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EFFECTIVENESS OF FLIPPED CLASS ROOM STRATEGY IN ENHANCING HIGHER ORDER THINKING SKILLS OF SECONDARY SCHOOL STUDENTS

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ABSTRACT

The present study is an attempt to investigate the effectiveness of flipped class room strategy for enhancing Higher Order Thinking Skills of secondary school students. The study is experimental in nature. A non-equivalent pre-test post-test experimental and control group design with a total sample of 60 Standard IX students , having 30 students each, in one group, was adopted for the study.Flipped Classroom Strategy was implemented in the experimental group while activity oriented method was used in the control group. Before the experiment, as a first step, pre -tests were administered to both experimental and control groups. Test of Higher OrderThinking Skills was used for conducting the pre test.

After the intervention, post- tests were conducted in both groups. The difference between Pre- test and Post- test was compared with the help of appropriate statistical techniques.Findings of the study revealed that both flipped class room strategy and activity oriented method marked their effectiveness in enhancing Higher Order Thinking Skills of secondary school students. However flipped class room strategy is superior to Activity Oriented Method in enhancing Higher Order Thinking Skills.

Keywords: Flipped Class Room Strategy, Higher Order Thinking Skills, Activity Oriented Method.

Introduction

Nurturingof higher-order thinking skillsamong students at their younger ages itself is the foremost agenda of Physics education community today.Teaching strategies that promote the use of these skills among students are required to be designed and practiced (Poddar,2021).But the adapted teaching strategy must have the capability to address the needs of a classroom of academically diverse learners (Tomlinson & Allan, 2000).

Flipped classroom strategy, one of the recent trends in instruction that is anchored in active learning, can satisfy all kind of students with varying abilities (Limueco, &Prudente, 2018).In a flipped classroom, the direct instruction normally given during class time is given as homework through video lectures and class time is used for engaging in hands on experiments, activities, group discussions, projects, assignments etc.In a flipped

classroom, students acquire knowledge before class and deepen and apply this knowledge during class. This way, lower-order learning goals are achieved before class and higher-order skills are reached during class.

Need and Significance of the study

Tendency for rote learning is high in the case of Physics learning since it is a regarded as a difficult subject both to learn and to teach (Angell, Guttersrud, Henriksen&Isnes, 2004; Mualem&Eylon, 2007; Mulhall&Gunstone, 2008).Over the past few years many experiments have been done with technology based teaching strategies, all over the world, in promoting meaningful Physics learning from secondary school onwards. But findings of many studies such as Oliveira and Rodrigues(2004), Rivard (2004) and Newton (1999) show that, science classrooms are still strongly teacher directed, and the teaching and learning model just act as transmission model which enhance rote learning and fail to foster critical or higher order thinking .So there is a felt need to develop teaching strategies that can promote higher order thinking skills.On reviewing the studies, the investigator realized that there are not many studies which examine the impact of flipped classroom in triggering Higher Order Thinking Skills. Since studies reported so far are rare, the present study assumes significance.

Statement of the Problem

As an attempt to investigate the influence of flipped classroom strategy on promoting Higher Order Thinking Skills the investigator decided to undertake an experimental study stated as "EFFECTIVENESS OF FLIPPED CLASS ROOM STRATEGY IN ENHANCING HIGHER ORDER THINKING SKILLS OF SECONDARY SCHOOL STUDENTS".

Definition of Key Terms

Effectiveness

Effectiveness means having an effect; producing a result or making a striking impression.

(Webster's Dictionary)

In the present study, effectiveness means the gain in the post-test scores on the Test of Higher Order Thinking Skills.

Flipped Classroom Strategy

The flipped classroom/flipped learning which is also called an inverted classroom is a pedagogical model in which lesson content is learned at home by means oftechnology, allowing teachers to devote class time to practicing lesson content withexercises, activities, discussions, or projects .

(Educause Learning Initiative, 2012)

In the present study , flipped class room strategy means a kind of teaching –learning procedure in which students are instructed to construct their own content knowledge using the learning experiences like videos, audio, simulations, virtual laboratory experiments etc , provided to them prior to the direct face to face class time. And as a follow up, in the class time, students are engaged in hands on experiments, activities, group discussions,projects, assignments, seminar etc.in a co-operative learning environment.

