

Effective Think-Pair-Share Pedagogical Strategy to Improve Inferential Statistics Concept Understanding

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Abstract : The Think-Pair-Share (TPS) technique is believed to encourage students who are shy to participate in classrooms. In this method, the instructor poses a problem and the students work on it individually to begin with. Next, they work in pairs and the final step is a discussion held by the entire classroom. The strategy allows students to think for a while, then talk to their partners, or group mates and share ideas. The students are encouraged and motivated to participate in the classroom. TPS is one of the cooperative learning methods that promotes group participation, discussion, critical thinking about the question being considered, presentation of personal ideas and opinions in a supportive environment. Statistics for Computer Science being a core subject and buzz word for the field of computer science engineering and data science, this strategy was implemented for the third-year computer engineering students to bring about an improvement in the conceptual understanding of inferential statistics concept. This proposed research work is an inferential statistical analysis of implemented TPS activity. Pre and post test was conducted for the inferential statistics concept on a random samples of 25 students. Parametric paired t-test is used to validate the hypothesis. Statistical results show that there is an improvement in concept understanding after TPS activity. Moreover, the outcome of the experiment along with feedback from the students related to this strategy are also excellent.

Index Terms : Think-pair-share, cooperative learning, t-test, Inferential Statistics

1. INTRODUCTION

It's a common observation that while conducting the lectures, many students remain unresponsive and unattentive. This happens because teachers are busy delivering content and students are either listening to the teacher passively or writing the notes given by the teacher. Teacher asks questions in between to keep students involved in the lecture but still it becomes difficult for the teacher to understand if students understood the concept well or not. The Think-Pair-Share strategy is a versatile and easy method for increasing student's involvement in the learning process. In Teaching Learning Evaluation, adopting necessary and new pedagogy is must for bridging the gap between online learning and in-person learning. The goal is to groom faculty in effective Pedagogy to encourage learner-centered teaching skills. Better online learning programs are operations, requiring both time to evolve and remarkable stakes to run. Many from us are

concerned that the speedy change to online learning will damage the reputation of online education. This does not represent that the pandemic situation faced due to COVID- 19 caused a shift to global remote teaching will be bad.

The widest future benefits of virtual learning will come after our professors and students return to their physical classrooms[6].

The need for teaching, learning with non contemporary (offline, Blackboard..) and contemporary (online) platforms will give majorable advantages when these pedagogues are mapped with in-person instruction. Offline courses will give better results for the students and professors that have evolved in using content online, as precious classroom teaching time will be highly productive for various debate, discussion, etc[8].

II. BACKGROUND THEORY

Students and lecturers, in collaboration, are able to undertake various activities that support education with the help of computers. Students and teachers make up the educational community and they function within the community by communicating with each other. Students with common academic goals are able to work in groups using the learning technique known as Collaborative Learning..

One more cooperative educational method is the think-pair-share technique and including it in the classroom curriculum can lead to advantages for the students. In depth studies of cooperative learning have revealed and proven that this method is extremely beneficial for its users [10-13]. Moreover, making use of the think-pair-share strategy mandates an increase in the wait time once the students have been assigned a task or asked a question [14]. This results in increased time for the students to ponder the question and allow for more students to participate in discussions leading to an improvement in the quality of the responses given by the students [15]. As a formative assessment, the think-pair-share method is a very valuable tool for the teachers [16]. The methodology of cooperative learning is conducive to students working together resulting in greater comprehension of the material covered in the class. This method works on the basis of students forming and working in groups that are small and the goal of these groups is to broaden the comprehension of all the students involved. The process of learning becomes rich

and lively because of collaborative learning [1]. This method has the capability of broadening the academic horizons of

students and at the same time strengthening their interest in a variety of subjects.

There are multiple strategies that lend themselves to collaborative learning. Given below is a list of the various techniques that are available:

