EFFECT OF MASTERY LEARNING STRATEGIES ON CONCEPT ATTAINMENT IN GEOMETRY AMONG HIGH SCHOOL STUDENTS

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ABSTRACT

The main aim of present investigation was to find out the effect of mastery learning strategies viz. Bloom's Learning For Mastery (LFM) and Keller's Personalized System of Instruction (PSI) on concept attainment in geometry among high school students. For achieving the objectives of this study, a random sample of 105 students studying in 9th class was selected and "Three Groups: Randomized Matched Subject Pretest-Posttest Design" was employed. The sampled students were divided into three homogeneous groups on the basis of their non-verbal intelligence level by administering Raven's Standard Progressive Matrices (SPM). The first group and second group were taught through Bloom's LFM and Keller's PSI respectively and thus, termed as experimental groups. The third group was imparted instruction through conventional method of teaching and named as control group. The data were collected by administering self-developed concept attainment test in geometry. The statistical technique of 'Analysis of Co-Variance (ANCOVA)' was employed to analyze the data. The results revealed that both Bloom's LFM and Keller's PSI were significantly more effective in attainment of geometrical concepts as compared to conventional method of teaching. It was further inferred that Bloom's LFM was significantly better in attainment of geometrical concepts in comparison to Keller's PSI.

Keywords: PSI, Mastery Learning Strategies, LFM and Self Development Concept.

INTRODUCTION:

Around the globe, education has been assigned a key role in promoting excellence in every sphere of life. One of the major objectives of education is the 'intellectual development of an individual'. However, the low academic achievement of students has emerged as a major obstacle in achieving the objective of intellectual development. This may be attributed mainly to lack of emphasis on conceptual learning and more stress on rote memorization by practitioners in schools. Even in subject like Mathematics, which is entirely based on scientific calculations, the stress is laid mostly on memorizing the concepts and formulae and not on conceptual understanding as well as their application. As a result, Mathematics teaching in schools has become stereotyped. In order to come out of such peculiar situation, a large number of instructional strategies have been developed and tried out by teachers and educators. Among a

host of such instructional strategies used in the classrooms till date, each claims to be capable of performing certain functions, though no strategy can boast of being the best and capable of achieving all the educational objectives. Out of such instructional strategies, the major instructional strategies have been developed under the rubric of 'Mastery Learning'.

There are two genotypic approaches to the use of mastery learning strategies. The first approach is 'group-based and teacher-paced' or Bloom's strategy of learning for mastery and the second approach is 'individual-based and learner-paced' or Keller's personalized system of instruction. In Bloom's approach of 'Learning For Mastery (LFM)', students learn cooperatively with their classmates and the teacher controls the delivery and flow of instruction. The theoretical basis for this strategy was provided by a conceptual model of school learning developed by Carroll (1963, 1965). Keller's approach was first described in his 1968 paper "good bye, teacher .....". This strategy is an 'individual-based and learner-paced' approach to mastery learning wherein, a student typically learns independently of his/her classmates. Personalized system of instruction (PSI) allows students to move through course material at their own rates, and requires that they show mastery of all major course objectives.

The teaching of Mathematics plays a significant role in developing problem-solving attitude, reasoning power and critical thinking among students. Mathematical concepts are given top priority at the school stage because of their wider applicability in future and in learning other subjects. Out of many branches of Mathematics, Geometry is considered most valuable because of its great utility and vocational value. But at present, Geometry teaching is in a miserable condition in the schools. This may be due to great emphasis on simple drilling of computations and little on conceptual understanding of mathematical processes in schools. So, there is a need for using such instructional methods and strategies which will ultimately result in development of mathematical concepts among children because the development of concepts is basic to growth of learning capacity.

Practices and research studies in India and abroad viz. researches by Drake (1988), Abadir (1993), Aviles (1996), Sharma (1998), Lang (2001), Havranek (2002), Mishra & Basantia (2003), Chauhan (2007) and many others revealed that use of innovative teaching strategies and mastery learning strategies in classrooms is much useful in conceptual learning as well as

enhancing students' achievement not only in Mathematics but also in other school subjects. However, some researchers like Brace (1992) and Mckenzie (1999) have revealed contrary results. They found that students in the traditional classroom scored significantly higher than students in the self-paced mastery learning strategies. The review of the previous studies indicates that although a sufficient number of researches have been conducted to assess the effects of mastery learning strategies on academic achievement, retention and other psychological variables such as level of aspiration, achievement motivation, study habits etc. However, there is lack of researches undertaken in the field of mastery learning strategies and their effect on conceptual learning in Mathematics, particularly in Indian school situations.