Enhancing

Enhance means to increase or improve something in value, quality, desirability or attractiveness.

(Webster's Dictionary, 2004)

In the present study enhancing means deliberately bringing visible changes in Higher Order Thinking Skills as measured by the Test of Higher Order Thinking Skills.

Higher Order Thinking Skills

Higher Order Thinking Skills is the ability to think beyond rote memorization of facts or knowledge. Higher Order Thinking Skills are the skills for analyzing, reasoning, application, judging and thinking critically and creatively.

(Bloom, 1956)

Higher Order Thinking Skills are the skills for analyzing (differentiating, organizing, attributing), evaluating (checking, critiquing), and creating (generating, planning, producing).

(Anderson and Krathwohl, 2001)

In the present study Higher Order Thinking Skills means the skills for analyzing, evaluating and creating as explained by Anderson &Krathwohl (2001) ,and is represented as the scores obtained on the Test of Higher Order Thinking Skills for the selected content topics.

1.3.6 Secondary School Students

The term secondary school students refer to students in VIII, IX and X standards. **(KER, 2010)**

In the present study students in Standard IX under Kerala State Syllabus are referred to as secondary school students.

VARIABLES

Independent Variables

i. Flipped Classroom Strategy

ii. Instruction using Activity Oriented Method

Dependent Variables

i. Higher Order Thinking Skills

HYPOTHESES

1. Flipped Classroom strategy is effective in enhancing Higher Order Thinking of secondary school students.

OBJECTIVES

1. To test the effectiveness of the Flipped Classroom strategy in enhancing Higher Order Thinking Skills of secondary school students.
2. To develop lesson transcripts based on Flipped Classroom strategy
3. To develop lesson transcripts based on Activity Oriented Method

Method Adopted for the Study

A non-equivalent pre-test post-test experimental and control group design with total a sample of 60 Standard IX students, having 30 students in each group, was adopted for the study.Flipped Classroom Strategy was implemented in the experimental group while activity oriented method was used in the control group.Before the experiment, as a first step, pre-tests were administered to both experimental and control groups. Test of Higher Order Thinking Skills was used for conducting the pre- test.After the intervention, post- tests were conducted in both groups.The difference between Pre- test and Post- test was compared with the help of appropriate statistical techniques to ascertain the relative effectiveness of instruction using Computer mediated Learning Package and instruction using activity oriented method.

The step wise details of the procedure in the study are:

i. Development and standardization of Test of Higher Order Thinking Skills for secondary school students, for the select content in Physics for Standard IX.
ii. Developing and validating Lesson Transcripts based on Flipped Class room strategy for secondary school students on select content portion from Standard IX Physics Text Book.
iii. Developing and validating Lesson Transcripts based on Activity Oriented Method for secondary school students on select content portion from Standard IX Physics Text Book.
iv. Administering pre-tests on the outcome variable for both experimental and control groups.
v. Administering Flipped Class room strategy to the experimental groups.
vi. Instruction using the Lesson Transcripts based on Activity Oriented Method to the Control groups.
vii. Administration of Test of Higher Order Thinking Skills as post-tests for Experimental and Control Groups.
viii. Hypothesis testing and interpretation of results

Theoretical Background of the Study

Flipped Classroom

The flipped classroom was popularized by Jonathan Bergmann and Aaron Sams,Woodland Park High School chemistry teachers. In 2007, they recorded their lectures for the benefit of absent students. But they observed that many students watched the lectures to study and prepare for tests(Bergmann &Sams 2012). They began posting their videos online, and started receiving emails from teachers and students from other districts requesting them to conduct workshops on this method**.**Then onwards flipped learning approach is used as an alternative instructional approach where the direct instruction during class time and homework are reversed.

Aflippedclassroomisatypeofblendedlearningwherestudentsareintroducedtocontentathomeandpracticeworkingthroughitatschool.The classroom activities in the flipped classroom take place outside the classroom and students use the class time for the use of active learning activities such as problem solvinghands on experiments, activities, group discussions, projects, assignmentsin the presence of the teacher (Jamaludin& Osman, 2014).

