

# T24S Vs TPS

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**Abstract**— Think-Pair-Share(TPS) is a well known active learning strategy in which students work on the problem posed by the instructor, first individually, then in pair and finally together with the class. TPS develops technical and soft skill and promotes confidence, self learning & critical thinking ability. TPS consist of three phases: Think, Pair and Share phase, so this activity is not suitable for complex problem requiring more than two students to work in group to complete the task. Hence in this current study, TPS activity is modified and I renamed the activity as T24S (Think-Pair-Four in Group-Share) activity. T24S consists of four phases: Think, Pair, Four in Group and Share. In phase “Four in group”, each pre-assigned pair team up with another pair creating a team of four students, they share their answer and work together to complete the task.

In this paper, how T24S method can be used for the Theory of Computation of Second Year, System Programming and Compiler Construction of Third Year Computer Science and Engineering course is explained.

To test the effectiveness of this T24S over TPS activity, two group post-test only method for the course Compiler Construction of Third Year Computer Science and Engineering is considered. The Learning Objectives (LOs) are – 1) Compute the FIRST set for the given context free grammar (CFG). (LO1), 2) Compute the FIRST set for the given context free grammar (CFG). (LO2) and 3) Construct the parsing table for LL(1) grammar (LO3). For control group TPS activity was considered after blackboard teaching while for experimental group, T24S activity was considered after blackboard teaching. Statistical analysis using t-Test and Mann Whitney test shows that statistically significant performance on a post-test is observed for the experimental group as compared to the control group. Also the feedback about the T24S activity was also conducted to check the students’ perception about this activity.

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## 1. Introduction

In engineering stream, many engineering courses like Mathematical Courses, Algorithm based courses and

Logical courses etc. contain complex problems. So there is a need of effective and innovative activity to solve the complex problems. Think-Pair-Share (TPS) activity is well known collaborative active learning strategy which engages the entire class and includes all students in teaching learning strategy. But for complex problem, working in the pair is not sufficient to solve the complex problem. Hence I modified TPS activity and integrate one more phase in TPS that is four in group phase. The modified TPS activity is renamed as T24S. In this study, how this modified TPS activity can be used for other courses is also explained with example.

## 2. Related Works

There are many approaches to teach Compiler Construction of Computer Science and Engineering. Ricardo Luis et al. in a paper titled “A pedagogical environment to teach formal languages, automata and compiler construction” proposed an environment and a methodology to teach the concepts involved that is highly experimental, based on operational models.

There are set of tools which can be useful for teaching the course Compiler Construction (Akim Demaille 2008, Marjan Mernik 2003).

Li Xu and Fred G. Martin, “Chirp on Crickets: Teaching Compilers Using an Embedded Robot Controller” demonstrated chirp design which covered key compiler construction techniques including lexing, parsing, intermediate representation, semantic analysis, error handling and code generation.

Wang Na<sup>1</sup>, a, Zhang ShiMing<sup>1</sup> in a paper titled “Construction of compiler technology course in application-based University” combined the theory and practice and divide compiler into two levels: compiler technology and compiler theory.

Keshav Pingali and Gianfranco Bilardi, “Parsing with Pictures”, explained the parsing as the problem of finding certain kinds of paths in a graph called the Grammar Flow Graph that is easily constructed from a context-free grammar.

TPS is a very useful activity which engages the entire class and useful in improving the quantity and quality of student engagement in a large class (Aditi Kothiyal 2013, Sunita Dol 2014). But sometimes working in pair of Pair phase of TPS activity is not sufficient to solve the complex problem. More than two students are required to complete the task. Hence in this study, the TPS activity is modified which is useful for solving complex problem statement.

### 3. Methodology

The study is considered for Compiler Construction Course of Third Year Computer Science and Engineering. The topic selected from this course for this study is Construction of Predictive Parsing table.

The learning objectives of this study are:

- Students will be able to compute FIRST set for given Context Free Grammar.
- Students will be able to compute FOLLOW set for given Context Free Grammar.
- Students will be able to construct the Parsing table for given Context Free Grammar for LL(1) grammar.

#### A. Sample

As Compiler Construction is the course of third year Computer Science and Engineering, so two groups of each 30 students from this class is considered. This is two group post-test methods.