- Fishbowl
- Jigsaw
- Paired Annotations
- Think-Pair-Share
- **Fishbowl Technique:** The very first collaborative learning method is the Fishbowl method[3] which has found a place in classrooms and business meetings because it is conducive for more animated discussions and group participation. This technique provides a unique opportunity to the participants to minutely observe social interactions and it is possible to use it in any content area. This cooperative learning structure is particularly suitable for small-group discussions or a partner discussion. [4].
- **Jigsaw Technique:** The strategy in this method is that each sub group tries to resolve a specific facet of the same question, issue or problem. If the Jigsaw strategy is to be used, it is crucial to define the contributions of a particular subgroup [5]. Jigsaws are an efficacious method to learn new materials. The key advantage of this process is that it encourages various skills such as engagement, comprehension and listening by assigning every member of the group a significant role in the academic process [3]. This technique also permits the administrators of the system to divide and shuffle various groups of participants dynamically.
- **Paired Annotations:-** In the technique of Paired Annotations, two participants are required to compare their own commentaries or impressions on a specific story, article or chapter. The same participants may pair up repeatedly to respond to the same article, chapter or material so as to be able to do an in-depth exploration of the differences and similarities and the salient points of the given material [2].
- **Think-Pair-Share:-** Think-Pair-Share is a four phase discussion technique that includes wait time along with other aspects of cooperative learning [3]. Members of the group ponder about a specific topic or question on their own and then exchange their thoughts with a partner. There is potential for summarized sharing in a large group [4].



Fig. 1: TPS Activity

III. METHODOLOGY

The topic chosen for the activity is inferential statistics which includes methods to draw conclusions as data science is a buzzword nowadays. Inferential statistics is a very important topic in data science and data analytics. The purposes of this activity are:

- 1) To encompass the elementary knowledge of t-test, chi square, F-test of Inferential statistics.
- 2) To improve the concepts understanding easy for calculating statistical test values for given data and drawing conclusions from the given data
- 3) To apply appropriate inferential statistical techniques on given data and given application.
- 4) To improve the overall performance of students in this course.

A. Think-Pair- Share (TPS) Activity

TPS is an active learning strategy in which students work in a collaborative manner. A problem is posed by the instructor initially in TPS, students think about the solution individually and in pairs and finally they share their solutions with the entire class or group[7]. The research [8] describes how reading skill is achieved and improved with implementation of Think-Pair-Share strategies during Guided Reading lessons. Three steps are required to implement the TPS techniques: First, the instructor needs to plan for TPS activity. Instructor poses some questions about the concept of the topic, and students start thinking of solutions during the Think phase. This will give them a small goal and make them feel some ownership of the assigned task, so they can understand the self-assessment process. Students work in pairs to find solutions. This will also fill the gap between the depth of knowledge required after understanding the topic. Next, they share the thought solutions among all. This involves class-wise discussion, reasoning of their solution, debating for alternative solutions also[9]. During this TPS activity, student's physical movement is not allowed so the discussion can be guided. TPS works in following phases:-

- (1) **Think (Read-Write):** In this first phase of the teaching-learning process, the teacher seeks answers to specific questions about the chosen or selected topic. This initiates the thinking process of students individually. Students read and write the solution using the knowledge which they have learned about the topic for a specific time slot allotted.

(2) **Pair:** This is the second phase of TPS that comes after Think. In this, student's are paired with another student and they share their thought solutions (of Think phase) to the given problem, discuss their ideas, and find out the solution by asking questions to each other. Instructor asks complex questions also related to previously asked problems and students are instructed to solve the problem. Students get enough time to discuss solutions with their partner.

(3) **Share:** In this last phase of TPS, instructors initiate to share students' solutions in the whole class. This process starts a whole-class discussion. Each group (student's group) chooses one representative to present their thoughts, ideas, and questions. After all the groups of the class 'share' their ideas, may again ask the pair to talk about how the 'share' activity helped them change their thinking for solution finding. Below example shows actual TPS activity conduction in class in following steps:-

1. Plan of TPS activity

Review and Discussion about inferential statistical techniques and implementing these techniques for given data for course 20PECE 501 "Statistics for Computer Science"

2. Think phase

Topic: "Inferential Statistical Techniques and its applications"

Think Phase Questions	(10 minutes)
1. What is inferential statistics, t-test, F-test, chi-square test.	
2. Illustrate formulas for t-test, F-test, chi square test. Also illustrate how and why to calculate which inferential statistical technique	
3. Make conclusions from results of F-Test, t-test, chi square test.	
4. Significance of Inferential statistical techniques	
5. Summarize Applications of Inferential statistics.	

