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TPS(Think-Pair-Share) : An Active Learning Strategy to Teach Theory of Computation Course

Sunita M. Dol
CSE Department Walchand Institute of Technology, Solapur, India
Email: sunita_aher@yahoo.com

ABSTRACT
TPS (Think-Pair-Share) which is a cooperative learning strategy where students think about their responses for a problem given by instructor then discuss their individual solutions in pairs and share those solutions with the class. As Theory of Computation is the core course of Computer Science and Engineering and the base for many courses like System Programming, Compiler Construction etc., so this TPS activity is considered for this course to improve students' conceptual understanding about the course. In this paper, one group Pre-Test Post-Test model is considered. Experimental results and student's perception about this activity are also presented.
Keywords- Think-Pair-Share(TPS), Theory of Computation, t-Test, Likert's Scale.

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INTRODUCTION

Theory of Computation is the core course of Computer Science and Engineering and the base for many courses like System Programming, Compiler Construction etc. So it is necessary to clear the concept of this course. Also this course is important as far as GATE examination is concerned. This course is important for modeling different kinds of hardware and software. As Theory of Computation is the course of Second year of Computer Science and Engineering/Information Technology, so students need active learning technique in addition to the blackboard teaching. Teaching and learning this subject is a challenging task. This subject is difficult to understand from student point of view. TPS which is cooperative learning strategy has been recommended for its benefits of allowing students to express their reasoning, reflect on their thinking, and obtain immediate feedback on their understanding [6], [7]. Hence the TPS activity is considered to teach the Theory of Computation Course. So the research question is "whether the use of TPS activity in class helps the students to improve the conceptual understanding about the course". To find the answer to this research question, one group pre-test post-test experimental study along with feedback was carried out. Results showed that this activity is useful for this course. Also feedback states that students agreed that think-pair-share activity developed interest in them to learn, thinking about the problem and writing the solution during the think phase helped them learn concepts more precisely and discussing the solution with the partner during the pair phase helped students learn concepts more clearly. Also 100% students agreed that they found the Think-Pair-Share activity effective.

RELATED WORK

There are many software tools to teach this course [4],[5]. In addition to this Mukta Goyal, Shelly Sachdeva in "Enhancing Theory of Computation Teaching through Integration with other Courses" [1] aimed towards introducing different approaches for making the course interactive and realistic by integrating it with other courses learnt in previous semesters and current semester of engineering. Carlos I. Ches˜nevar et al. in "Didactic Strategies for Promoting Significant Learning in Formal Languages and Automata Theory" [2] introduced a number of didactic strategies based on a constructivist approach. Carlos Iv´an Ches˜nevar et al. in "Teaching Fundamentals of Computing Theory: A Constructivist Approach" [3] were proposed a strategies based on a stronger use of technology and a constructivist approach.

METHODOLOGY

The objectives of this study were:

- To clear the concepts about finite automata, regular expression etc.
- To improve the performance of students in this course.
- To make easy the concepts like converting one form of machine to another, converting regular expression to NFA, converting grammar to normal forms etc.

To test the effectiveness of TPS activity, one group Pre-Test Post-Test model is considered. The course considered is Theory of Computation which is Second Year Computer Science and Engineering Course. Simplified forms and normal forms is the topic considered from this course for this activity. First instructor taught this topic by traditional teaching method that is blackboard teaching method to the class. In this topic, subtopics covered were - eliminating null production from the given context free grammar, eliminating unit production the given context free grammar, eliminating useless variable the given context free grammar and finally converting the given context free grammar to Chomsky Normal Form. Pre-test covering these subtopics was conducted for 25 marks. After conducting the pre-test, we considered TPS activity in the classroom. For TPS activity, the problem statement was to convert the given context free grammar to Chomsky Normal form which consist of following steps:

Step 1: Eliminate null productions from given context free grammar if any.
Step 2: Eliminate unit productions from given context free grammar if any.
Step 3: Eliminate useless variable from the productions of given context free grammar if any.
Step 4: Convert the context free grammar to Chomsky Normal Form.

TPS activity for converting the given context free grammar to Chomsky Normal form consist of

Think: In think phase of TPS activity, instructor asked the question to students to eliminate null productions, unit productions and useless variable if any from given context free grammar.