High Order Thinking Skills

Researchers describe and classify thinking skills in different ways. Different kinds of taxonomies are available which describes thinking skills.One of the well known taxonomy is Bloom's Taxonomy.Bloom (1956)

developed a classification of cognitive skills and learning behavior.This taxonomy contained three overlapping domains Viz., the cognitive, affective and psychomotor. Lower Order Thinking Skills and Higher Order Thinking Skills are described in the cognitive domain of Bloom'sTaxonomy.Within the cognitive domain, six levels have been identified: knowledge, comprehension, application, analysis, synthesis and evaluation. The learning objectives at the top level of the Taxonomy such as skill for application, analysis, synthesis and evaluation are considered as higher order thinking skills. The remaining two that is knowledge and understanding are known as lower order thinking skills.

Lorin Andersonand David Krathwohl (2001) revised the Bloom's Taxonomy and thus made some changes in the cognitive domain of Bloom's Taxonomy (1956).The revision includes minor yet significant changes. Bloom's six levels were changed from noun to verb forms. The lowest level, knowledge, was renamed as remembering.Comprehension, application, analysis, synthesisand evaluation became, understanding, applying , analyzing ,creating and evaluating. In the revised taxonomy, skill for remembering, understanding and applying are considered as the lower order thinking skills and skill for analyzing, evaluating and creating are classified as higher order thinking skills.

Sample Selected for the Experiment

Sample selected for the present study, belongs to the population of secondary school students in standard IX studying under Kerala State Syllabus. Purposive Random Sampling Technique was used for selecting the sample. Sample chosen for the experiment involved a total of 60 secondary school students from the same population.Details of the sample for this purpose are given in Table1.

Table1
Details of the Sample Selected for the Experiment

Groups	Name of the school	Locality	Type of management	Sample	Total
Experimental	Govt.HSS ,Kulakkada	Rural	Government	30	30
Control	Govt.HSS ,Kulakkada	Rural	Government	30	30
Total (N)					60

Tools to be used

i. Test of Higher Order Thinking Skills
ii. Lesson Transcripts based on Flipped Class room strategy
iii. Lesson Transcripts based on Activity Oriented Method

Statistical Techniques Used

i. Test of Significance of Difference between Means (Dependent Samples t-test and Independent Samples t-test)
ii. Analysis of Co-Variance (ANCOVA)

STATISTICAL ANALYSIS OF DATA

Statistical analysis was done by using the following techniques and the results are discussed under 5sections.

i. Comparison of Pre-test scores of the Experimental group and of the Control group for Higher Order Thinking Skills.
ii. Comparison of Pre-test and Post-test scores of the Experimental group for Higher Order Thinking Skills
iii. Comparison of Pre-test and Post-test scores of the Control group for Higher Order Thinking Skills
iv. Comparison of Post-test scores of the Experimental group and of the Control group for Higher Order Thinking Skills.
v. Comparison of adjusted Post- test scores of the Experimental group and Control group for Higher Order Thinking Skills using Analysis of Co-variance

Comparison of Pre-test Scores of Experimental Group and of the Control Group for Higher Order Thinking Skills

For the purpose of comparing Pre-test scores of the two groups, Arithmetic Mean, Standard Error of Mean, Standard Deviation, and Critical Ratio of the pre-test scores of the two groups were tabulated and results of the Mean comparison are presented in Table 2.

Table 2
Data and Results of Mean Comparison for Higher Order Thinking Skills between Experimental Group and Control Groups

Sl. No.	Groups Compared	N	Arithmetic Mean	SE_M	SD	Critical Ratio
1	Pre-test Experimental Group	30	5.6	0.298	1.632	1.36 NS (P >0.05)
2	Pre-test Control Group	30	6.233	0.358	1.959	

NS indicates difference in the Mean scores Not Significant

Discussion of Results

The calculated value of Critical Ratio is 1.36 and is not significant at 0.05 level (C.R. = 1.36; p>0.05). That means the Mean of the ExperimentalGroup do not differ significantly from that of the Control Group in pre-test scores for Higher Order Thinking Skills.