Action: Instructor will pose the question based on similar lines, asking students to think and write the solutions of asked questions individually. Student's will think and write different applications of inferential statistical techniques F-test, t-test, chi-square, their formulas, solutions using given data and using appropriate statistical inferential techniques.
\Deliverable from this Phase:

Students will recall the notes or references given for the respective problem.
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3. Pair phase:

Student's try to find as many different applications as possible of inferential statistical techniques such as t-test, chi square test, F-test and discuss their list of applications with neighboring students and compare with their list. They also discuss how and which formulas they applied for given data and how they reach a conclusion.	(5 minutes)
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Action:

Instructor asks students to pair up with other students and discuss the solutions. Instructor keep vigilance around the class to check, students are discussing and observing responses of students, also helps to pairs who are in doubt.

Students pairs up with neighbors, check each other's solutions and applications, discuss their conclusions made to give data.

Deliverable from this Phase:

As a result of identified applications and problem for chosen topic, students will able to review Inferential statistical techniques for 20PECE501 Statistics for Computer Science course

4. Share phase:

Share a list of applications and how they applied inferential statistical techniques and how they draw conclusions for that application with the class. They share their respective application for F-test, t-test, chi square test.	(10 minutes)
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Action:

One representative student of each group shares their solution and answers to the whole class

Deliverable from this Phase:

Better understanding and performance improvement for Inferential statistical techniques concept and overall academic improvement for 20PECE501 Statistics for Computer Science course

B. Research Design

Design of this research is quantitative i.e. it is a kind of the research which is with group using pretest and posttest data. **Figure 2 shows the architecture.** Before carrying on the activity, simple classroom black-board teaching was done, and a test was conducted for statistics courses on different topics such as descriptive statistics, inferential statistics, data representation and statistics applications. After teaching, one pretest of 25 marks was conducted in the class which covers all the taught topics. While checking the papers, the instructor

found that there was confusion in inferential statistics while applying these on real life cases so the instructor decided to conduct think-Pair-Share activity in the class. After completion of TPS activity, an immediate feedback and posttest of 25 marks was conducted. The instructor found the

best result after evaluating post test papers. Inferential statistics t-test is applied on test results to draw conclusions about the effectiveness of the think pair share activity on this topic.

