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A Comparative Analysis of TPS-Cooperative Learning Model Over Conventional Teaching Method for Students' Achievement in Environmental Science: An Indian Case Study

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Abstract

The present study ascertains the effectiveness of the Think-Pair-Share (TPS) Cooperative Learning Model over the lecture-based conventional teaching of Environmental-Science (EVS) on a sample of 78 students at the secondary level. Pre-test-Post-test Intact group design was adopted for this purpose. TPS Cooperative learning Instructions were followed for 4 weeks with the experimental group and data collected through TPS based Lesson-plan and EVS-Achievement test. The Validity of the test was established through experts' opinions and its reliability was tested by Split-half-method and Spearman's Brown Prophecy formula obtaining reliability coefficients of 0.886 and 0.940, respectively. Pre-test and Post-test were administered on both groups to determine the difference in achievement levels before and after the intervention. Independent sample t-test, Dependent sample t-test and ANCOVA were performed at 0.05 significant level for testing the tenability of hypothesis. Results from the independent sample t-test revealed the significant difference in Post-test scores of both groups. A dependent sample t-test was run to differentiate the effect of the intervention on scores of the experimental group. The t-value obtained is significant for P= 0.000 ($p<0.05$), showing a significant difference in Pre-test and Post-test scores before and after the treatment. ANCOVA on the Post-test mean scores of the samples reported a significant effect on the achievement levels with TPS-Cooperative learning mode. The findings reflected that learners who taught EVS using the TPS instructional-strategy gave outstanding performance when compared to the control group. The TPS strategy is thus recommended at different levels in various disciplines for better academic gain towards action-oriented participatory learning.

Keywords: Think-Pair-Share (TPS), Academic achievement, Environmental science, Conventional method

Introduction

Environmental Education is an indispensable approach to creating awareness of the significance of the environment and issues in its sustainable management. Environmental education is a key factor in preserving, conserving, and dwelling in the environment suitably and sustainably. Individual initiative and social participation to achieve sustainability is the need of the hour (Sauvé, 1996). The depletion of natural resources by over-exploitation leads to an imbalance in the ecosystem and environmental degradation. The present scenario calls for a strategy involving the student community to resolve this complex issue. Owing to the current need, Environmental education was added as a separate discipline in all grades from primary to higher education level for generating interest in active participation towards environmental protection, preservation, and conservation (Sauvé, 1996; Tilbury, 1995).

Effective teaching strategy has proved its efficacy in fostering the aptitude, communication skills, application ability, comprehension, problem-solving ability, creative thinking, practical and productive skills, and confidence level in students to acquire meaningful learning. Professor Frank Lyman at the University of Maryland in 1981 postulated the Think-Pair-Share structure, which is a cooperative learning strategy and it was highly recommended by many educators (Lyman, 1981). The Strategy has a remarkable impact on Environmental-Science (EVS) learning. In Madhya Pradesh (India), EVS is being taught from primary to senior secondary school level to develop an aptitude to resolve current environmental issues. Therefore, an emergent need arises to change people's attitudes towards environmental protection (Sauvé, 1996). A broad range of teaching strategies for EVS has redefined the processes of imparting appropriate information to society for ensuring a sustainable environment (Monroe et al., 2007).

Teaching through conventional methods is not widely acclaimed for effective learning. Therefore, a restructured teaching pattern is necessitated, highlighting action-oriented learning for the development of the multi-sensory domain of learners. Hence, the investigator wanted to adopt a new 'Think-Pair-Share Strategy' for teaching EVS to the students. Think Pair Share (TPS) is an instructional strategy of cooperative and collaborative learning (Raba, 2017; Sumarni, 2016; Umar, 2018). It provides 'food for thought' to the students on a topic allocated by the teacher which enables them to utilize their think tanks and enable them to formulate individual ideas and then to share it with a peer (Rahmawati, 2017). The strategy comprises of Thinking-Pairing-Sharing described as:

Thinking

The Teacher initiates the topic by posing an open-ended question to the students at which a variety of answers are expected. Think time is given to the students to explore the myriad of responses that may shoot up in their minds. It thus promotes critical thinking among the learners at the classroom interface (Nugraha et al., 2018; Sumarni, 2016).

Pairing

Students are paired up either by the students themselves or on the teacher's wish. Here students turned towards their group partners to work together, to explore the concept, share their ideas, discuss the doubts, take up the challenges. During this phase, students are allowed to revise or alter their previous ideas if they feel any error. This mutual working on the concept gives them a crystal-clear understanding (Ningsih et al., 2019; Yusuf et al., 2018).

Sharing

It is the last step where a single student from each group comes out as a representative and asserts their discourse and conclusions, thus participating in the whole-class by putting the ideas of self as well as his partners (Raba, 2017).

