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Use of Flipped Classroom Activity as an Active Learning Strategy: An Experimental Analysis

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Abstract : *Due to rapid development in teaching-learning and its methodologies, technology has opened entirely new avenues for educational research. It is one of the challenging fields as well. Research in teaching-learning approach is one of the most popular tools for teachers, to help students understand the things in a better and easier way. There are variety of methods for the teaching-learning process like problem-based learning, project-based learning, case-based teaching, discovery learning, in-person and just-in-time. Out of those methods, flipped classroom is one of the most popularly used pedagogical approaches which allow the instructors to share video lectures and some practice problems/quiz based on video lectures as homework and active, group-based problem solving activities in the classroom for students. The flipped classroom method includes pre-recorded video lectures, online study material, quizzes/problems to solve by students. In this paper, we presented an experimental study of our flipped classroom activity in combination with Think-Pair-Share (T-P-S) - an active learning method while teaching the concepts of Process Management under the course Operating Systems. The success of the approach was assessed on the basis of perceptions held by the teaching faculty and student's experience. Overall, the students shared a high level of satisfaction with this flipped classroom approach.*

Keywords*: Flipped Classroom, In-class activity, Learning management systems (LMS), Out-class activity, Pedagogy, Teaching-Learning Process*

1. INTRODUCTION

Our education system is taking a gradual shift from the traditional methods of rote learning to newer interactive, innovative and technology oriented methods. With the recent transformation of the education system to an outcome based learning system, we came across the flipped classroom technique. This gives the teaching-learning process a new dimension. As the word flipped suggested,

it flips over the traditional style of teaching. Flipped classroom is a pedagogical approach which focuses on providing an interactive learning environment where the teacher will act as guide to the students as they apply concepts and engage them creatively in the subject. Various affordable recording technologies and web based learning management systems are available due to which use of flipped classroom is very efficient and cost-effective [1].

The flipped classroom is a form of education in which an instructor provides learning materials like videos, ppts, e-books etc. before the class. Students learn new content using learning material shared by instructors during out-of-class-time. In-class time can be used for activities, problem solving, and other forms of instruction with active participation from the students [4, 7, 10, 11].

There are advantages and certain limitations to the flipped classroom technique. Use of the flipped classroom will try to accommodate a certain type of student whose learning style does not fit to the tradition lecture conduction. It can build skills, like analytical thinking, communication, confidence, that may not be exercised as much in a traditional lecture-based course. Flipped classroom encourage long-term retention of what was learned, but it is difficult to evaluate that [11]. Some of the challenges found in implementing Flipped classrooms are such as the compatibility of classrooms that are reversed. Suitability of the flipped classroom for poor quality of video lectures and untrained instructor.

Flipped class can be applied in teaching and learning activities for different levels of education [2]. Its main focus should be to find out the best way to reach out to weaker students. The teacher needs to address some of the problems like students may assume that they do not need to read a textbook and rely only on the material shared by the teacher [12].

2. MATERIALS AND METHODS

We studied several research papers to understand the impact of flipped classrooms. J. Bishop et. al. suggested to employ controlled studies on flipped classroom to analyze student performance throughout a semester, with both traditional and concept-inventory style problems. Further, they emphasized that researchers should clearly describe the activities used for both in-class and out-of-class [1]. Mahmud Mustafa et. al. analyzed the implementation of Flipped class on the latest articles from 2015-2018. They applied a descriptive qualitative methodology using the method of collecting documents and concluded that flipped classrooms have a positive impact on student learning activities. Further they stated that using flipped classroom students can acquire skills like problem solving, creative thinking and teamwork [2]. Colleen McCabe et. al. studied the impact of flipped classroom on student learning and confidence in a professional degree program of pharmacy course. They observed that students in the traditional course scored higher than students using flipped approach. They suggested, to use the flipped model in a substitution for didactic delivery of pharmacy education [3].

Raymond Szparagowski also explored the flipped classroom and its effects on student learning. They implemented it in a high school mathematics subject. They collected data from student grades, before and after activity and informal data from class interviews/discussions. They found some potential benefits of the flipped classroom and its positive impact on the students [4]. Zamzami Zainuddin et. al. done research survey on the flipped classroom trends and contents. They used descriptive analysis,

percentages, and frequencies to analyze the result. They concluded that flipped classroom concepts were used in various fields, and some technology tools were used as the online platform to implement it. They added that flipped classrooms brought positive changes toward students' learning activities like engagement in the class, sharing achievement, motivation and group interaction as limited time dedicated to the traditional lectures, students have more occasions to practice the contents with peers [5].

Torstein Lag et. al. compared flipped classroom teaching with traditional, lecture-based teaching to evaluate the impact of flipped classroom on continuous-learning measures, pass/fail rates, and student evaluations of teaching. Their results indicated a minor effect in favor of the flipped classroom on learning [6]. Michail N. Giannakos et. al. designed and implemented flipped classroom. They developed a framework to support the implementation of it and suggested how to integrate it in regular teaching to enhance learning experience [7]. R. Elliott demonstrates that flipped classroom structure is acceptable to students [8].

B. Tyler e.t al. did not encounter any significant differences in student performance between traditional and flipped classroom approach. They demonstrated how they have used the flipped classroom in their courses, and how their approach has evolved over time [9]. J. K. Huggins suggested that one can use flipped classroom techniques without using advanced digital technology. He indicated that the principal goals of flipped classrooms do not a priori require such technologies, and that instructors should not depend upon it [10]. M. B. Cohen et. al. have experimented teaching electromagnetics course a total of 6 times with the flipped classroom approach. They compared their techniques as well as efforts to assess learning outcomes using flipped classroom to the traditional lecture-based course [11]. C. P. Rosiene et.al. carried out a "semi-flipped" approach where they conducted some of the delivery techniques used in a flipped classroom and blended it with some traditional approaches. They focused on a computer science course which highlights object-oriented topics in addition to algorithm design. They specified some classroom activities and the out-of-class activities were appreciated by students [12].