#### B. What is TPS?

Think-Pair-Share(TPS) is a well known active learning strategy in which students work on the problem posed by the instructor, first individually, then in pair and finally together with the class. So TPS activity takes 15-30 minutes depending on the complexity of the problem. The TPS activity and activity performed by Instructor and students is shown in figure 1 and 2 respectively. This activity engages the entire class and includes all the students in the teaching-learning process. This activity develops soft skills, promotes confidence, self learning & critical thinking ability.

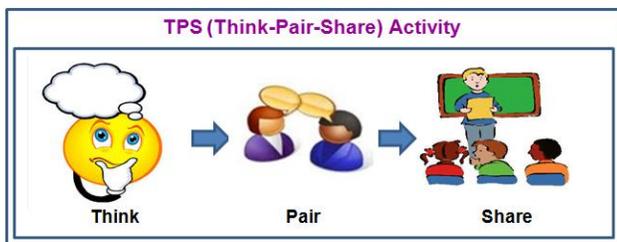


Fig. 1: Think-Pair-Share activity

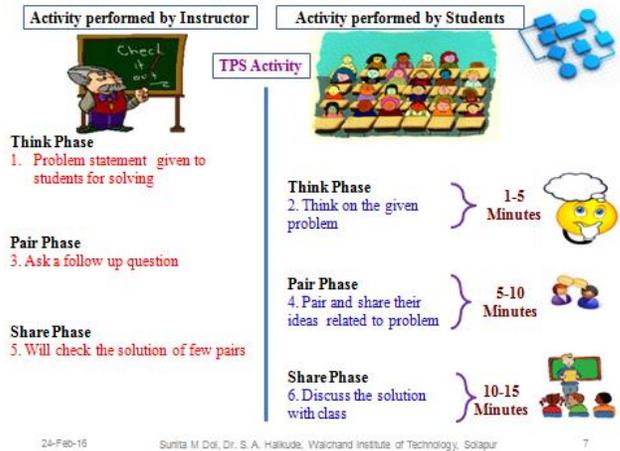


Fig. 2: Activity performed by instructor and students in TPS activity

#### C. Need to modify TPS?

Advantages of TPS to Students are

- Students are actively engaged.
- Students learn from each other.
- Students can tackle large and ill-structured problems, and develop the ability to consider multiple points of views
- It develops the technical and soft skills.
- It promotes confidence, self learning & critical thinking ability

Advantages of TPS to Instructor are

- The quality of students' responses also improves.
- Instructors address the confusion in a timely and helpful manner
- It allows instructor to check students' level of understanding before moving deeper into the subject matter

Limitation of TPS

- TPS activity consists of only three phases - Think, Pair and Share phase. So for complex examples consisting of more than two steps to solve, there is burden either on Think phase or Pair phase
- For complex examples, only working in pair is not sufficient to solve the problem.
- So More than two students in a group required to solve the complex problem.

**Example 1:** To demonstrate the limitation of TPS, the topic from Compiler Construction (CC), "Construction of Parsing table", is considered. So construction of parsing table consists of following three steps:

Step 1: Compute the FIRST set for the given context free grammar (CFG).

- Step 2: Compute the FOLLOW set for the given context free grammar (CFG).
- Step 3: Construct the parsing table.

The steps required to construct the parsing table with example is explained in figure 3.

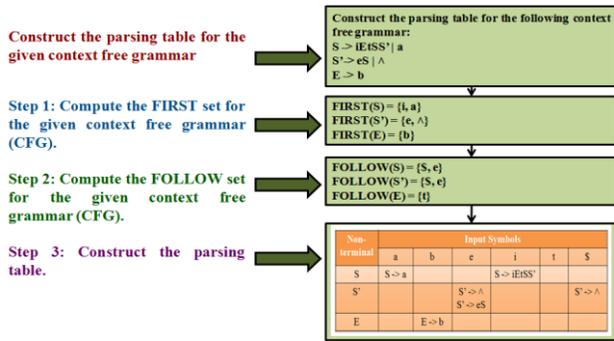


Fig. 3: Steps for constructing the parsing table.

Now if the TPS activity is considered, step 1 and 2 are considered in Think phase while step 3 is considered in Pair phase followed by share phase. Solving the problem statement using TPS activity is shown in figure 4.