Being simple, this is a highly effective and versatile technique which can be implemented at any level from early childhood to tertiary level and beyond also (Indra et al., 2018; Marhaeni et al., 2013; Rahayu & Suningsih, 2018; Sugiarto & Sumarsono, 2014; Tint & Nyunt, 2015). It lays the foundation stone for a collaborative and cooperative learning structure in the classroom scenarios. It catalyzes the processing of information, substantiate effective communication among a group, and other groups within the class, and also with the teacher. It develops a habit of sharing, listening, query making, summarizing ideas of all, and paraphrasing (Marhaeni et al., 2013; Okolocha et al., 2020; Oloyede et al., 2020). It encourages positive interdependence and provides for an opportunity for equal participation among students. It augments academic achievement, peer acceptance, quality response and an overall classroom-based interactive learning (Yarisda Ningsih, 2019; Nugraha et al., 2018; Rohim & Umam, 2019).

Theoretical Framework

Modern pedagogy involves various cooperative learning techniques that are specially designed for a limited number of interactive groups. Exploratory studies were conducted by many researchers over the group of students to find out the efficacy of different cooperative and collaborative learning techniques. The results of the study revealed the enhancement

of thinking skills and learning effectiveness through the TPS strategy (Bataineh, 2015). The responsive classroom discussions, peer interaction and peer support has increased the learning manifold. Another study conducted using the TPS strategy in classroom teaching analyzed that this strategy helped lower the anxiety level of students in solving mathematical problems and improved the learning outcome of the students to a great extent (Kwok & Lau, 2015). A study on the effectiveness of the TPS strategy by Abdul and co-workers claimed that students taught through this strategy had an outstanding performance in civic education. This active learning engaged all students in exploring previous experiences to construct new knowledge (Yusuf et al., 2018). A further research study on the outcome of mathematics learning through TPS showed an increased level of achievement when compared with the conventional method (Y. Ningsih et al., 2019).

Similarly, the study was carried out in the chemistry discipline, where the efficacy of this instructional strategy was investigated. The researcher found no significant difference in the learning of both groups under study. Another study explored the relation between TPS and students' creativity for the history curriculum and concluded an increase in learning competencies in the experimental group (Indra et al., 2018). Findings of one study in Economics curriculum learning explained the fact that the incorporation of cooperative learning improves the performance of learners in the course by motivating them to study and engage in the learning process (Kitaoka, 2013). Alternative learning approaches supplement collaborative skills among students. A classroom action research on student reading achievement by the TPS approach further demonstrated stimulating participation, simultaneous interaction, communication in group learning and reduction in conflicts among learners (Demirci & Duzenli, 2017; Sumekto, 2018). A comparative study on Project-based learning and Think-pair-share models of teaching for a group of students validated academic gain and better cognitive learning outcomes in the former group (Sulistyorini & Purwanti, 2018). The achievement level and retention ability among secondary school students of Financial accounting were also found augmented through the implementation of TPS instructional strategy in the classroom (Okolocha & Chukwudi, 2020). TPS mode was recommended for increasing the active participation of students during the teaching-learning process for longer retention of the content taught.

Furthermore, the effect of this strategy on conceptual learning and epistemological beliefs on physics learning was investigated by experimental design using the 'Mechanics Baseline Test (MBT)' to monitor the conceptual learning among students (Gok, 2018). The positive effect on students' conceptual learning was seen under TPS Strategy than the conventional teaching method. Similarly, Students' perspectives changed towards mathematics from a difficult subject to an interesting and enjoyable one when collaborative learning techniques were followed on the classroom platform. This study also depicted that mathematical ability and student's self-efficacy increased through the application of TPS with autograph (Ragelia et al., 2018). Afthina and co-workers asserted the maximum learning output through an interesting mode of TPS-led teaching in Mathematics branches like Geometry. An integrated active learning concept of the TPS learning model along with the Realistic Mathematics Education (RME) approach involved four stages viz, recognizing contextual issues, deducing solutions, comparing and sharing answers and conclusion. The findings revealed that coupling TPS with RME increased students' attentiveness, improved conceptual understanding, sharpened inductive/deductive logical reasoning skills and showed super problem-solving ability, hence maximizing learning output (Afthina et al., 2017).

The various studies advocated for the TPS as one of the facilitators of learning for greater achievement levels and cognition performance in students at different academic grades. It simultaneously develops the personality of students by enriching self-efficiency, self-confidence, communication skill, cooperation, etc. in them. Many studies have focused on implementing the collaborative techniques in core subject domains like Mathematics, Physics, History, Civics, Economics, English literature, etc. but a missing link exists for investigating the effect of such innovative techniques of learning in a subject

of contemporary context having multi-dimensional interlinkages. Since the world is facing many environmental issues and challenges, therefore EVS as a subject domain holds much wider applicability in creating awareness of such issues among the world community. Undeniably an emergent need exists to impart environmental knowledge through an effective teaching-learning process among school students. Within this framework, the present work undertakes to examine the effectiveness of the Think-Pair-Share strategy for augmenting achievement among EVS secondary school students. The present study focused on following objectives to work for:

- To study the effectiveness of Think-Pair-Share Strategy on achievement in Environmental Science at the secondary level.
- To compare the effectiveness of Think-Pair-Share strategy over the traditional Lecture method on achievement in Environmental Science among secondary school students.
- To compare the effectiveness of Think-Pair-Share Strategy on each of the dimensions of achievement viz. understanding, knowledge attainment, and application ability of secondary school students.