Comparison of Pre-test and Post-test Scores of the Experimental Group for Higher Order Thinking Skills

For the purpose of finding the significance of difference in Higher Order Thinking Skills of the Experimental Group before and after the intervention, dependent samples t-test was used. The details of the Mean comparison are presented in Table 3

Table 3
MeanComparison of Pre-test and Post –test Scores of the Experimental Group for Higher Order Thinking Skills

Sl. No.	Groups Compared	N	Arithmetic Mean	SE_M	SD	Critical Ratio
1	Pre-test Experimental Group	30	5.6	0.298	1.632	16.66**

2	Post –test Experimental Group	30	10.93	0.307	1.680	(P<0.05)

** indicates difference in Mean scores Significant at 0.05 level

Discussion of Results

The calculated value of Critical Ratio is16.66 and is significant at 0.05 level (C.R. = 16.66; p<0.05). The Arithmetic Mean of the post- test scores is significantly greater than that of the pre-test scores. This shows that Flipped Classroom strategy is capable of enhancing Higher Order Thinking Skills.

Comparison of Pre-test and Post-test Scores of the Control Group for Higher Order Thinking Skills

For the purpose of finding the significance of difference in Higher Order Thinking Skills of the Control group taught through Activity Oriented Method, dependent samples t –test was used. The details of the Mean comparison are presented in Table 4.

Table 4
Mean Comparison of Pre-test and Post –test Scores of the Control Group ForHigher Order Thinking Skills

Sl. No.	Groups Compared	N	Mean	SE_M	SD	Critical Ratio
1	Pre-test Control Group	30	6.233	0.358	1.959	8.81** p<0.05
2	Post –test Control Group	30	9.3	0.424	2.322	

** indicates difference in Mean scores Significant at 0.05 level

Discussion of Results

The calculated value of C.R. is 8.81 and is significant at 0.05 level (C.R. = 8.81; p<0.05). The Mean of the post -test scores is significantly greater than that of the pre-test scores.The higher Mean score on the post –test indicates that students are better in post -test scores compared to their pre- test scores. This shows that the Activity oriented method is capable of enhancing Higher Order Thinking Skills.

Comparison of Post-test Scores of Experimental Group and of Control Groupfor Higher Order Thinking Skills

For the purpose of comparing post-test scores of two groups, Arithmetic Mean, Standard Error of Mean, Standard Deviation, and Critical Ratio of the post-test scores of the two groups were tabulated and results of the Mean comparison are presented in Table 5.

Table 5
Mean Comparison of Post-test Scores of Higher Order Thinking Skills between Experimental Group and Control group

Sl. No.	Groups Compared	N	Mean	SE_M	SD	Critical Ratio
1	Post-test Experimental Group	30	10.93	0.307	1.680	3.12** (p<0.05)
2	Post-test Control Group	30	9.3	0.424	2.322	

****indicates difference in the mean scores Significant at 0.05 level

Discussion of Results

From Table 5 it is clear that the Critical Ratio is 3.12 which is greater than the critical value required at 0.05 level of significance when the post- test scores were compared between the Experimental Group and the Control Group. This means that there is significant difference in the post- test scores of the Experimental Group when compared to that of the Control Group. Since the Mean score of Experimental Group is higher than that of the Control Group, the Experimental group taught through Flipped Classroom Strategy is superior to the Control Group taught through Activity Oriented Method for enhancing Higher Order Thinking Skills.

Comparison of Adjusted Post- test Scores of the Experimental Group and Control Group for Higher Order Thinking Skillsusing Analysis of Co-variance (ANCOVA) - Pre-test Scores as Co-variates

Test of significance of difference between Means, done in the previous sections strongly suggests that there exist no significant difference on the initialscores of students belonging to Experimental Group and Control Group on the variable Higher Order Thinking Skills.From the results, it is evident that the Mean Post- test scores of Experimental Group is higher than that of the Control Group.That means the Mean scores of Experimental Group for Higher Order Thinking Skills is significantly higher than that of the Control Group after the treatment.But it cannot be authentically said that the Post- test scores of the two groups differ significantly due to the treatment alone .There may be any extraneous variables which can influence the results. In order to statistically control the influence of such variables the technique of Analysis of Co-variance (ANCOVA) was used.Andthisprocedureofcomparison of Post-test scores of the two groups forHigher Order Thinking Skills was done initially by taking Pre –test scores as Co-variate. Details of the comparison are presented under three sub sections.

a. Summary of Analysis of Variance (ANOVA)
b. Summary of ANCOVA
c. Calculation of Adjusted Means

4.2.7.1(a) Summary of ANOVA for Experimental Group and Control Groups for Higher Order Thinking Skills

Using ANOVA, the Sum of Squares, Mean Square Variance and F-Ratios for the Pre –test and Post -test scores were computed and the details are presented in Table 6.