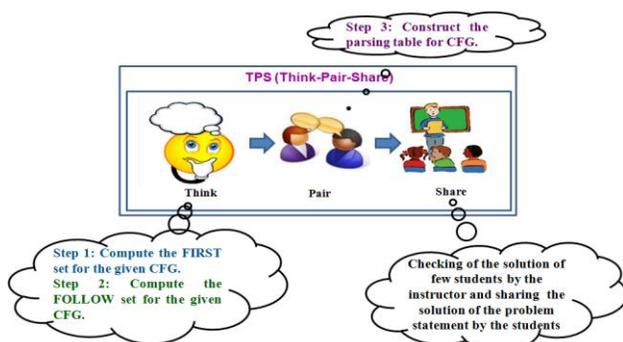


Fig. 4: Solving the problem statement of CC using TPS activity

In this TPS activity, as step 1 and step2 are considered in Think Phase, so there is burden on individual student in that phase. Step 3 requires more than two students to solve it, working in pair is not sufficient to solve the problem. Even step 2 requires students in pair to compute FOLLOW set. So there is a need to modify the TPS for complex problem.

**Example 2:** To demonstrate the limitation of TPS, the topic of the course Theory of Computation (TOC) of Second Year Computer Science and Engineering: Simplified Form and Normal Forms is considered.

The problem statement is of type “convert the given context free grammar to Chomsky Normal Form” which consist of four steps

- Step 1: Eliminate null productions from given context free grammar (CFG) if any.
- Step 2: Eliminate unit productions from given CFG if any.

- Step 3: Eliminate useless variable from the productions of given CFG if any.
- Step 4: Convert the CFG to Chomsky Normal Form (CNF)

The steps required to convert the given context free grammar to Chomsky Normal Form with example is explained in figure 3.

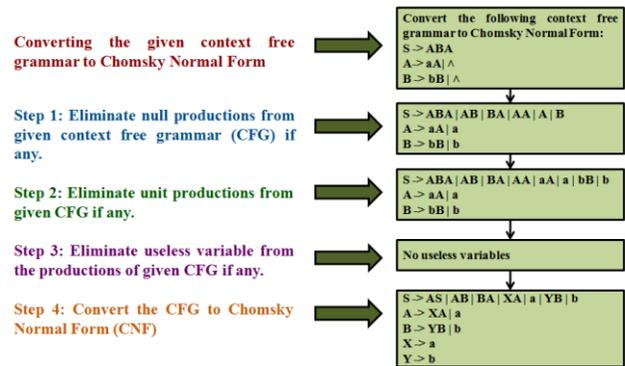


Fig. 5: Steps required converting the given context free grammar to Chomsky Normal Form

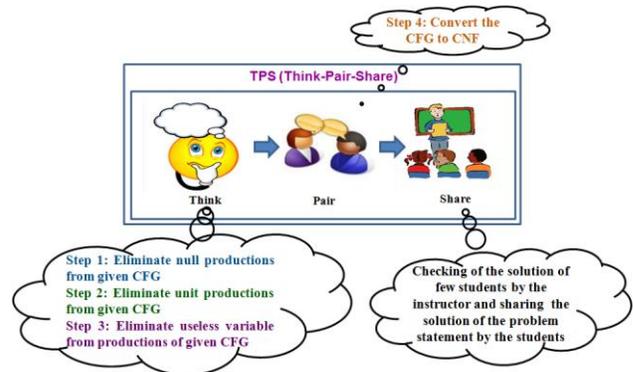


Fig. 6a:

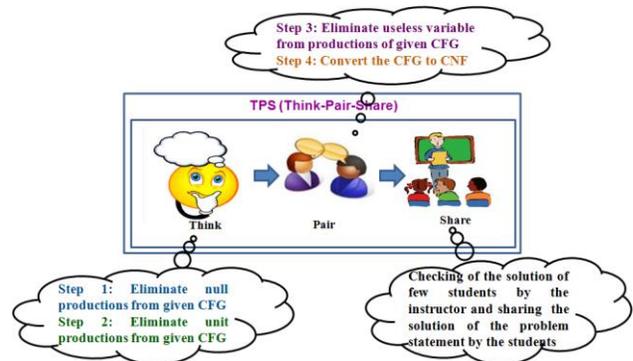


Fig. 6b:

Fig. 6: Solving the problem statement of TOC using TPS activity

Figure 6a and 6b shows possible way of how the problem statement can be solved using TPS activity.