Hypotheses of the Study

The study proceeded with four hypotheses in the workflow as:

H1 - Think–Pair–Share strategy is highly effective than the Lecture method in teaching Environmental Science at the secondary school level.

H2 - Think Pair Share Strategy intensively promotes the level of knowledge than the Lecture method.

H3 - Think-Pair-Share strategy is effective in developing an understanding of the concept over the Lecture method.

H4 - Think-Pair-Share Strategy efficiently enhances the application ability of the students rather if taught by the Lecture method.

Methodology

The present study involved three types of variables, namely:

- **Independent Variable:** Think-Pair-Share strategy and Lecture Method
- **Dependent Variable:** Scores of the EVS-Achievement Test
- **Intervening Variable:** Intelligence

The study began with selecting core EVS topics from the science syllabus prescribed for class X students. The population of study was 1250 students of New Government HS school situated in the Bhopal district of India. The study was conducted over 4 regular weeks involving 78 samples, among which 35 students belong to the control group and 43 to the experimental group. Here the control & experimental groups were selected from the intact classroom. The Raven's Progressive Matrices Intelligence test developed by J.C. Raven was administered in both groups (Lohman et al., 2008). Originally developed by J.C. Raven in 1936, it is a nonverbal group test administered to various age groups from 5-year-olds to adults. Each test item consists of identifying missing element by the subjects that completes a pattern. The test consisted of 60 multiple choice questions arranged in order of difficulty to measure the test-taker's cognitive component. The students of both groups were found almost equal in their IQ. The control group received the Lecture-method and the experimental group received the Think-Pair-Share treatment. Before beginning the treatment, a Pre-test was administered to both groups and at the end of the fourth-week Post-test was conducted to determine the effectiveness of the Think-Pair-Share strategy.

Research Instrument

The instrument used in the study were:

1. Raven's Standardized Intelligence Test
2. TPS-Lesson Plans for the selected content of EVS from the science book prescribed by NCERT (National Council of Educational Research and Training, India) for class X.
3. EVS-Achievement test prepared by giving due weightage to content, objectives, form of questions and difficulty level.

Finally, a blueprint of 50 marks was constructed having 5 Multiple Choice Questions and 5 Fill-ups of 1 mark each, 5 Short-answer type questions carrying 4 marks each and 3 Essay type questions allotting 6 marks to two of them while other carried 8 marks. Item Analysis was done by finding the item-difficulty index (p) and discriminative power (d).

Table 1: Data and Results of Item Analysis

Item No.	Difficulty Level (p)	Discriminative Power (d)	Remarks (Item)	Item No.	Difficulty Level (p)	Discriminative Power (d)	Remarks (Item)
1	0.548	0.429	Excellent	11	0.595	0.619	Excellent
2	0.500	0.238	Average	12	0.381	0.286	Average
3	0.524	0.571	Excellent	13	0.429	0.476	Excellent
4	0.405	-0.048	Very Bad	14	0.667	0.095	Bad
5	0.429	0.286	Average	15	0.643	0.619	Excellent
6	0.500	0.429	Excellent	16	0.405	0.238	Excellent
7	0.381	0.476	Excellent	17	0.357	0.333	Good
8	0.286	0.381	Good	18	0.595	0.524	Excellent
9	0.238	0.095	Bad	19	0.214	0.238	Average
10	0.286	-0.095	Very Bad	20	0.500	0.333	Average

The Discriminative Power (d) is classified in the range values as: Excellent item, if $d > 0.39$, Good item, if $0.30 < d < 0.39$, Average item, if $0.20 < d < 0.29$, Bad item, if $0.00 < d < 0.20$, Very Bad item for $d = -0.01$. Two Very Bad items were rejected and the two Bad items were reviewed, and their distractors were modified after discussion and suggestion with the moderators. Thus, a total of 18 items were considered in the test.

The validity of the Achievement Test

To validate the test, it was discussed with three experts from science and education streams who were well equipped with modern teaching techniques in college and university. The test was developed, matching the criteria of standardized tests available and frequently used for the research. Based on their comments and suggestions, the test was edited. This ensured the content validity of the test.

Reliability of the Test

Test reliability was evaluated by Split Half Method. Applying Pearson's Product Moment Correlation, the Coefficient of correlation was found to be 0.886. The reliability of the test was found to be 0.886. Spearman's correlation was also found by Spearman's Brown Prophecy formula: rtt= 2rh/(1+rh) where, rtt = reliability of the entire test and rh = Correlation between the two halves. The value obtained was 0.940 which confirmed a high degree of reliability of the designed EVS-Achievement test.