Pair: In pair phase, each student was asked to pair with the partner, shared their thinking with each other and proceeds with the task. Instructor asked the question related previous one that is suitable to deepen the students' understanding of the topic. The students were asked to convert the grammar obtained in 'Think' phase to Chomsky Normal form.

Share: In share phase, students shared the solution with the entire class. Instructor discussed the problem of converting context free grammar to Chomsky Normal form and highlights important points.

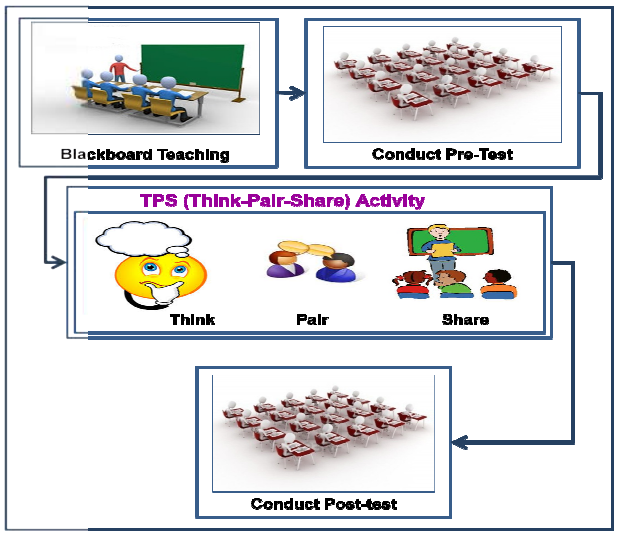

Figure 1: Experimental Set up

EXPERIMENTAL DETAIL

A. Sample

Since Theory of Computation is the course of Second year Computer Science and Engineering, a group of 40 students was selected for this experiment.

B. Think-Pair-Share (TPS)Activity

TPS is a collaborative, active learning strategy, in which students work on a problem posed by instructor, first individually (Think), then in pairs (Pair) or groups, and finally together with the entire class (Share) [7]. So this TPS consist of three phase:

Think: Faculty starts the teaching-learning process by seeking answers to specific question about the topic. Students "think" about what they know or have learned about the topic for a given specified time slot.

Pair: Each student is paired with another student. Students share their solution to given problem in think phase, discuss ideas, and ask questions to each other. Faculty asks complex question related to previously asked problem and students are asked to solve the problem.

Share: Pair has adequate time to share their thoughts and have a discussion; teachers expand the "share" into a whole-class discussion. Allow each group to choose who will present their thoughts, ideas, and questions. After the class "share," you may again ask the pair to talk about how their thinking changed as a result of the "share" element.

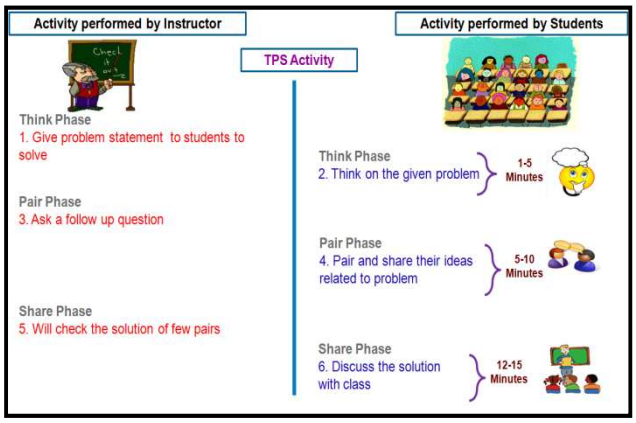

Figure 2: TPS activity

C. Pre-Test and Post-Test

Pre-Test and Post-Test were conducted on the topic: Simplified Forms and Normal Forms. The weightage of both tests was 25 marks. Both tests consist of questions like eliminate null productions, eliminate unit productions, eliminate useless variable and convert the given grammar into Chomsky Normal Form. These question covers Apply and Analyze level of Bloom's Taxonomy. The sample question in tests is shown as below:

> Convert the following context free grammar to Chomsky normal form
>
> S->PQP
>
> P-> 0P|^
>
> Q-> 1P|^

D. *Procedure*

In this one group Pre-Test Post-Test Model, first blackboard teaching was done related to the topic Simplified Forms and Normal Forms. After teaching this topic, Pre-Test was conducted on this topic. Two TPS activity was conducted to convert the given context free grammar to Chomsky Normal Form. To know about the students' perception about activity, feedback was also conducted at the end of this activity. Post-Test was conducted after TPS activity to check the effectiveness of this activity.