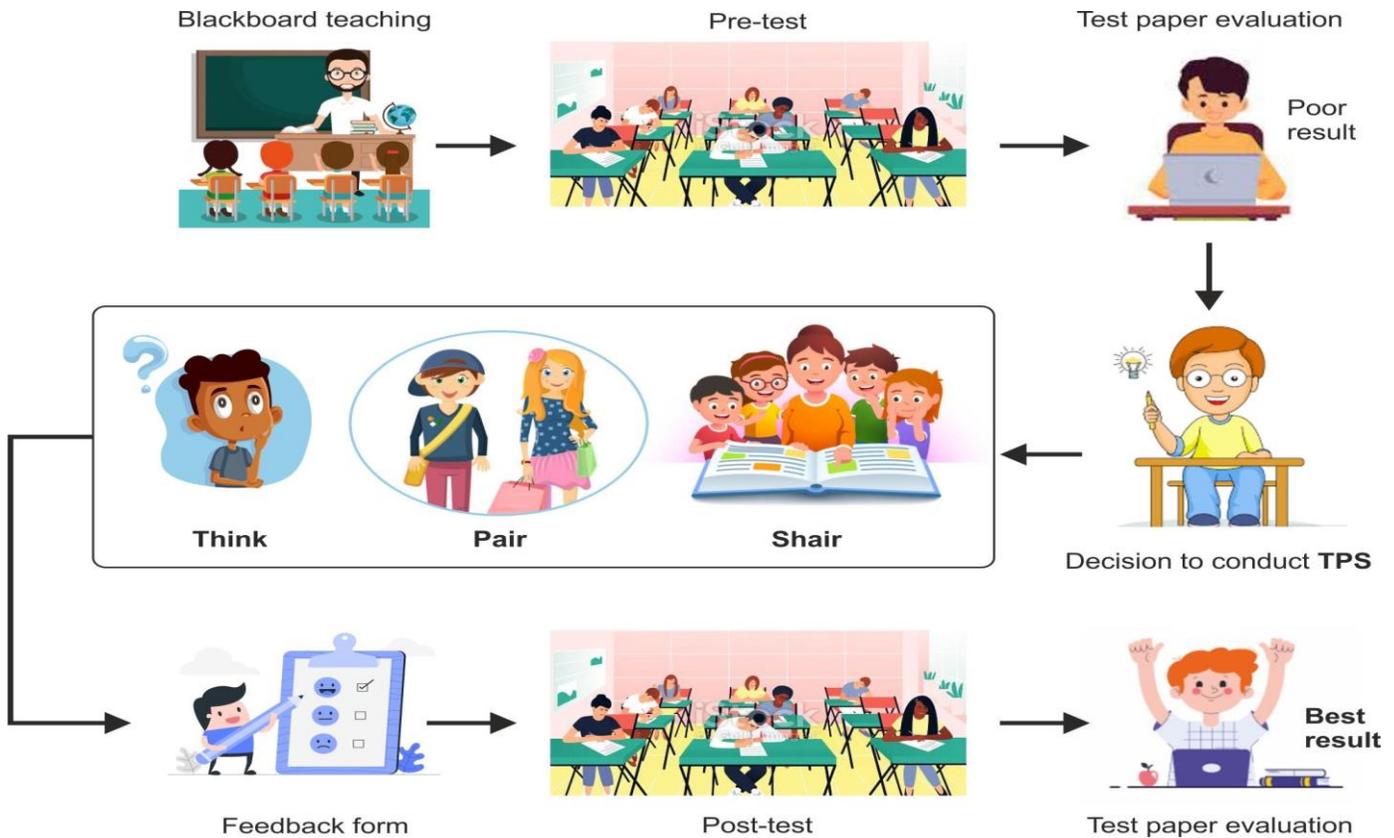


Figure 2: Architecture

C. Samples

A random group of 25 students from Third Year Computer Science and Engineering of Cummins college is taken as sample data.

D. Instrument of the Research

The device which is used by researchers for data collection and data processing are considered as instruments of research. Instruments help researchers to complete his work in a systematic and easy way to get the best results. The instrument applied for this research are the following:-

Test

The pre and posttest were conducted to assess students' understanding for the Inferential statistics concept. The tests aim to measure the students' progress in concept understanding. While designing the test, questions based on how to apply different inferential statistical tests such as t-test for independent and dependent samples, chi-square test, F-test on given data, drawing conclusions based on these tests were asked.

Data Analysis

The score of pre and post tests on inferential statistics for students were classified into five different levels: Excellent, very good, good, fair and poor based on marks.

Table 1: Scores classification

Marks	Level
=24 or =25	Excellent
<20 and <=23	Very good
<15 and <=20	Good
<10 and <=15	Fair
<=10	Poor

Table 2: Pre Test scores

No of students	Level
1	Excellent
7	Very good
13	Good
4	Fair
0	Poor

Table 3: Post test scores

No of students	Level
8	Excellent
3	Very good

10	Good
3	Fair
0	Poor

Pre Test and Post Test

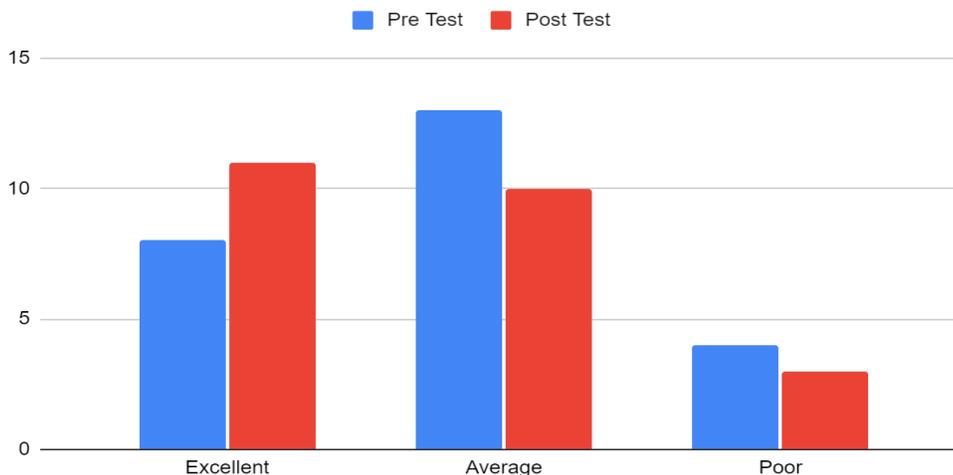


Figure 3: Performance improvement after applying think pair share

Table 2 and table 3 test score data shows that there is improvement in performance of concept understanding of inferential statistics using think pair share pedagogical activity. Excellent score of marks has increased and poor and average marks decreased after applying the think pair share pedagogical activity.