Hence, present study was undertaken to investigate the effect of Bloom's LFM and Keller's PSI on attainment of geometrical concepts among high school students:

- To study and compare the effect of Bloom's LFM strategy and conventional method of teaching on concept attainment in geometry among high school students.
- To study and compare the effect of Keller's PSI and conventional method of teaching on concept attainment in geometry among high school students.
- To study and compare the effect of Bloom's LFM strategy and Keller's PSI on concept attainment in geometry among high school students.

Following hypotheses were formulated in the present investigation:

- The students taught through Bloom's LFM strategy do not differ significantly from the students taught through conventional method of teaching with regard to concept attainment in geometry.
- The students taught through Keller's PSI do not differ significantly from the students taught through conventional method of teaching with regard to concept attainment in geometry.
- The students taught through Bloom's LFM strategy do not differ significantly from the students taught through Keller's PSI with regard to concept attainment in geometry.

MATERIALS AND METHODS:

For realizing the objectives of the study, "Three Groups: Randomized Matched Subject Pretest-Posttest Design" was employed which included following variables:

Independent variables: Bloom's LFM strategy, Keller's PSI and conventional method of teaching.

Dependent variable: Concept attainment in geometry.

Intervening variables: Intelligence level of students, teacher effect and level of concept attainment in geometry before application of treatment variables.

Following research tools were developed for collecting data in the present investigation:

1. Study-Guides

For imparting instruction through Keller's personalized system of instruction, study-guides were developed on first two chapters of 9th class geometry textbook viz. Basic Geometrical Facts and Some Angle Relations. These two chapters were then divided into eight sub-units for preparation of study-guides. Each study-guide was comprised of five parts namely; introduction, instructional objectives, suggested procedure for achieving instructional objectives, suggested reading material and questions for self-evaluation. The reading material given in study-guides was validated by seeking the views of Mathematics experts, language experts and technical (research) experts. Further, for evaluating the structural accuracy of study-guides, the experts from the field of educational technology were consulted.

2. Formative Tests and their Parallel Forms

For assessing mastery of the students over different sub-units, formative tests and their parallel forms were developed for each small learning unit. The main purpose of these tests was to identify the learning difficulties of those students who were not able to achieve pre-specified mastery criterion of 80/80 and to provide them with remedial instruction on the un-mastered content. The students who were not able to achieve pre-specified mastery criterion were provided remedial instruction and parallel form of formative test of the same sub-unit was re-administered on them to check their mastery. The students could proceed to the next sub-unit only when 80/80 criterion was achieved by them either on formative test or its parallel form. Each formative test and its parallel form were validated in terms of its included content by employing the same procedure as in case of development of study-guides.

3. Concept Attainment Test in Geometry

In order to evaluate the attainment of geometrical concepts by the students at the end of experimental treatment, concept attainment test in Geometry was constructed and standardized. First of all, preliminary draft of the test (comprising of 125 items) was prepared which comprised of various types of items viz. multiple choice type, completion type, matching type and true-false type items. At this juncture, the assistance of language experts was sought to remove linguistic ambiguity in the test items. In addition, the assistance of subject experts was taken while creating an item pool of 125 items. It was ensured that each instructional objective should have due representation in the test which was done by assigning at least one item for each instructional objective. While preparing the preliminary draft, it was also kept in mind that the items of the test should be distributed along different levels of Bloom's taxonomy of cognitive domain as well as among all four levels of concept attainment model given by Klausmeier et al. (1974). Afterwards, concept attainment test in Geometry was evaluated in terms of criterion difficulty (Dc) and index of sensitivity to instructional effects (S) of the test items and thus, its final draft was developed. The final draft of concept attainment test in Geometry was comprised of 95 test items (22 T/F type, 40 MCQ type, 31 completion type and 2 matching type items). Then onwards, concept attainment test in Geometry was standardized in terms of its reliability and validity. The test-retest reliability was found to be 0.856, which was quite high. The content validity of concept attainment test in Geometry was ensured by employing the procedure as suggested by Tuckman (1979) i.e. by examining subsequent performances of students in short time, in terms of 'gain' from 'pre-test' to 'post-test'. It was observed that a group of 30 students of 9^{th} class obtained an average score of 42.93 on the pre-test. On the post-test, the students obtained an average score of 65.73, thereby showing a gain of 22.80 from pre-test to post-test. This pre-test to post-test gain, not only showed the success of instruction but also indicated the content validity of the test.

Apart from these self-developed research tools, Raven's Standard Progressive Matrices (SPM) was employed for subject to subject matching on non-verbal intelligence level (pertinent control variable).