Table 6
Summary of ANOVA for Experimental and Control Groups for Higher Order Thinking Skills

Sl. No.	Source of Variation	df	SS_x	SS_y	MS_X (Vx)	MS_Y (V_y)	F value
1	Among Means	1	6.01	40.01	6.01	40.01	$F_x=1.84^{NS}$ (p>0.05)
2	Within Groups	58	188.57	238.17	3.251	4.10	$F_y=9.75^{**}$ (p<0.05)
	Total	59			…..	……	…….

NS indicates difference in the Mean scores Not Significant
** indicates difference in theMean scores Significant at 0.05 level

The obtained value of $F_x$is 1.84 and is less than F at 0.05 level of significance. Thus it is clear that there is no significant difference between the Pre-test scores of Experimental Group and that of Control Group.The

tabulated $F_y$value is 9.75 which is significant at 0.05 level, suggests that there exist significant difference in the Post –test scores of Experimental and Control Groups, when pre-test scores are considered as the Co-variates.

Summary of ANCOVA for Experimental and Control Groups forHigher Order Thinking Skills

Difference existing in the X scores (Pre-test) and Control Group for Higher Order Thinking Skills may lead to a corresponding difference in the final Y scores(Post-test scores).Therefore adjusted Mean scores for post-tests were compared. The sum of squares of Y adjusted for X differences (SS_{YX}) are presented in Table 7.

Table 7
Summary of ANCOVA for Experimental and Control Groups for Higher Order Thinking Skills

Sl. No	Source of Variation	df	SS_x	SS_y	SS_{xy}	SS_{yx}	$MS_{yx}(V_{yx})$	SD_{yx}	F_{yx}
1	Among Means	1	6.01	40.01	-15.52	59.83	59.83	….	20.49** (p<0.05)
2	Within Groups	57	188.57	238.17	116.1	166.36	2.92	1.71	
	Total	58					……	……	……

**indicates difference in the Mean scores Significant at 0.05 level.

Discussion of Results

F =20.49
From the Table 'F'df (1, 57),
F at 0.05 level of significance = 3.94

Here the calculated $F_{yx}$is greater than F at 0.05 level of significance.That means, there exist significant difference among the Means of the final scores.It is clear from the significant F_{yx}ratio that the two final Means of the Experimental and Control groups differ after they have been adjusted for the initial differences in the Pre-test scores. This difference may be due to the treatment provided to the Experimental group.

Calculation of Adjusted Means

The adjusted Means of Post- test scores (M_{yx}) after ruling out the initial differences in X scores (Pre-test scores), of students in Experimental and Control Groups were calculated .The difference between the adjusted Y Means was tested for significance. The data for the adjusted Y Means of Post test scores of students in Experimental and Control Groups are presented in Table 8.

Table 8
Data for Adjusted Means of Post-test Scores for Experimental and Control Groups forHigher Order Thinking Skills

Sl. No.	Groups Compared	N	M_x	M_y	M_{yx}	t-value
1	Experimental Group	30	5.60	10.93	11.13	3.7** p< 0.05
2	Control Group	30	6.23	9.3	9.11	

** indicates difference in the Mean scores Significant at 0.05 level

M_{yx}in the last column represent Means of final Y scores after ruling out the initial differences in X scores

Standard Error of Difference (SE_D) between the two Adjusted Means = 0.44

Difference of Adjusted Means obtained

D = M_{yx}(Experimental) - M_{yx}(Control)

= 10.93-9.3 =1.63

$$t = \frac{D}{SE_D} = \frac{1.63}{0.44} = 3.7$$

Discussion of Results

The calculated value of 't' is 3.7 which is greater than 1.98 at 0.05 level of significance of the test. This shows that there exists significant difference between Adjusted Mean scores of Experimental Group and of Control Group in their Post- test scores forHigher Order Thinking Skills. This significant difference between the Adjusted Post- test Means indicate that the students of Experimental Group and Control Groups differ significantly in their post- test scores of Higher Order Thinking Skills after they have been adjusted for initial differences in pre-test scores.Since the Adjusted Mean of Experimental Group is significantly greater than of the Control Group, it can be said that the Experimental Group taught through Flipped Class room Strategy is superior to the Control group taught through Activity Oriented Method, in Higher Order Thinking Skills.

