanding level for both the groups.

3.2 Level of Mastery of Experimental and Control Groups

In order to evaluate the effectiveness of the mastery learning strategy and the conventional method of teaching in developing mastery, a thorough analysis of mastery of the individual learning tasks and total task of the groups was made. For this purpose, the percentage of correct responses of each member of the experimental and control groups in each of the formative tests and summative test were obtained. The results are shown in table - 3.

A comparison of the range of percent correct responses of experimental and control groups revealed that high and low percent correct responses of the experimental group were higher than that of the control group. It may also be noted that 70 or more percent of correct responses in the formative tests 1, 2 and 3 were given by 100 percent of the students and in the tests 4 and 5 by 96 and 97 percent of students of the experimental group.

In the control group, 60 or more percent of students had given less than 70 percent of correct responses.

In the experimental group, 90 percent of the students had attained the minimum level of mastery of 80 percent or more correct responses in the formative test-1, 100 percent in formative test-2, 66 percent in test-3, 86 percent in test-4, and 76 percent in test-5. In contrast, only 8, 24, 12 and 12 percent of control group had attained the mastery in formative tests - 2, 3, 4 and 5 respectively. None from the control group could attain mastery of the first learning task.

On the summative test, 42 percent of the experimental group got 80 percent or more correct responses while 04 percent of the

Table-3: Percentage of Correct Responses in Formative and Summative Tests of Experimental and Control Groups

Percentage of correct response	Percentage of Students											
	FT - 1		FT - 2		FT - 3		FT - 4		FT- 5		Summative Test	
	Exptl.	Cont.	Exptl.	Cont.	Exptl.	Cont.	Exptl.	Cont.	Exptl.	Cont.	Exptl.	Cont.
100 -							10		17			
90-100	62		69		41	04	24		35		04	
80-90	28		31	08	24	24	52	12	24	12	38	04
70-80	10	24		24	35	12	10	08	21	32	55	48
60-70		34		32		20	04	32	03	20	03	32
50-60		28		20		20		08		20		12
40-50		16		16		04		28		04		04
30-40						04				08		
20-30						08		04				
10-20						04		04		04		
0-10								04				

control group could only attain the minimum level of mastery. It can also be observed that 55 percent of the experimental group and 48 percent of the control group got between 70-79 percent of correct responses. But an equal percentage of the control group got less than 70 percent correct responses as against 3 percent of the experimental group.

A comparison of percentages of correct responses on pre- and post-tests revealed that the average percentage of correct responses of the experimental group increased from 20 to 80 percent as against the increase in percentage of correct responses from 20 to 68 for the control group.

These results suggest that the mastery learning strategy appeared to be more effective in developing mastery of the subject under consideration than the conventional method.

3.3 Analysis of Proportion of Masters of Learning Tasks in the Experimental and Control Groups

One of the purposes of this study was to determine whether or not the mastery learning strategy enables the largest proportion of students to attain mastery of the subject under consideration. In this study, it was assumed that the mastery learning strategy would enable at most 70 percent of students to attain mastery. The 70 percent (equivalently 0.70) is considered as the proportion of masters. The related research hypothesis has been stated as follows:

Hypothesis - 1

The mastery learning strategy and the conventional method of teaching produce significant proportion of masters of learning tasks in biology.

Therefore, $H_0 : p \leq 0.70$ (p: observed proportion of masters)
$H_1: p > 0.70$

To test the null hypothesis, the z-test was employed based on the assumption that the sampling distribution of a proportion can be considered as normal distribution if Np and Nq, whichever is smaller, is equal to or greater than 5. In this study, since the value of p is considered as 0.70, N_q for the experimental group (N=29) equals 8.7 and for the control group (N=25) 7.5. From the normal distribution table, it could be seen that the critical region of size $\infty = 0.05$ consists of all the observed proportions greater than 0.84. Therefore, the null hypothesis had to be rejected if the observed proportion of masters was less than 0.84.

Further analysis was made to estimate the proportion of students who would master the learning tasks from the observed proportion of masters. That is, for the obtained value of p (proportion of masters in the sample), the value that might be considered for p_0 (the parameter) in the hypothesis

$$H_0: p \leq p_0$$

such that a one tailed normal test would result in rejection of H_0 was arrived. This value of p is called the significant proportion.

The proportion and the significant proportion of masters of the learning tasks in the experimental and control groups are given in table – 4.

Examination of data in table - 4 revealed that the observed proportion of masters of learning tasks - Respiration in plants and lower animals, Respiration in higher animals and Excretion in plants and lower animals were 0.90, 1.00 and 0.86 respectively in the experimental group. These proportions are greater than 0.84. Therefore, the null hypothesis relating to each of these learning tasks was rejected at 0.05 level of significance. Hence, the proportion of masters of each of the learning tasks was greater than 0.70. From the obtained proportion of masters of the three learning tasks, it can be concluded that the mastery learning strategy could develop mastery of the learning tasks in 78, 91 and 72 percent of students respectively in the population.