With regard to sampling procedure in the present investigation, the procedure of multi-stage sampling was adopted. At first, a sample of 50 students was selected to carry out item analysis of preliminary draft of concept attainment test. At second stage, a sample of 42 students was selected to calculate the test-retest reliability of concept attainment test. At last, a cluster sample of 203 students was selected for distributing the students into three different groups for conducting the experiment. These initially sampled students were matched on their non-verbal intelligence level. The group-wise mean intelligence scores for three treatment groups i.e. Bloom's group, Keller's group and Control group were 34.17, 34.17 and 34.14 respectively. The significance of differences among the means for three groups was tested using the technique of analysis of variance (ANOVA). The calculated F-value came out to be 0.0002, for df 2/102, which was not significant even at 0.05 level of significance. Hence, subject-to-subject matching on the variable of non-verbal intelligence was considered to be satisfactory. Thus, three groups with 35 students in each group were randomly assigned to three different experimental treatments. The remaining 98 students were weeded out.

The experiment was conducted in following manner for realizing the objectives of present investigation:

Phase –I (Pre-Testing)

During the first phase of experiment, concept attainment test in Geometry was administered on the students of three treatment groups. The obtained scores were named as 'pre-test scores'.

Phase –II (Experimental Phase)

All three groups were exposed randomly to different experimental treatments for a period of seven weeks. First group was taught with the help of Bloom's LFM strategy (Bloom group), second through Keller's PSI (Keller group) and third group was taught through conventional method of teaching (Control group). All three groups were taught by the investigator for removing teacher effect (intervening variable).

Phase –III (Post-Testing)

After completion of instruction to all three groups, concept attainment test in Geometry was re-administered on all three groups. The obtained scores were named as 'post-test scores'.

After completion of the experiment, for testing the significance of difference among means of concept attainment scores at the time of post-test and to adjust the initial mean differences in the pre-test scores of different treatment groups if any, the statistical technique of 'Analysis of Covariance (ANCOVA)' was employed. Before starting with actual procedure of analysis of covariance (ANCOVA), the assumptions of normality, randomness, homogeneity, additivity, correlation and regression were tested.

RESULTS:

After testing all assumptions of analysis of covariance, the investigator further proceeded to test the significance of difference between the adjusted mean scores on concept attainment test in Geometry among three treatment groups. The summary of the results of analysis of covariance is given in Table 1.

TABLE 1

Summary of the Results of Analysis of Covariance for Scores on Concept Attainment Test in Geometry for Bloom, Keller and Control Group

Sr. No.	Components of Variability	Sum of Squares	df	Variance	F-Ratio	S.D.y.x.
1	Between Treatments	27041.10	2	13520.55	126.64**	
2	Within Samples of Error	10782.40	101	106.75		10.33
3	Total	37823.50	103			

** *Significant at 0.01 level of significance.*

The results mentioned in Table 1 showed that three groups namely; Bloom, Keller and Control group differed significantly ($F = 126.64$, $p<0.01$, df 2/101) from each other with regard to their mean concept attainment scores in Geometry. Then onwards, magnitude of differences in mean concept attainment scores of three groups was computed to test their significance. So, in order to find out significance of difference in the adjusted mean scores of three treatment groups in different combinations (following any two instructional strategies at a time), least significant differences (LSDs) at 0.01 level of significance were computed. The results of means of pre-test,

post-test and adjusted mean scores of students of all three treatment groups on concept attainment test in Geometry are given in Table 2.

TABLE 2

Means of Pre-Test, Post-Test and Adjusted Scores on Concept Attainment Test in Geometry of Three Groups: Bloom, Keller and Control

Sr. No.	Group	N	Mean (Pre-Test)	Mean (Post Test)	Adjusted Means	Difference between Adjusted Means
1	Bloom (A)	35	36.83	81.17	81.64	38.07** A-C
2	Keller (B)	35	40.37	72.20	71.26	27.69** B-C
3	Control (C)	35	36.86	43.11	43.57	10.38** A-B
4	General Means (GM)		38.02	65.49	65.49	

** *Significant at 0.01 Level.*

For df 101, Least Significant Difference at 0.01 level of significance = 6.49

It is clear from Table 2 that the students taught through Bloom's LFM strategy and Keller's PSI have achieved 85.94% (81.64 marks out of 95 marks) and 75.01% marks (71.26% marks out of 95 marks) respectively in concept attainment test in geometry. In the similar manner, the percentage concept attainment marks of students taught through conventional instructional method was found to be 45.86% (43.57 marks out of 95 marks). Further, Table 2 makes it evident that the computed value of difference in adjusted means of concept attainment scores between Bloom's group and Control group came out to be 38.07 which is much greater than the least significant difference (6.49) at 0.01 level of significance, for df 101. So, the null hypothesis (Ho) stated as, "the students taught through Bloom's mastery learning strategy do not differ significantly from the students taught through conventional method of teaching with regard to concept attainment in Geometry", was rejected. So, it was interpreted that the adjusted mean concept attainment score of students taught through Bloom's mastery learning strategy (81.64

marks or 85.94%) was significantly higher than the students taught through conventional method of teaching (43.57 marks or 45.86%). Hence, Bloom's mastery learning strategy was significantly more effective in concept attainment in Geometry as compared to conventional method of teaching.