Mean score of the pretest and post test marks were calculated. And it was observed that there is change in mean marks of students after applying a think pair share pedagogical strategy. It is also observed that mean marks have increased after activity as shown in results.

Inferential statistics: Paired t-test

The paired t-test or dependent sample t-test, best suits for given data analysis. As this procedure is applied to validate the hypothesis made on the mean of data. In paired t-test, the entity under consideration is measured twice i.e. before and after activity data, which results in observations in pairs for given data or entity. It is used to determine if the difference between the means of two sample sets is significant or not. Null and alternative hypothesis here are:

$H_0: \mu_1 = \mu_2$ (No significant difference between the means of two sample)

The alternative hypothesis can be either based on two-tailed, left-tailed, or right-tailed. Here we consider left tailed

III. RESULT AND DISCUSSION

Table 4 shows the observed pre and post test scores.

Table 4: Test Scores

Sample No.	1	2	3	4	5	6	7	8	9	10	11	12	13
Pre test	20	18	18	16	15	16	23	19	22	12	13	25	22
Post test	24	18	25	18	19	15	24	18	25	18	14	24	22

as it conveys that pre test mean score is less than the post test score mean. And hypothesis being validated here is that our post test results are better than pretest.

H_1 (left-tailed): $\mu_1 < \mu_2$ (There is significant difference between the means of two samples. i.e. pre test score mean is less than post test score mean)

The formula used to calculate the t-test statistics is:

$$t = \frac{\sum d}{\sqrt{\frac{n(\sum d^2) - (\sum d)^2}{n-1}}}$$

where d : difference per paired value
n : number of samples

The t-test performed here is under the 5% level of significant i.e value of p is .05 and degree of freedom is $df=25-1=24$. Level of significance determines the area of acceptance and rejection. We accept null hypothesis if the test statistics results fall within the acceptance region. Given degree of freedom 24, critical t statistics table value is 2.064. It indicates that if the calculated t-test statistical value is less than equal to 2.064, the H_0 null hypothesis will be accepted, and if the calculated t-test statistical value is more than 2.064, the H_0 null hypothesis will be rejected, which eventually indicates that an alternative hypothesis is accepted.

Sample No.	14	15	16	17	18	19	20	21	22	23	24	25
Pre test	18	21	16	17	14	18	23	21	17	20	19	22
Post test	22	25	17	16	15	20	19	23	20	25	16	24

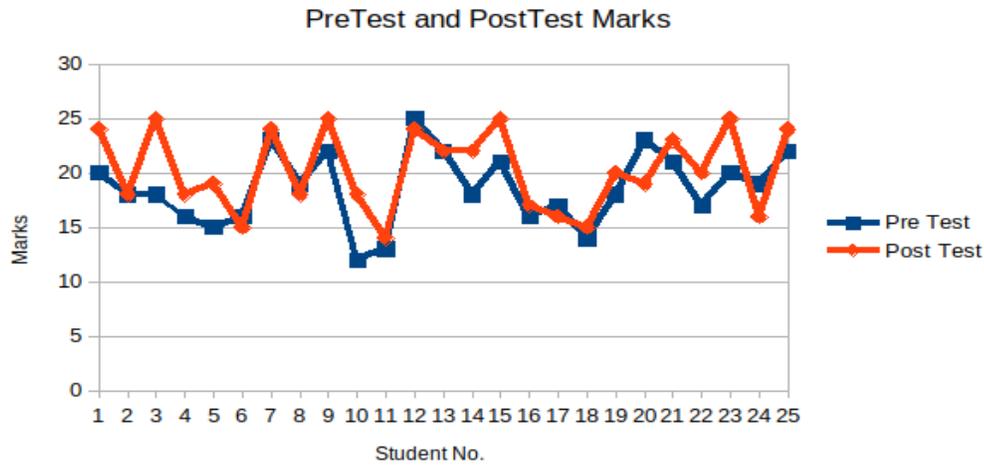


Figure 4: Pre test and Post Test Marks

Here figure 4 shows that post test marks are on a higher side compared to pretest marks. Calculated mean marks of pre test is 18.6 and mean post test marks are 20.24, which also indicates that post test marks have improved.