Experimental Design

The experimental design of the Pre-test Post-test Two, Intact Group study, was applied where the subjects were selected from an intact classroom. One class is considered an Experimental group and the other as a Control group. The extraneous variable that may intervene in the treatment is controlled statistically in Pre-test & Post-test intact group. Both groups were administered a Pre-test as a measure of the dependent variable. The treatment was introduced to the experimental group for a specified period. The control group was taught by the traditional method. At the end of the experiment, the experiment and control groups were administered the Post-test as the measure of the dependent variable. Both the groups were treated similarly, and in the end, scores were collected and compared.

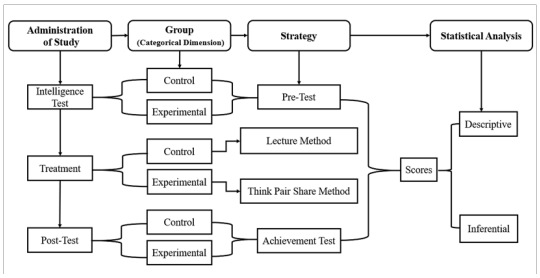

Figure 1: A Generalized Workflow of Experimental Design Used in the Study

Data Analysis and Interpretation

The present study dealt with descriptive and inferential statistical measurements on the data sets. These statistical techniques were applied in testing

the hypothesis for meaningful deductions. All the statistical analysis was done with Microsoft Office Excel version 2010 and SPSS Software version 20. Beginning with the experiment, a Pre–Test was administrated to both groups and statistics drawn is summarized in table 2 below.

Table 2: Statistical constants of Pre-test scores of the experimental and control group in EVS

Group	N	Mean	Median	Mode	S.D.	Skewness	Kurtosis
Control	35	12.67	13.50	15	3.288	- 0.975	1.249
Experimental	43	13.93	13.50	12	3.487	0.222	0.380

The values in table 2 depict the normality in pattern without much differences in two groups.

Pie-Chart illustrates that the Pre-test scores of both groups vary with very low differences. After that, an independent sample t-test was done at a 0.05 significance level for the Pre-test scores of both Groups. The same was applied to the dimension (Knowledge / Understanding / Application) wise scores of the Pre-Test. Results are shown in Table 3 below:

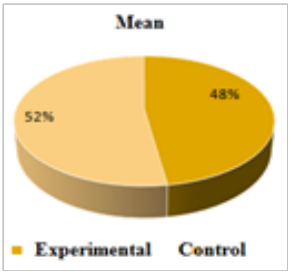

Figure 2: Mean Difference between Pre-Test Score of Experimental and Control Group

Table 3: Independent Sample t-test for Complete Pre-test scores and Pre-test Scores of Three Dimensions - K, U & A individually

Group	Control	Experimental	Control (*K)	Experimental (*K)	Control (*U)	Experimental (*U)	Control (*A)	Experimental (*A)
N	35	43	35	43	35	43	35	43
Mean	12.35	13.95	2.357	2.023	5.343	6.047	4.943	5.860
SD	3.91	3.48	1.320	1.090	2.039	2.055	1.881	1.887
T	1.87		1.223		1.509		2.138	
Sig (2- tailed)	0.065		0.225		0.135		0.036	

Note: *K: Knowledge Dimension; *U: Understanding Dimension; *A: Application Dimension

The t-value showed in Table 3 obtained from Pre-test scores of students belonging to the control and experimental group is not significant for (P>0.05). Hence it shows that there is no significant difference in total Pre-test scores of both groups. Further, no significant difference was detected in dimension wise-(Knowledge/Understanding level) scores of students of both groups in their Pre-tests, whereas for the Application dimension, the obtained t-value is significant for (P<0.05). Hence it shows that there is a significant difference in the application ability of students of both groups. The t-values obtained for total scores, knowledge, and understanding dimension scores were found not significant. This prompted the investigator to go ahead with further analysis. Stepping ahead with statistical analysis, an independent sample t-test was conducted for the Post-test scores between the control and experimental group for the total Post-test scores and dimension (Knowledge/Understanding/Application) wise Post-test scores of both groups individually. Here Mean, SD, t-value and significant-value (2 tailed) were obtained as shown in Table 4.

Table 4: Independent Sample t-test for Complete Post-test scores and Post-test scores of Three Dimensions - K, U & A individually

Group	Control	Experimental	Control (*K)	Experimental (*K)	Control (*U)	Experimental (*U)	Control (*A)	Experimental (*A)
N	35	43	35	43	35	43	35	43
Mean	12.35	13.95	2.357	2.023	5.343	6.047	4.943	5.860
SD	3.91	3.48	1.320	1.090	2.039	2.055	1.881	1.887
T	1.87		1.223		1.509		2.138	
Sig (2-tailed)	0.065		0.225		0.135		0.036	

Note: *K: Knowledge Dimension; *U: Understanding Dimension; *A: Application Dimension

The t-value in Table 4 for the total Post-test scores of both groups obtained as 6.264. The t-value obtained is significant for (P=0.000, p<0.05). Hence it shows that there is a significant difference in total Post-test scores of students belonging to the control and experimental group in their Post-test. The experimental group mean was found higher than the control group which indicates that the treatment has a significant effect in improving the achievement of the experimental group. Conclusively, the Think-Pair-Share strategy is effective in promoting the achievement level of the students. After that, the independent sample t-test was again applied to the dimension-wise Post-test scores of both groups (Table 4).