In the similar manner, the difference in adjusted means of concept attainment test scores between Keller's group and Control group was found to be 27.69, which was again greater than the least significant difference (6.49) at 0.01 level of significance, for df 101. So, the null hypothesis (Ho) stated as, "the students taught through Keller's personalized system of instruction do not differ significantly from the students taught through conventional method of teaching with regard to concept attainment in Geometry", stood cancelled. Therefore, it was interpreted that the adjusted mean concept attainment score of students taught through Keller's PSI (71.26 marks or 75.01%) was significantly better than adjusted mean concept attainment score of those students who were taught through conventional method of teaching (43.57 marks or 45.86%). Hence, Keller's PSI was found to be significantly more effective in the attainment of geometrical concepts in comparison to conventional method of teaching.

Thus, it was concluded that both Bloom's LFM strategy and Keller's PSI were significantly more effective in concept attainment in Geometry as compared to conventional method of teaching. The present findings were supported by the results of Kohli (1999) who reported that the students when taught through mastery teaching strategies attained more geographical concepts as compared to the students taught through non-mastery teaching strategies. The reason for such results may be attributed to the fact that in both of these strategies, objectives are clearly stated, instructional/study material is properly planned, difficulties of students are identified and remedial instruction and corrective feedback is provided wherever necessary. On the contrary, the present results were not in agreement with Brace (1992) and McKenzie (1999) who reported that the students taught through mastery learning strategies did not have significantly higher achievement scores when compared with the students taught through conventional method of teaching.

Table 2 further reveals that the difference in the adjusted means of concept attainment scores between Bloom's group and Keller's group was computed to be 10.38 which was significantly

higher than the least significant difference (6.49) at 0.01 level of significance, for df 101. So, the null hypothesis (Ho) stating that, "the students taught through Bloom's mastery learning strategy do not differ significantly from the students taught through Keller's personalized system of instruction with regard to concept attainment in Geometry", was not accepted. Hence, it was interpreted that the adjusted mean of concept attainment test scores of Bloom's group (81.64 marks or 85.94%) was significantly higher than the Keller's group (71.26 marks or 75.01%). In other words, it was inferred that Bloom's mastery learning strategy was significantly more effective in concept attainment in geometry as compared to Keller's personalized system of instruction. The higher and effective conceptual learning in Geometry among students when taught through Bloom's LFM may be attributed to the presence of teacher in the class and his control over flow of instruction whereas, in case of Keller's PSI, there is very little control of teacher over the class and flow of instruction.

DISCUSSION:

It was revealed that both Bloom's LFM strategy and Keller's personalized system of instruction were significantly more effective in attainment of concepts in Geometry as compared to conventional method of teaching. Hence, the teachers should emphasize on greater use of principles of mastery learning strategies in their conventional classroom situations. For this, the teachers should make an extra effort to define the objectives of teaching, present the learning material sequentially and to identify learning difficulties of students. On the basis of such diagnosis, remedial instruction/corrective feedback should be provided to the students for improving their conceptual understanding.

Considering from a different angle, it may be pointed that introduction of Keller's personalized system of instruction in classroom situations may need lot of finances because for each discipline, additional material in the form of study-guides has to be prepared. The schools which can afford to spend some extra finances in preparing such material (study-guides) can safely make use of this strategy. Otherwise, the task of preparing study-guides for using personalized system of instruction in different school subjects can be undertaken by NCERT at National level and SCERTs / SIEs / University Departments of Education at State level. By doing this, the cost

of preparing study-guides can be reduced and use of personalized system of instruction can be made accessible to large number of school-going children. On the other hand, introduction of Bloom's mastery learning strategy needs an extra effort on the part of teachers and no extra finances are required. Hence, it is of vital significance to organize in-service training programmes for teachers to sensitize them regarding the methodology and use of such mastery learning strategies at school level in different school subjects. Further, it is recommended that at pre-service training stage, pupil-teachers should be thoroughly oriented with the concept of mastery learning strategies and they should be imparted practical training in the use of mastery learning strategies in school situations at the time of practice teaching / internship so that they can further use such innovative instructional strategies when they will be appointed as regular teachers in schools. Hopefully, this will act as a boon for enhancing the quality of school education on a wider scale.

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