SUMMARY OF FINDINGS

When the effectiveness of Flipped Classroom Strategy for enhancing Higher Order Thinking Skills was analysed, it was found that,

i. In terms of the comparison of Mean scores on Higher Order Thinking Skills

- No significant difference exists between the Experimental Group and Control Group in the Pre-test scores.

-Mean Comparison [C.R, t= 1.36; p > 0.05]

- Significant difference exists in the Mean scores between Pre-test and Post -test of the Experimental Group

-Mean Comparison [C.R, t= 16.66; p < 0.05]

- Significant difference exists in the Mean scores between Pre-test and Post- test of the Control Group

-Mean Comparison [C.R, t= 8.81; p < 0.05]

- Significant difference in the Mean scores exists between the Experimental Group and Control group in the Post- test.

-Mean comparison [C.R, t= 3.12; p < 0.05]

- Significant differenceexists in the Adjusted Mean scores of Experimental Group and of the Control Group in their Post test scores when Pre-test was taken as the covariate.

- Mean comparison [C.R, t= 3.7; p < 0.05]

- ANCOVA [F_{yx}=20.49;p<0.05]

TENABILITY OF HYPOTHESES

Tenability of hypotheses was examined based on the evidences obtained from the statistical analysis and interpretation of the data. This is explained as follows:

Hypotheses formulated for the study is "Flipped Classroom strategy is effective in enhancing Higher Order Thinking Skills of secondary school students".

The results of the analysis done so far with regard to the variable Higher Order Thinking Skills showed that:

a) The Critical Ratio [C.R , t=16.66; p<0.05] obtained in the Mean Comparison done between Pre-test and Post- test scores of the Experimental Group who taught through Flipped Classroom strategy , is significant at 0.05 level of significance of the test.

b) The Critical Ratio [C.R, t=8.81; p<0.05] obtained in the Mean Comparison done between Pre-test and Post- test scores of Control Group who taught through Activity Oriented Method, is significant at 0.05 level of significance of the test.

c) The Critical Ratio [C.R, t=3.12; p<0.05] obtained in the Mean Comparison done between the Post–test scores of Experimental Group and Control Group, is significant at 0.05 level of significance of the test .

d) The Critical Ratio[C.R, t= 3.7 ; p<0.05] obtained in the Mean Comparison done between Adjusted Mean Scores of Experimental Group and of the Control Group in their Post-test scores when Pre-test was taken as the covariate, is significant at 0.05 level of significance of the test.

Hence the Hypothesis which states that "Flipped Classroom Strategy is effective in enhancing Higher Order Thinking Skills of secondary school students" is substantiated.

CONCLUSION

From the core findings of the study, the major conclusion drawn is;

i. As a learning strategy for promoting Higher Order Thinking Skills of secondary school students, both Flipped Classroom Strategy and Activity Oriented Method marked their effectiveness. This finding was substantiated by the significant Critical Ratio obtained for the Mean comparison between Pre-test and Post test scores of Experimental and Control Groups taught by Flipped Classroom Strategy and Activity Oriented Method respectively, for the variableHigher Order Thinking Skills.

ii. However the two learning strategies viz; Flipped Classroom Strategy and Activity Oriented Method promotes Higher Order Thinking Skills of secondary school students, Flipped Class room Strategy is superior to Activity Oriented Method in enhancing the variable. This was strongly substantiated by:

a) The Significant Critical Ratio obtained in the Mean Comparison done between Post –test scores of Students who taught through Flipped Class room Strategy and students who taught through Activity Oriented Method for the variable Higher Order Thinking Skills.

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