The t-value obtained for the Post-test scores under the knowledge dimension came out as 3.150 with the significant-value P=0.002. In contrast, for the Understanding dimension, the t-value obtained was 7.039 with a significant-value P = 0.000. Likewise, the t-value for the Application dimension obtained was 3.962 with a significant-value P = 0.000. The t-values obtained for all dimensions under consideration were significant for P < 0.05 at α (0.05) which reveals that the significant difference lies in the Knowledge, Understanding and Application abilities of students of both groups. The mean score of these dimensions of the experimental group is higher than the control group, which further elucidates the efficacy of TPS in improving knowledge, understanding level and application competency stands better than the control group.

Henceforth, a test of significance of the difference in the pre-test and Post-test scores of the control group was obtained. Therefore, dependent sample t-test (paired t-test) was done for the total Pre-test and Post-test scores of the control group and likewise dependent sample t-test (paired t-test) was done for the Pre-test and Post-test scores of the experimental group concerning all three-dimension (Knowledge/ Understanding/Application) individually. Here the correlation coefficient (r), t- value and significant-value (2-tailed) at α (0.05) are shown in Table 5:

Table 5 highlights the t-value for complete Pre-test and Post-test scores of the control group as 12.084 with the significant-value P= 0.000. However, t-values for knowledge, understanding and application dimensions are 9.528, 6.505 and 10.577, respectively. The significant-value found as P = 0.000 which is significant at α (0.05). Hence significant difference lies in Pre-test and Post-test scores (Complete & Dimensions-wise) of students belonging to the control group.

Table 5: Dependent Sample t-test scores of Complete Pre-test and Post-test of Control Group and Dimension-wise Individually

Control Group								
Scores	Pre-test (Total)	Post-test (Total)	Pre-test (*K)	Post-test (*K)	Pre-test (*U)	Post-test (*U)	Pre-test (*A)	Post-test (*A)
N	35	35	35	35	35	35	35	35
Mean	12.35	22.65	2.357	5.043	5.340	7.90	4.94	9.71

SD	3.917	5.134	1.320	1.554	2.039	1.969	1.881	2.847
Correlation	0.405		0.336		0.327		0.422	
T	12.084		9.528		6.505		10.577	
Sig (2-tailed)	0.000		0.000		0.000		0.000	

Note: *K: Knowledge Dimension; *U: Understanding Dimension; *A: Application Dimension

The dependent sample t-test (paired t-test) was done for the Pre-test and Post-test scores (complete & Dimension-wise individually) for the experimental Group. The obtained results for Mean, SD, Correlation-coefficient (r), t- value and significant-values (2-tailed) are represented in Table 6.

Table 6: Dependent Sample t-test of Complete Pre-test and Post-test Scores and Dimension-wise (Individually) Scores of Experimental Groups

Scores	Pre-test (Total)	Post-test (Total)	Pre-test (*K)	Post-test (*K)	Pre-test (*U)	Post-test (*U)	Pre-test (*A)	Post-test (*A)
N	43	43	43	43	43	43	43	43
Mean	13.93	30.20	2.023	6.256	6.047	11.872	5.860	12.058
SD	3.487	5.422	1.090	1.794	2.055	2.824	1.887	2.378
Correlation	0.495		0.088		0.204		0.467	
T	22.332		13.768		12.183		18.129	
Sig (2-tailed)	0.000		0.000		0.000		0.000	

Note: *K: Knowledge Dimension; *U: Understanding Dimension; *A: Application Dimension

Citing table 6, t-value for Pre-test and Post-test scores and (Knowledge/Understanding/Application) Dimension-wise scores of the experimental group obtained was 22.332, 13.768, 12.183 and 18.129 respectively. The t-values for them were significant for $P<0.05$ at α (0.05). This conveyed the significant difference in Pre-test and Post-test scores and dimension-wise scores of students belonging to the experimental group. The mean of the total Post-test score is higher than the Pre-test scores of the experimental group showing the remarkable impact of the treatment towards improving the achievement level. Therefore, evidently, Think-Pair-Share worked as an effective strategy in schools for augmenting achievement levels.