As shown in figure 6a, in TPS activity, as step 1, step 2 and step 3 are considered in Think Phase, there is burden on individual student in that phase. The step 4 requires more than two students to solve it, working in pair is not sufficient to solve the problem.

As shown in figure 6b, in TPS activity, as step 1 and step 2 are considered in Think Phase, there is burden on individual student in that phase depending on the complexity of the problem statement. The step 3 and step 4 are considered in Pair phase, hence there is burden on pair phase also.

Hence there is a need to modify the TPS for complex problem.

Hence, the TPS method is modified and one more phase is integrated in it that is four in Group Phase.

T24S consist of four phases: Think, Pair, Four in Group and Share. In phase “four in group phase”, each pre-assigned pair team up with another and create a team of four students. They share their answer and work together to complete the task as shown in figure 7.

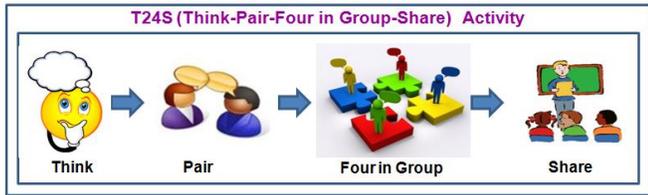


Fig. 7: T24S activity.

So the activity performed by instructor and students for T24S activity is shown in figure 8. The addition of one more phase in the TPS format works best for problem solving strategies and/or complicated case studies. So T24S takes 20-40 minutes depending on the complexity of problem statement.

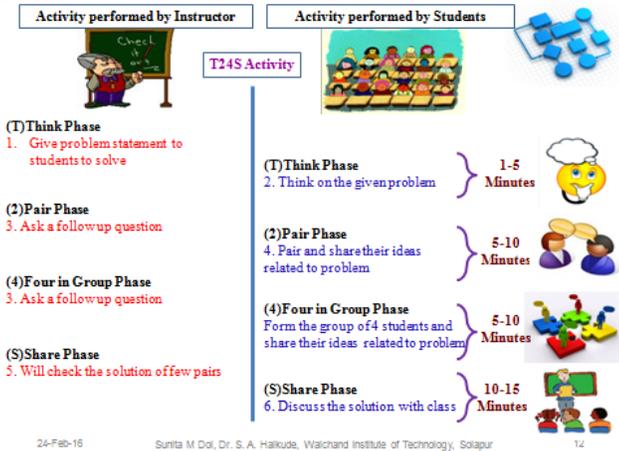


Fig. 8: Activity performed by instructor and student in T24S activity

**Example 1:** T24S activity for Compiler Construction-Topic: Construction of Parsing table

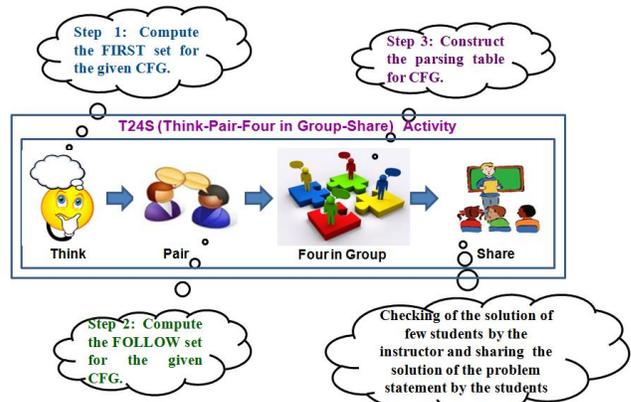


Fig. 9: T24S activity for Compiler Construction Course

**Example 2:** T24S activity for Theory of Computation-Topic: Conversion of Context free grammar (CFG) to Chomsky Normal Form (CNF)

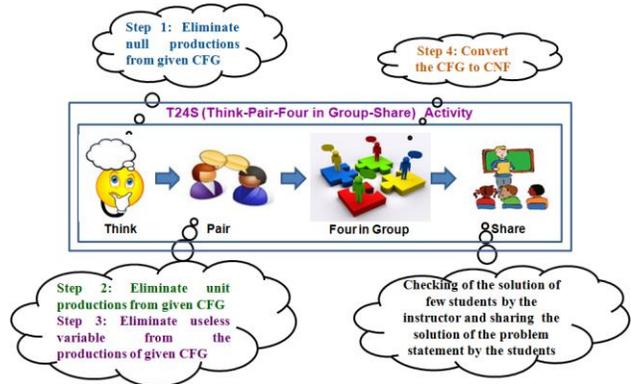


Fig. 10: T24S activity for Theory of Computation Course

**Example 3:** T24S activity for the topic of the course System Programming of Third Year Computer Science and Engineering is shown in figure 11.