E. Feedback

To understand student's perception about this activity, the feedback was conducted at the end of activity as shown in table 4. Feedback contains the question like how frequently did you write the solution to the problem given by the instructor during the think phase? , How frequently did you discuss your solution with your partner during the pair phase?, I stayed interested in the content of the lecture because of the think-pair-share activities?, Thinking about the problem and writing the solution during the think phase helped me learn <topic> concepts, Discussing my solution with my partner during the pair phase helped me learn <topic> concepts, I would not have learned as much from the lecture if there had been no think-pair-share Scale activities etc.

Table 4: Students' perception about TPS activity

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?	2%	21%	27%	50%
2	How frequently did you discuss your solution with your partner during the pair phase?	0%	21%	21%	57%
		Strongly Disagree	**Disagree**	**Agree**	**Strongly Agree**
3	I stayed interested in the content of the lecture because of the think-pair-share activities.	0%	1%	70%	29%
4	Thinking about the problem and writing the solution during the think phase helped me learn <topic> concepts.	0%	0%	64%	36%
5	Discussing my solution with my partner during the pair phase helped me learn <topic> concepts	0%	4%	48%	48%
6	Listening to other students' solutions and discussion during the share phase helped me learn <topic> concepts.	3%	4%	57%	36%
7	I would not have learned as much from the lecture if there had been no think-pair-share Scale activities.	2%	30%	55%	13%
8	Did you like the Think-Pair–Share activity: Yes/No Why?	TPS Yes= 100%			

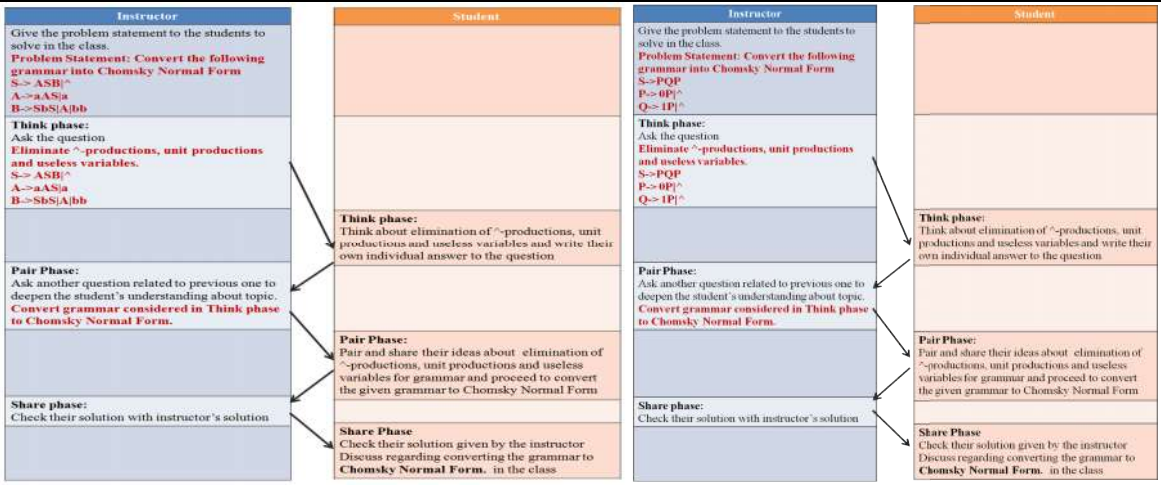

Figure: 6: TPS activity example for Theory of Computation

RESULTS ANALYSIS

Students' conceptual understanding was analyzed using pre-poet test marks as shown in figure 3. Graph in figure 3 shows that students performed better in post-test as compared to pre-test. Normalized gain is also calculated as shown in figure 4.