The proportion of masters of the learning tasks - Mechanism of Respiration and Excretion in Man were 0.66 and 0.76

Table-4: Masters of Learning Tasks in the Experimental and Control Groups with their Significant Proportions

Test	Learning Task	Percentage of Masters	
		Experimental Group (N:29)	Control Group (N:25)
Formative Test - 1	Respiration in plants and lower animals	90* (0.78)	00 (0.0)
Formative Test - 2	Respiration in higher animals	100* (0.91)	08 (0.07)
Formative Test - 3	Mechanism of respiration	66 (0.51)	24 (0.13)
Formative Test - 4	Excretion in plants and lower animals	86* (0.72)	12 (0.04)
Formative Test - 5	Excretion in man	76 (0.61)	12 (0.04)
Summative Test	Respiration and Excretion	42 (0.28)	04 (0.0)

* Significant at 0.05 level.
The number in bracket indicates significant proportion.

respectively in the experimental group. These proportions are less then 0.84. Therefore, null hypothesis was accepted at 0.05 level of significance. The corresponding estimated proportions were 0.51 and 0.61 respectively. That is, 51 and 61 percent of students in the population receiving instruction through mastery learning strategy could attain mastery of the two learning tasks.

The proportion of masters of the five learning tasks in the control group ranged from a low of 0 for the learning task - Respiration in plants and lower animals, with the highest being 0.24 for the learning task - Mechanism of Respiration. The proportion of masters of all the five learning tasks was less than 0.84. Hence, the null hypothesis was accepted at 0.05 level.

It can also be said that the percentage of students receiving instruction through the conventional method who could attain mastery of the learning tasks ranged from 0 to 13.

On the summative test, the proportion of masters in the experimental and control groups were 0.42 and 0.04 respectively. These proportions were less than the expected value of 0.84. Hence the null hypothesis was accepted at 5 percent level. The percentage of students in the experimental and control groups who could develop overall mastery of the learning tasks would be 28 and 0 respectively.

Though, significant proportion of the experimental group could master three learning tasks and large proportion could master the remaining two learning tasks, only 28 percent of the students could be expected to develop overall mastery of the learning. It is not clear whether the summative test measures retention and if so, whether the mastery learning strategy is not effective for retention of mastery of the subject under consideration.

3.4 Comparison of Proportion of Masters of the Learning Tasks in the Experimental and Control Groups

Having investigated the significance of proportion of masters of the objectives of teaching the individual learning tasks and overall learning task from both the groups, it was decided to ascertain how well the groups differed in their mastery. This amounted to establishing the statistical significance of the difference in the proportion of masters between the two groups. For this purpose the following hypothesis was formulated.

Hypothesis - 2

The proportion of students of the experimental group mastering the learning tasks is significantly greater than that of the control group.

In order to establish the tenability of the hypothesis, the z-test was used. The results are shown in table - 5.

A scrutiny of the results in table-5 revealed that the difference in the proportion of masters between the two groups on each of the learning tasks, and the total task yielded z-value which was significant at 0.01 level for a directional test with 52 degrees of freedom. Therefore, the research hypothesis that 'the proportion of students of the experimental group mastering each of the learning tasks was significantly greater than that of the control group' was accepted. Thus it was concluded that the mastery learning strategy was more effective in developing mastery in a significantly larger percentage of students than the conventional method.

Table-5: Significance of the Difference between the Proportion of Masters on Formative and Summative Tests in the Experimental and Control Groups.

Test	Learning Task	Proportion of Masters		p_1-p_2	Sp_1-p_2	z-value
		Experimental Group (p_1)	Control Group (p_2)			
Formative Test - 1	Respiration in plants and lower animals	0.90	0.00	0.90	0.136	6.62**
Formative Test - 2	Respiration in higher animals	1.00	0.08	0.92	0.135	6.81**
Formative Test - 3	Mechanism of respiration	0.66	0.24	0.42	0.136	3.09**
Formative Test - 4	Excretion in plants and lower animals	0.86	0.12	0.74	0.136	5.44**
Formative Test – 5	Excretion in man	0.76	0.12	0.64	0.136	4.71**
Summative Test	Respiration and Excretion	0.42	0.04	0.38	0.117	3.16**

** Significant beyond 0.01 level.

3.5 Correlations of Pre- to Post-Test with Intelligence

If student ability to learn is mainly a function of time (rather than qualitative factor, for example), then an instructional method which is identical for all students except for the time factor should result in achievement which is less correlated with intelligence than other forms of instruction. Comparison of the intelligence - achievement correlation between students taught by mastery learning strategy and those taught by the conventional method was another purpose of this study.

In other words, the purpose of the study was to determine whether or not there would be a significant decrease in the correlation between intelligence and pre- to post-test achievement for the mastery learning class. If the correlation between intelligence and pre-test is higher than the correlation between intelligence and post-test, one could infer that mastery learning strategy is an effective tool regardless of intelligence. But, if the correlation between intelligence and pre-test is less than the correlation between intelligence and post-test, one could infer that the instructional strategy is effective only for highly intelligent students. Therefore the following hypothesis was formulated.

Hypothesis - 3

There is no significant difference between the pre-test to post-test correlations with intelligence for the experimental and control groups.