**Topic considered:**  
Conversion of Assembly Language to Machine Language

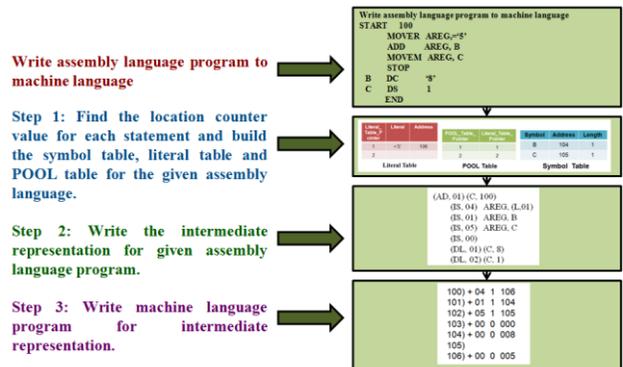


Fig. 11a: Problem Statement

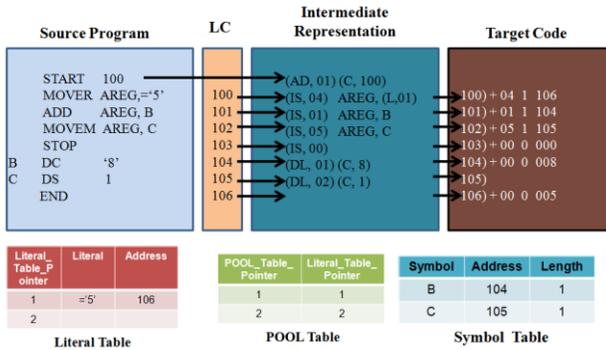


Fig. 11b: Example of the Problem Statement

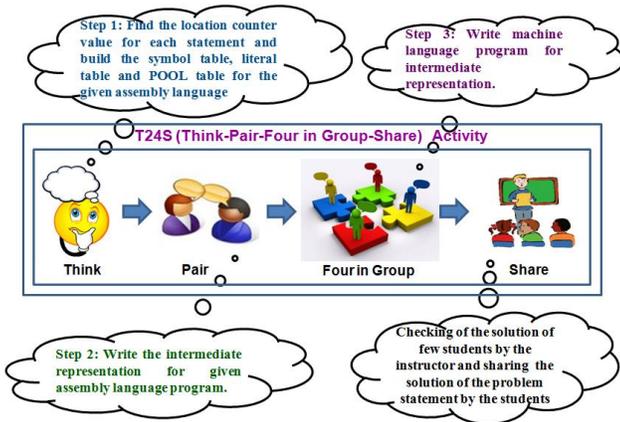


Figure 11c: T24S activity for problem statement

Figure 11: T24S activity for System Programming Course

Figure 12 shows how the same problem statement can be solved using TPS and T24S for Compiler Construction and Theory of Computation.

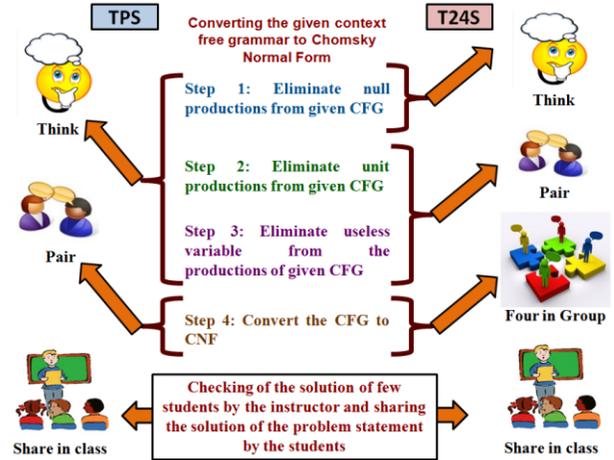


Figure 12b: Theory of Computation

Figure 12: Solving same problem statement using TPS and T24S

## 4. Experimental Details

### A. Experimental Setup

The experimental details are given in figure 13.