Table 5: Pre test and Post test result statistical analysis

Calculated paired t-test value for df = 24	t-test table value for df = 24
3.26	2.064

$\sum d^2 = 241$ $\sum n = 25$, so t-test statistical value calculated is 3.26, which is greater than 2.064. So, null hypothesis is rejected. Therefore, there is strong evidence that, on average, the think pair share does lead to improvements in scores of students. A result of feedback is shown in figure 5 below:

The students took a survey about their class participation and confidence at the beginning and at the end of the study. Below are charts from figure 5- 1 to 4 comparing the answers students selected in the pre-survey (blue) and post-survey (red).

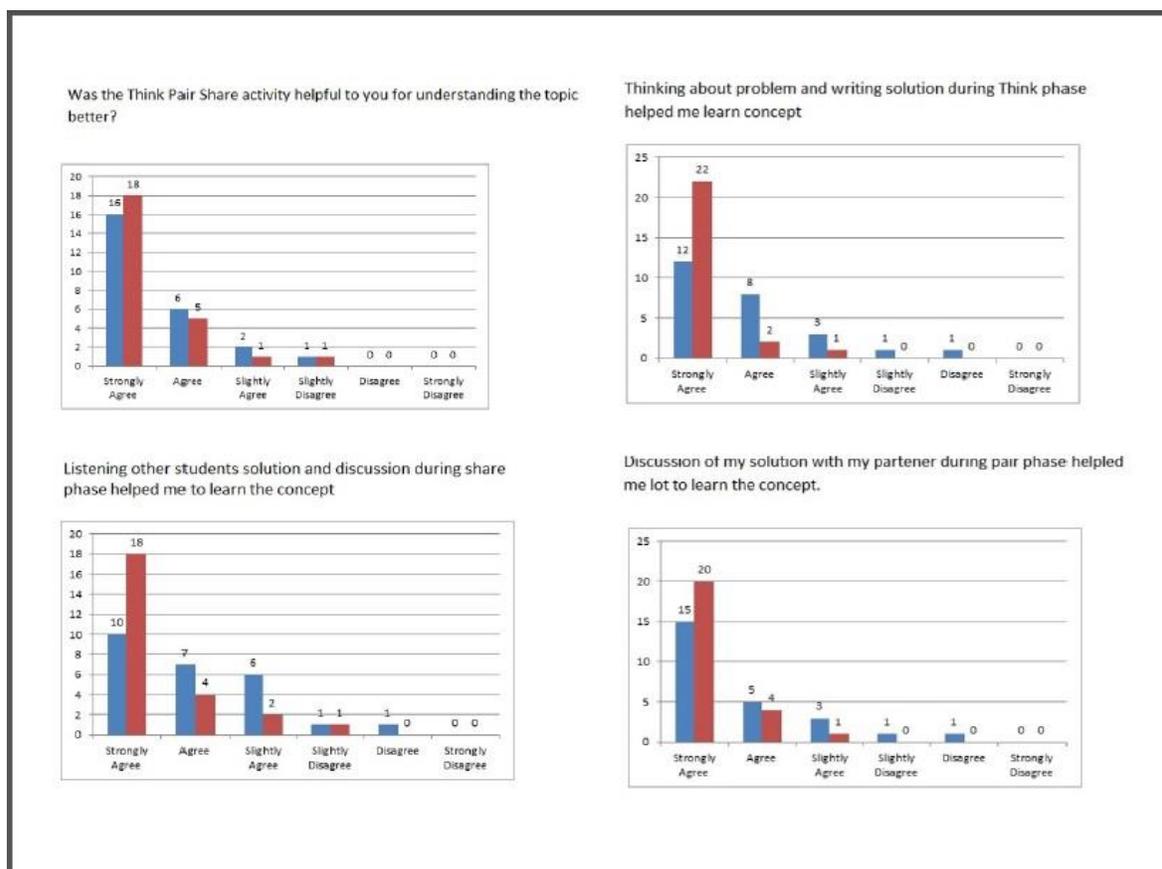


Figure 5 : Feedback of think-pair-share activity

IV. CONCLUSION

From this analysis and study of the proposed idea, it is observed that improvement in student performance and concept understanding is achieved using think-pair-share in the classroom. It also allows Teaching Learning Evaluation to increase the amount of student's participation. Increasing student participation in class increases students' interest and involvement in classroom teaching. This has many advantages like facilitating the opportunity for students to learn from their classmates, developing their confidence, presentation skills, and ability to contribute in class discussion. These statistical analysis of results reinforce the education system to use effective think-pair-share pedagogy. In the future, other pedagogical strategies can also be effectively applied to help the overall growth of the education system.

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