Analysis of Covariance (ANCOVA)

ANCOVA is a generalized representation of linear model using ANOVA and regression which evaluates whether population means of a dependent variable are equal across levels of a categorical independent variable often called a treatment, by controlling statistically the effects of other continuous variables known as covariate or nuisance variables which may not be of primary interest. Hence, while accomplishing ANCOVA, the dependent variable means are adjusted to what they would be if all groups were equal on the covariates. Since the current study selected two intact groups for the treatment; therefore, there were chances of the influence of intervening variables on students' achievements. Based on a review of the literature (Glomo Narzoles, 2012) and discussions with subject experts, the investigator decided to treat intelligence and Pre-test as intervening variables that were statistically controlled. For this, the investigator used ANCOVA (Hamdan, 2017).

ANCOVA for the Total Post-Test Using Intelligence as Covariate

As for the first step of ANCOVA, the test of homogeneity of variance was checked. Homogeneity of the variance of the groups compared are the important assumption to be stratified for analysis of covariance. In this, Levene's test of equality of variances for total Post-test scores was found out where Levene's F-test check the homogeneity of variances.

Table 7(a): Levene's Test of Equality of Error Variances

Dependent Variable: Post-test			
F	df1	df2	Sig.
0.842	1	76	0.362

Table 7(a) shows that Levene's F-value is not significant for (P=0.362, p>0.05). Hence, assumption of homogeneity of variance, which is an important assumption to proceed for ANCOVA is satisfied.

Table 7(b): ANCOVA results for Post-test scores using Intelligence as the Covariate

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1089.455[a]	2	544.728	30.070	.000
Intercept	4913.192	1	4913.192	271.215	.000
Intelligence	10.743	1	10.743	.593	.444
Group	1088.543	1	1088.543	60.089	.000
Error	1358.660	75	18.115		
Total	81363.00	78			
Corrected Total	2448.115	77			

a. R Squared = .445 (Adjusted R Squared = .430)

From Table 7(b), it is clear that the calculated significant-value (P=0.000) is less than the level of Significance α (0.05). It is evident from the findings that the groups are significantly different in achievement when taught with TPS and Conventional teaching strategy [F(1,75)=60.089]. Hence it can be assumed that the experimental group with TPS instructional strategy has a more significant effect on student's achievement level when compared with the conventional method.

ANCOVA for Knowledge Dimension with Intelligence as Covariate

Table 8: ANCOVA for Knowledge Dimension with Intelligence as Covariate

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	32.518[a]	2	16.259	5.719	.005
Intercept	84.373	1	84.373	29.675	.000
Intelligence	4.130	1	4.130	1.453	.232
Group	18.130	1	18.130	6.377	.014
Error	213.241	75	2.843		
Total	2790.250	78			
Corrected Total	245.760	77			

a. R Squared = .132 (Adjusted R Squared = .109)

Table 8 elucidates the result of the analysis of covariance, stating the significant difference between the Post-test scores of experimental and control groups [F(1,75)=6.377] where (P=0.014, p<0.05). Since P-value is less than 0.05, stating that there is a significant effect of the Think-Pair-Share instructional strategy on the knowledge dimension of achievement in students of the experimental group.

ANCOVA for the Dimension Understanding with Intelligence as Covariate

Table 9: ANCOVA results for Post-test understanding dimension scores using Intelligence as the Covariate

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	330.033[a]	2	165.017	28.043	.000
Intercept	213.415	1	213.415	36.267	.000
Intelligence	25.608	1	25.608	4.352	.040
Group	210.551	1	210.551	35.781	.000
Error	441.339	75	5.885		
Total	8712.00	78			
Corrected Total	771.372	77			

a. R Squared = .428 (Adjusted R Squared = .413)

Table 9 depicts the statistically significant difference between Post-test scores of both groups [F(1,75)=35.781], where calculated P-value = 0.000, which is < sig. α (0.05). The analysis of the Post-test scores signifies the difference found in students' understanding levels of both groups taught by TPS and conventional method, respectively.

ANCOVA for the Application Dimension using Intelligence as Covariate

Table 10: ANCOVA results for Post-test Application Dimension Scores using Intelligence as Covariate

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	133.161[a]	2	66.581	10.273	.000
Intercept	270.212	1	270.212	41.692	.000
Intelligence	27.162	1	27.162	4.191	.044
Group	60.394	1	60.394	9.318	.003
Error	486.086	75	6.481		
Total	10068.250	78			
Corrected Total	619.247	77			

a. R Squared = .215 (Adjusted R Squared = .194)

As can be seen from Table 10, the significant difference lies in Post-test scores of both groups [F(1,75)=9.318], where the calculated significance P-value (0.003) < sig. α (0.05). Thus, the analysis of the Post-test scores is indicative of the difference in students' application ability among groups taught by TPS and Conventional methods respectively.

ANCOVA using Pre-Test as Covariate

Again, to control the pre-test effect as a covariate, the test of homogeneity of variance was checked considering the Pre-test as an intervening variable. Levene's Test of equality of variances for total Post-test scores was obtained.