|                      |  |
|----------------------|--|
| Techniques used      | T24S (Think-Pair-Four in Group-Share) and TPS (Think-Pair-Share) Activity                            |
| Course considered    | Compiler Construction of Third Year Computer Science and Engineering                                 |
| Sample               | Two group of each 30 students from Third Year Computer Science and Engineering of Solapur University |
| Method               | Two group post-test model  |
| Instruments used     | 1. Post-test<br>2. Survey questionnaire and feedback from open ended questions                       |
| Learning Domain used | 1. Bloom's Taxonomy<br>Cognitive Domain-ApPLY Level  |

Fig. 13: Experimental Details

### B. Instruments used

#### 1. Post-Test

Post-test were conducted for 30 marks. Test after one month was of 25 marks. All tests contained the questions covering analysis level of Cognitive category (Bloom's Taxonomy). The sample question in these tests is given below:

- Consider the following CFG
- $$S \rightarrow aABb$$
- $$A \rightarrow c \mid \wedge$$
- $$B \rightarrow d$$
- Compute the FIRST set.
  - Compute the FOLLOW set.
  - Construct the parsing table.

Figure 12a: Compiler Construction

2. Previous Semester University Examination Result for the equivalence of Two Groups

Since this study is two group post-test methods, so instead of dividing the students in two groups randomly, previous semester university examination result is considered. Each group consists of 10 students having distinction class, 11 students having first class and 9 students having second class. So each group consists of 30 students.

Table 1: Experimental and Control Group

| No. of Students in→<br>Class↓ | Experimental Group | Control Group |
|-------------------------------|--------------------|---------------|
| Distinction Class             | 10                 | 10            |
| First Class                   | 11                 | 11            |
| Second Class                  | 09                 | 09            |
| Total                         | 30                 | 30            |

C. Research Design

This experiment was carried out for third year Computer Science and Engineering students. The experimental set-up for this two group post test model is given in figure 14.

For control group, the topic, “Construction of Parsing table for given Context Free Grammar (CFG) using SLR method” was taught using traditional method. After blackboard teaching, Think-Pair-Share activity was considered for control group followed by post-test.

For experimental group, topic was taught using traditional method followed by T24S activity, After T24S activity, the post-test was conducted to test the effectiveness of the activity conducted.

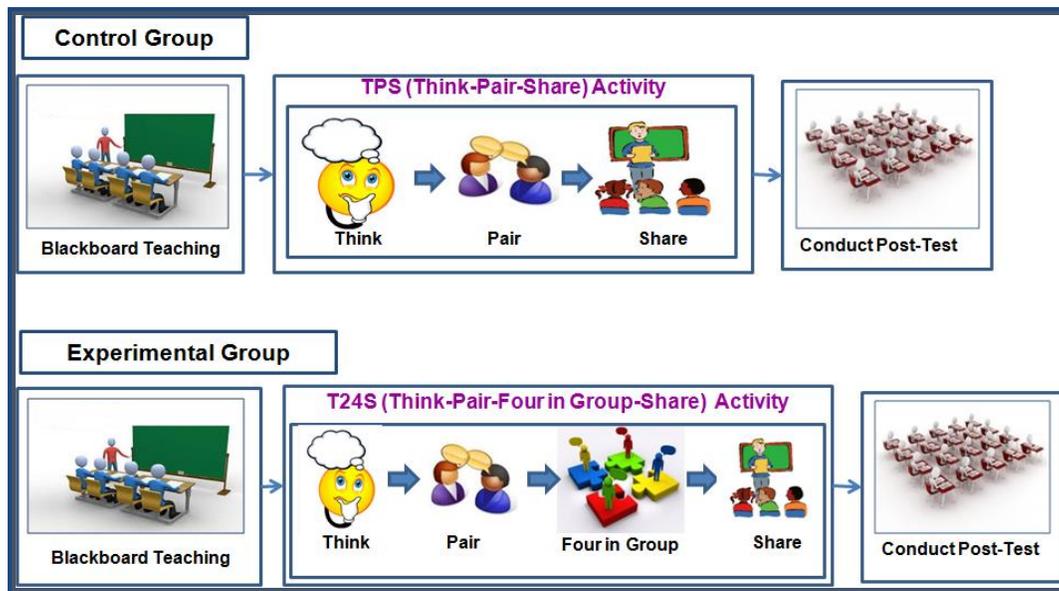


Fig. 14. Experimental Setup

D. Learning Objectives (LO) and Research Question (RQ)

Learning Objectives (LO) of this study is to teach problem solving skill. These LOs are:

- Compute the FIRST set for the given context free grammar (CFG). (LO1),
- Compute the FOLLOW set for the given context free grammar (CFG). (LO2) and
- Construct the parsing table for LL(1) grammar (LO3).