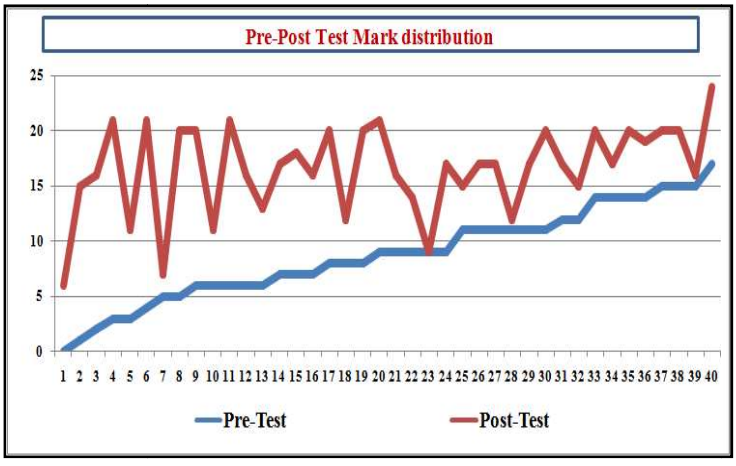

Figure 3: Pre-Post Test marks of students

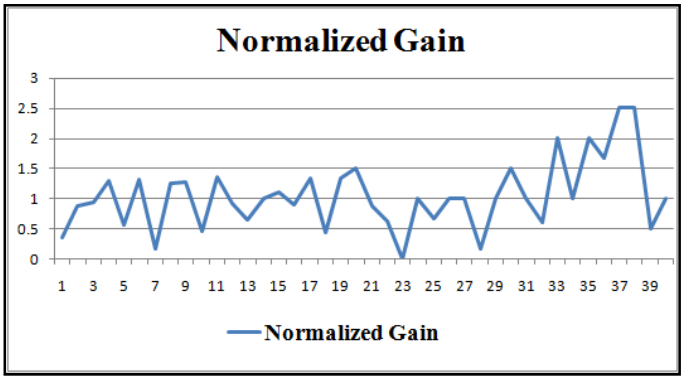

Figure 4: Normalized Gain

Average gain and relative gain were calculated and is shown in table 1. Relative average gain is 0.87.

Table 1: Average Gains

Average Pre-test	Average Post-Test	Absolute Average Gain	Relative Average Gain
9	16	7	0.87

Table 2: Average Gains

Pre-Test Level	**No. of Students**	**Mean of Pre-Test**	**Mean of Post-Test**	**Average Gain**
High (>=60 %)	4	15.5	20	4.5
Medium (40-59%)	12	12.16	17.16	5
Low (<40%)	24	5.95	15.75	9.8

As shown in figure 5, there is significant difference in pre-test and post-test marks. It means this activity is useful for low performer.

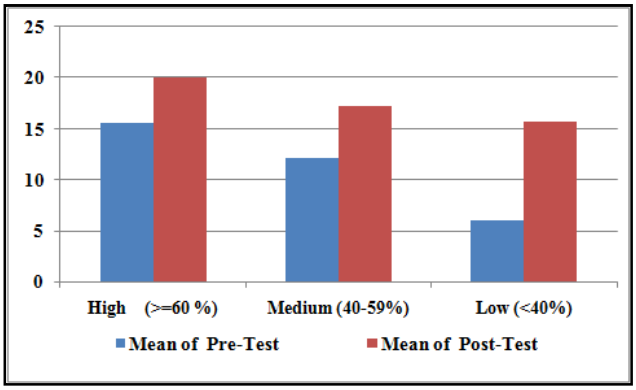

Figure 5: Mean of Pre-Post Test for high, medium and low

t-Test is used to determine if two sets of data differ significantly from each other. For t-Test to be significant statistically, t value must be 2.145 and p value must be less than or equal to 0.05. t-Test result is shown in table 3. t-Test result also shows statistical significant difference between pre-test and post-test conducted for this activity

Table 3: t-Test Result

Degree of Freedom	Standard Deviation	t value	p value
78	4.14	8.45	0.0001

CONCLUSIONS

In this paper, how TPS activity can be used for Theory of Computation is explained. From the feedback, 99% students agreed that think-pair-share activity developed interest in them to learn. 100% students agreed that thinking about the problem and writing the solution during the think phase helped them learn concepts more precisely. 96% students agreed that discussing the solution with the partner during the pair phase helped students learn concepts more clearly. 93% students agreed that listening to other students' solutions and discussion during the share phase helped to learn concepts. Also 100% students agreed that they found the Think-Pair-Share activity effective.

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