Table 11(a): Levene's Test of Equality of Error Variances

Dependent Variable: Post-test			
F	df1	df2	Sig.
0.117	1	76	0.733

Table 11(a) shows that Levene's F-value is not significant for (P=0.733, p>0.05). Hence the assumption of homogeneity of variance to proceed for ANCOVA is satisfied.

Table 11(b): ANCOVA results for Post-test Scores with Pre-test as Covariate

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1160.832[a]	2	580.416	33.816	.000
Intercept	4094.445	1	4094.445	238.552	.000
Pre-test	82.120	1	82.120	4.785	.032
Group	350.509	1	350.509	20.421	.000
Error	1287.283	75	17.164		
Total	81363.00	78			
Corrected Total	2448.115	77			

a. R Squared = .474 (Adjusted R Squared = .460)

Table 11(b) reflects the results of ANCOVA [F(1,75)=20.421] where the calculated significant-value (P=0.000) is less than α (0.05). It is evident from the findings that the groups are significantly different in achievement when taught with TPS and Conventional teaching strategy. Hence it is verified that the experimental group with TPS instructional strategy has a more prominent effect on student's achievement level when compared to the conventional method.

ANCOVA for the Dimension Knowledge using Pre-Test as Covariate

Table 12: ANCOVA results for Post-test Knowledge Dimension Scores with Pre-test as Covariate

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	65.680[a]	2	32.840	13.677	.000
Intercept	55.097	1	55.097	22.947	.000
Pre-test	37.292	1	37.292	15.531	.000
group	15.407	1	15.407	6.417	.013
Error	180.080	75	2.401		
Total	2790.250	78			
Corrected Total	245.760	77			

a. R Squared = .267 (Adjusted R Squared = .248)

Table 12 represents the significant difference between the Post-test scores of both groups

[F(1,75)=6.417], where P-value obtained as (0.013) < sig. α (0.05). The analysis reveals the difference in students' knowledge levels between both groups taught by TPS and Conventional method.

ANCOVA for the Understanding Dimension using Pre-Test as Covariate

Table 13: ANCOVA results for Post-test Understanding Dimension Scores with Pre-test as Covariate

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	342.245[a]	2	171.123	29.908	.000
Intercept	301.368	1	301.368	52.671	.000
Pre-test	37.820	1	37.820	6.610	.012
Group	248.534	1	248.534	43.437	.000
Error	429.126	75	5.722		
Total	8712.00	78			
Corrected Total	771.372	77			

a. R Squared = .444 (Adjusted R Squared = .429)

As seen from the results of ANCOVA [F(1,75)=43.437] in Table 13, the computed significant-value was (P=0.000) < sig. α (0.05) depicting the difference in students' understanding level of both groups intervened by TPS and Conventional method.

ANCOVA for the Application Dimension using Pre-Test as Covariate

Table 14: ANCOVA results for Post-test Application Dimension Scores with Pre-test as the Covariate

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	186.324[a]	2	93.162	16.140	.000
Intercept	289.204	1	289.204	50.102	.000
Pre-test	80.325	1	80.325	13.916	.000
Group	66.934	1	66.934	11.596	.001
Error	432.923	75	5.772		
Total	10068.250	78			
Corrected Total	619.247	77			

a. R Squared = .301 (Adjusted R Squared = .282)

From Table 14 it is clear statistically that a significant difference lies in Post-test scores of both groups where [F(1,75)=11.596] and the obtained P-value (0.001) < sig. α (0.05). It brings out the difference in students' application competency among both groups when taught by TPS and Conventional methods respectively.

Tenability of Hypotheses

Consequent to the findings, the tenability of the hypothesis for the study were examined and the conclusions drawn are as follows:

H1 stated that Think–Pair–Share strategy is highly effective than the Lecture method in teaching Environmental Science at the secondary school level. The results of the Independent samples t-test between control and experimental group, Dependent sample t-test for the Pre-test and Post-test of the experimental group and the results of ANCOVA substantiated Hypothesis–I. Therefore Hypothesis–I am fully accepted.

H2 stated that the Think-Pair-Share strategy of teaching intensively promotes the level of knowledge than the Lecture method. The results of the Independent samples t-test between the control and experimental group, the Dependent sample t-test for the Pre-test and Post-test of the experimental group and the results of ANCOVA validated Hypothesis-II. Therefore Hypothesis–II is accepted.

H3 stated that the Think-Pair-Share strategy is effective in developing an understanding of the concept over the Lecture method. The results of the Independent samples t-test between the control and experimental group, the Dependent sample t-test for the Pre-test and Post-test of the experimental group and the results of ANCOVA substantiated Hypothesis-III. Therefore Hypothesis–III is accepted.

H4 stated that the Think-Pair-Share strategy efficiently enhances the application ability of the students rather if taught by the Lecture method. The results of the Independent samples t-test between control and experimental group, Dependent sample t-test for the Pre-test and Post-Test of the

experimental group and the results of ANCOVA verified Hypothesis-IV. Therefore Hypothesis–IV is also accepted.