The pre-test to post-test correlations with intelligence for the experimental group were 0.271 and 0.086. There was a decrease in the correlation between intelligence and pre- to post-test achievement of the experimental group with the correlation between intelligence and post-test approaching zero.

The test of significance of the correlation co-efficients in table - 6 indicated that the pre-test to post-test correlations with intelligence for the experimental group were not significant as the obtained t-values were less than the value of 2.05 required at 0.05 level of significance for a df of 27.

The test of significance of the difference between correlation coefficients for correlated samples in table - 6 indicated the difference between the pre-test to post-test correlations with intelligence for the experimental group yielded a t-value of 1.29. For df=26, a 't' of 2.06 was required for significance at 5 percent level. Therefore, the null hypothesis that 'there is no significant difference between the pre-test to post-test correlations with intelligence for the experimental group' could not be rejected.

The data in Table- 6 showed that there was an increase in the correlation between intelligence and pre- to post-test achievement of the experimental group. The test of significance of the correlation coefficients showed that the coefficient of correlation with pre-test scores and intelligence was not significant as the obtained t-value 1.46 was less than the table value of 2.07 for df=23 at 0.05 level of significance. But the coefficient of correlation between post-test and intelligence yielded a t-value of 5.11 which was greater than the value of 2.81 required for significance at 0.01 level for df=23.

The higher significant positive correlation between post-test and intelligence than the correlation between pre-test and intelligence showed that the conventional method of teaching is an effective tool only for students of higher intelligence levels.

The difference between correlation coefficients for correlated samples (pre- to post-test with intelligence for the control group) yielded a t-value of 3.11. This value was greater than 2.82, the required value for the difference to be significant at 0.01 level for a df=22. Hence, the null hypothesis that 'there is no significant difference between the pre-test to post-test correlation with intelligence for the control group' was rejected.

This result leads to the conclusion that conventional method of teaching is not an effective tool regardless of intelligence.

3.6 Comparison of Proportion of Masters of Boys and Girls

In comparing the effectiveness of mastery learning strategy with the conventional method of teaching, it is possible that one method might be more appropriate for boys than for girls. Therefore, the following hypothesis was formulated for testing.

Hypothesis - 4

There is no significant difference in the proportion of boys and girls mastering overall learning task in the experimental and control groups.

Table-6: Significance of Correlation Coefficients and difference between Correlation Coefficients for Correlated Samples.

Group	Correlation Coefficient		t-value	Difference between Correlation Coefficients	t-value
Experimental (N: 29)	Pre-test vs. Intelligence	0.271	1.46 (n.s)	0.185	1.29 (n.s)
	Post-test vs. Intelligence	0.086	0.45 (n.s)		
Control (N: 25)	Pre-test vs. Intelligence	0.292	1.46 (n.s)	0.437	3.113**
	Post-test vs. Intelligence	0.729	2.81**		

** significant at 0.01 level

n.s not significant at 0.05 level

Table-7: Significance of the Difference between the Proportion of Boys and Girls Mastering Overall Learning Task

S. No.	Group	Proportion of Masters		Sp_1-p_2	z-value
		Boys (p_1)	Girls (p_2)		
1.	Experimental	0.214	0.60	0.183	2.109*
2.	Control	00	0.056	0.087	0.644

*Significant at 0.05 level for df=27

In order to test the hypothesis, the z-test was used. The results are shown in table - 7.

A scrutiny of the data in table-7 indicated that 21 percent of boys of the experimental group had mastered the overall learning task as compared to 60 percent of girls of the group. The difference between the proportion of masters resulted in a z-value of 2.109 which was significant beyond 0.05 level for a non-directional test for df=27. Hence the null hypothesis was rejected. It may be concluded that significantly greater percentage of girls seemed to attain mastery under the mastery learning conditions as compared to boys.

Under conventional method of teaching, about 6 percent of girls mastered the overall learning task as compared to none of the boys. The difference between the proportions yielded a z-value of 0.644 which was not significant at 0.05 level. It may be said that both boys and girls attained same level of mastery under conventional method of teaching.

3.7 Educational Implications of the Study

The findings of this study suggest that

- The ability of students to learn is mainly a function of time, the mastery learning strategy which was identical for all students except for the time factor results in achievement which is less correlated with intelligence. Implication of these findings is that mastery learning is possible for students of all intellectual levels provided teachers can find the means for helping each student's work towards attaining mastery of a learning task.

- The relative effectiveness of different self-pacing strategies to develop mastery of a learning task should be investigated so that the strategies appropriate to the learner characteristics could be used.

- The enabling activities or instructional strategies that are used for a self-instructional package should ideally have firm foundations in learning theory as well as in related research and development and instructional technology.

Therefore, there is a need to develop the competence in pre-service and in-service teachers to develop and use self-pacing instructional strategies. Institutes and organisations engaged in improving the quality of education may be encouraged to develop and use different types of instructional packages for individualising instruction to facilitate students to attain minimum level of competence in various subjects.

Competing Interests

The authors have declared that no competing interests exist.

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