Our research question (RQ) was

- RQ: What is the difference between post-test scores of experimental and control group students for checking problem solving ability after conducting the activity TPS for control group and T24S for experimental group?

E. Advantages of T24S Activity

Fe.g. activity has the following advantages:

- More Ideas can be discussed and shared.
- It improves communication skills.
- Different minds discussing about a topic, generates good questions and find their relevant answers
- Group discussion
  - ✓ Enables the students to think in divergent directions to generate more points and a good presentation of the topic in the group.
  - ✓ Enhances the peer learning.
  - ✓ Gain more knowledge by getting others opinion.
  - ✓ Encourages learners to exchanges their own experiences, thereby making the learning more active.
  - ✓ Attain deeper understanding of topics.

F. Feedback

To understand student’s perception about these activities, the feedback for control group as well as for experimental group was conducted at the end of activity. The questions in feedback form for control group and experimental group is shown in table 5 and 6 respectively.

5. Result Analysis

Students’ conceptual understanding about the topic was analyzed using post test marks as shown in figure 15. The graph showed the improved performance in the post test of experimental group as compared to control group.

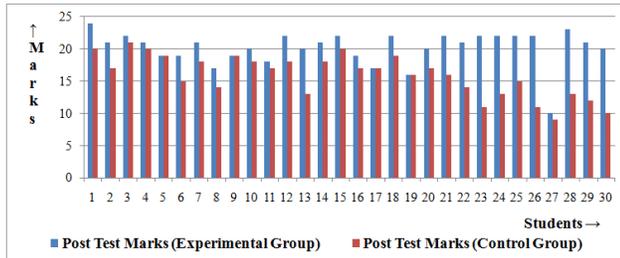


Fig. 15. Post-test marks comparison of control group and experimental group

t-Test was calculated to test if two groups differed significantly from each other. The t-Test result of post-test for control group and experimental group is shown table 2.

Table 2: t-Test Result of Pre-test and Post-Test

| Degree of Freedom | Standard Deviation | t value | p value |
|-------------------|--------------------|---------|---------|
| 58                | 2.99               | 5.54    | 0.0001  |

The Mann-Whitney U test is the alternative test to the independent sample t-test and used to compare differences between two independent groups when the dependent variable is either ordinal or continuous, but not normally distributed. It is used for equal sample sizes, and is used to test the median of two populations. Usually the Mann-Whitney U test is used when the data is ordinal. The normality test and histogram is shown in table 3 and figure 16.

Table 3: Test of Normality

|       | Kolmogorov-Smirnov <sup>a</sup> |    |      | Shapiro-Wilk |    |      |
|-------|---------------------------------|----|------|--------------|----|------|
|       | Statistic                       | df | Sig. | Statistic    | df | Sig. |
| Marks | .139                            | 64 | .004 | .929         | 64 | .001 |

a. Lilliefors Significance Correction

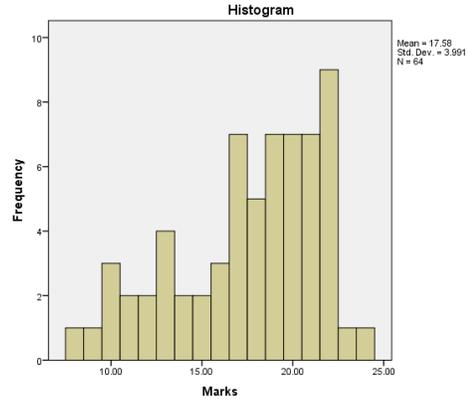


Fig. 16. Histogram Representation

Table 3 implies that data has non-normal distribution. Hence, the non-parametric Mann-Whitney test is done to compare group means. Table 4 shows the Mann Whitney test and implies the significant difference between two groups.