Results and Discussion

Findings of ANCOVA shows that the effect of the Think-Pair-Share strategy in Environmental science is substantial even after controlling the intelligence. Also, this instructional strategy yielded a discernible increase in achievement relevant to knowledge/understanding/application dimensions of the learning process after controlling intelligence as an intervening variable (Kwok & Lau, 2015). Results revealed that the strategy upgrades the knowledge level increases the understanding of the concept for longer retention (Tran, 2014) and promotes the application ability of students when compared with the conventional method of teaching. This shows that the Think-Pair-Share strategy is a robust method used extensively in our daily classrooms (Y. Ningsih et al., 2019). The cooperative structure of learning delivers greater thinking and social skills among learners. It drastically fills the achievement gap in the learners by incorporating proactive and action-oriented learning. This structured process of pedagogy assists students to imbibe the character virtues, acquisition of leadership, team-work, individual accountability, employability skills and improved self-esteem in them (Kagan, 1990).

Henceforth, the other intervening variable Pre-test was controlled statistically and the result of ANCOVA obtained shows that the Think-Pair-Share strategy in EVS renders efficacy and augments the achievement level of the students. These results are matching and being supplemented by various exploratory studies done under the same scenario (Yarisda Ningsih, 2019; Umar, 2018). Findings of ANCOVA depicted that the TPS instructional-strategy amplifies the level of all three dimensions viz. Knowledge, Understanding, and Application potency in learners of EVS even after controlling the effect of Pre-test. This elucidates that the TPS strategy is a functional and a remedial teaching strategy catering to the need for knowledge productivity, upgraded comprehension and application competency among secondary students. This upholds the fact that the learning objectives of the teacher are attained successfully by the incorporation of such a cooperative and collaborative teaching-learning method in EVS. The findings of the present work are strongly supported by earlier studies conducted by various researchers. (Altun, 2015) studied that cooperative learning fosters interpersonal skills, cognitive skills and meta-cognitive awareness among students. (Farmer, 2017; Kagan, 1990)in his studies documented the view of individual accountability, extensive participation, cooperation, team-spirit and intense engagement in learning. (Gemechu & Abebe, 2017) through an extensive study recommended adoption of collaborative learning as a participatory approach allowing maximum interaction for enhancing students' performances. The use of interactive structure results in a greater gain in terms of learning. (Tran, 2014) in his study emphasized the metacognitive strategies as an effective means of improving academic achievement under TPS strategy. Tran recommended that posing questions infused with meta-cognitive strategies in the classroom help students to learn the content more sturdily by increasing their retentive memory. (Daouk et al., 2016) also remarked that the Think-Pair-Share collaborative learning model is efficient because of its simplicity and relatively low-risk. (Hetika et al., 2018) also inferred from their study that the use of Think-Pair-Share strategy strengthens the student participation in class discussions and ensures their easy learning. (Ariana, 2013) The students' participation increased the social interaction, communication skills, confidence-level and achievements among them. Therefore, quite satisfactorily, the study has been supported by numerous reviews that the Think-Pair-Share strategy is a highly efficient way of augmenting the achievements of students at every level of schooling.

Conclusions

A think-Pair-Share instructional strategy is highly effective compared to the conventional Lecture method in teaching EVS among the secondary level students. Different learning dimensions like Knowledge, Understanding and Application ability of learners also showed remarkable academic progress with the application of TPS as a medium of instruction. It increases face-to-face interaction,

motivates peer-learning, analyzes the learning task of the team, promotes self-assessment and simultaneously increases social skills like trust-building, leadership, decision-making, and effective-communication. Strategy tends to upraise active-participation, critical-thinking, higher-order thinking, problem-solving skills, cooperation and inquiry research-skills for growing learners. Students based on their previous experiences move ahead towards constructing new knowledge under the objective of mutual goal accomplishments. Hence, the practicality of TPS is verified for a wider acceptance and is being recommended pragmatically for further usage in developing other core-content of different subjects.

Recommendations and Future Direction

The study supported that innovation in teaching yields better results in the achievement level of the students over the conventional method. Therefore, while framing the curriculum, importance may be given to the Think-Pair-Share technique. The strategy should be applied from the primary level onwards to inculcate active participation among students, thereby developing confidence. In-service courses and training modules should be organized for teachers to demonstrate lesson plans using the Think-Pair-Share strategy for their respective subject domains. The teacher-pupil ratio should be reduced from 1:45 to 1:25 for the smooth implementation of the Think-Pair-Share strategy. A combined effect of various cooperative learning methods can be studied and two or more than two approaches can be incorporated for reaping higher benefits. The study can be extended over to large samples covering larger portions of the syllabus to examine the reliability of the findings. Further, the Impact of the Think-Pair-Share strategy can be extensively studied on more dependent variables like Leadership, Confidence, Management, Study habits, Personality Dynamics etc.

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