Table 4: Mann Whitney Test

| Ranks |                    |    |           |              |
|-------|--------------------|----|-----------|--------------|
|       | Group              | N  | Mean Rank | Sum of Ranks |
| Marks | Experimental Group | 30 | 45.53     | 1366.00      |
|       | Control Group      | 34 | 21.00     | 714.00       |
|       | Total              | 64 |           |              |

| Test Statistics <sup>a</sup> |         |
|------------------------------|---------|
|                              | Marks   |
| Mann-Whitney U               | 119.000 |
| Wilcoxon W                   | 714.000 |
| Z                            | -5.284  |
| Asymp. Sig. (2-tailed)       | .000    |

a. Grouping Variable: Group

6. Conclusion

In this paper, why there is a need to modify the TPS activity and how the modified TPS activity - T24S can be used for engineering courses are explained. To test the effectiveness of this T24S method, two group post-test methods is considered for the course Compiler Construction of Third Year Computer Science and Engineering. Statistical analysis using two methods (t-Test and Mann Whitney Test) shows the statistically significant higher performance on a post-test for the experimental group compared to the control group. So

this modified TPS activity T24S is useful for solving the complex problem.

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Keshav Pingali and Gianfranco Bilardi. Parsing with Pictures. Accessed on 08-12-2020 from <https://tm.durusau.net/?p=31860>

**Table 5: Students’ perception about TPS Activity of Control group**

| Sr. No. |  | Never                    | Sometimes       | Often        | Always                |
|---------|--|--------------------------|-----------------|--------------|-----------------------|
| 1       | How frequently did you write the solution to the problem given by the instructor during the think phase?       | 5%                       | 18%             | 27%          | 50%                   |
| 2       | How frequently did you discuss your solution with your partner during the pair phase?                          | 0%                       | 24%             | 20%          | 56%                   |
|         |  | <b>Strongly Disagree</b> | <b>Disagree</b> | <b>Agree</b> | <b>Strongly Agree</b> |
| 3       | I stayed interested in the content of the lecture because of the think-pair-share activities.                  | 0%                       | 0%              | 72%          | 29%                   |
| 4       | Thinking about the problem and writing the solution during the think phase helped me learn <topic> concepts.   | 1%                       | 1%              | 60%          | 38%                   |
| 5       | Discussing my solution with my partner during the pair phase helped me learn <topic> concepts                  | 0%                       | 2%              | 48%          | 48%                   |
| 6       | Listening to other students' solutions and discussion during the share phase helped me learn <topic> concepts. | 3%                       | 4%              | 55%          | 38%                   |
| 7       | I would not have learned as much from the lecture if there had been no think-pair-share Scale activities.      | 3%                       | 20%             | 54%          | 18%                   |
| 8       | Did you like the Think-Pair-Share activity: Yes/No Why?  | TPS Yes= 80%             |                 |              |                       |

**Table 6: Students’ perception about T24S Activity of Experimental group**

| Sr.No. |  | Never                    | Sometimes       | Often        | Always                |
|--------|--|--------------------------|-----------------|--------------|-----------------------|
| 1      | How frequently did you write the solution to the problem given by the instructor during the think phase?       | 6%                       | 8%              | 20%          | 66%                   |
| 2      | How frequently did you discuss your solution with your partner during the pair phase?                          | 2%                       | 14%             | 24%          | 59%                   |
| 3      | How frequently did you discuss your solution with your partner during the four in group phase?                 | 2%                       | 8%              | 45%          | 45%                   |
|        |  | <b>Strongly Disagree</b> | <b>Disagree</b> | <b>Agree</b> | <b>Strongly Agree</b> |
| 4      | I stayed interested in the content of the lecture because of the T24S  | 4%                       | 2%              | 67%          | 27%                   |
| 5      | Thinking about the problem and writing the solution during the think phase helped me learn <topic> concepts.   | 2%                       | 2%              | 53%          | 43%                   |
| 6      | Discussing my solution with my partner during the pair phase helped me learn <topic> concepts                  | 0%                       | 4%              | 63%          | 33%                   |
| 7      | Discussing my solution with my partner during the four in group phase helped me learn <topic> concepts         | 2%                       | 11%             | 66%          | 20%                   |
| 8      | Listening to other students' solutions and discussion during the share phase helped me learn <topic> concepts. | 0%                       | 12%             | 63%          | 25%                   |
| 9      | I would not have learned as much from the lecture if there had been no T24S.                                   | 4%                       | 31%             | 53%          | 12%                   |
| 10     | Did you like the T24S activity: Yes/No Why?  | T24S=100                 |                 |              |                       |