In this paper, we report the results of the use of Flipped classroom –as an active learning method and attempt to analyze students' participation in the discussions related to problem analysis and sharing the solution during the large class for Operating Systems course setting.
Hence, the objectives of the present study are:

For outclass activity:

- To understand the process scheduling criteria
- To understand preemptive and non-preemptive algorithms
- To apply scheduling algorithms for the given problem.

For in class activity:

- To compare various scheduling algorithms.
- To solve real-life scenario problems

In addition to the benefits reported by earlier researches viz. [4, 7, 10, 11] we chose Flipped classroom for the following reasons: OS being a core course, two key learning outcomes are that students should be able to analyze scheduling algorithms and identify suitable algorithms for selected problems. For

most of such tasks, multiple valid solutions may be possible. So it is desirable that students must be able to analyze the pros and cons of various solutions. Procedural steps for implementing Flipped classroom (FC) technique:

Flipped classroom technique consists of two phases as shown in Figure 1, which is structured as: Out-Class activities and In-class Activities. [Procedural steps are in line with guidelines given during AICTE approved FDP on 'Pedagogy for Online and Blended Teaching- Learning Process' conducted by, IIT Bombay].

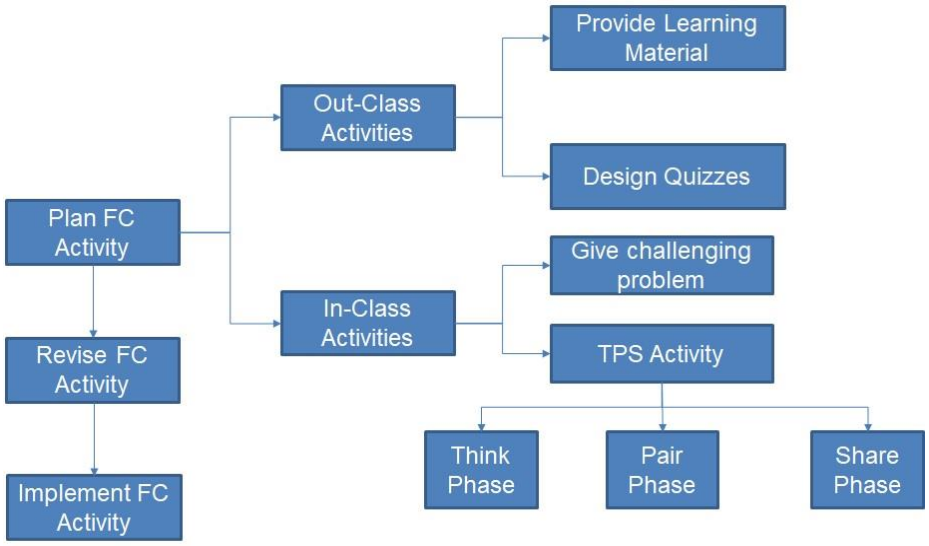

Fig. 1. Procedural steps commonly used for implementing Flipped Classroom technique.

2.1 Plan FC Activity:

Flipped classroom is an active learning strategy that can be modified to fit any class size and any situation. It offers benefits of small-group collaborative learning in a large lecture class, makes students to think about course content under consideration and allows students to formulate their reasoning individually before sharing with others, which helps them to develop higher order thinking skills. Furthermore, in-class activity provides students prompt and descriptive feedback on their understanding, both from their peers and from the instructors, which they can use to tweak their learning. In a traditional classroom, the teacher explains concepts in class and students solve problems at home. In class activities needed lower cognitive levels and out of the class activities needed higher cognitive levels. Flipped Classroom reverse this concept. The teacher prepares study material and shares it with students. Students will go through it before coming to the class. This is called Out-Class activities. In-class time is used to solve problems which require higher cognitive levels. Teacher is present to solve any doubt while attempting these problems.

2.2 Revise FC Activity:

Discuss with a colleague who is familiar with your topic or the Flipped Classroom technique. Revise the activities if needed.

2.3 Implement FC Activity:

Some guidelines for what to do out-class and in class when you implement your FC activity:

- Prepare topic-wise study material. Video's should be of short duration (Not more than 10 minutes)
- Design quizzes to test how much students understood from out-class activity
- Give proper guidelines to the students regarding study material and quizzes.
- Encourage students to participate in the in-class activities.

3. IMPLEMENTATION

Flipped classroom is a type of blended learning, in which students are introduced to the content at home and practice working through it in the classroom. The paper describes how the flipped classroom technique has been implemented. The Process Scheduling topic from the Operating Systems subject for Second year B. Tech students was conducted using the flipped classroom technique. A class of 220 students were involved in this process.

As stated above the entire process of the flipped classroom is divided into two parts namely, preparation of the topic and its evaluation.

For the preparation of the activity, all the course instructors came together and systematically planned the activity. The first task at hand was to have a common platform to communicate with all the students. The advancements in learning management systems (LMS) came handy to accomplishment of this task. We have used the Google classroom platform to bring all students and instructors at one place to share their ideas and interact. The classroom was named as OS 2019-20. The links were shared to all the students enrolled for this particular course. Once the students joined the classroom, they were able to discuss their experiences with each other and their teacher.

3.1 Out-Class Activity:

We decided objectives of out of class activity and prepared a plan as shown in following table.

Concept	**Video Segment**	**Duration (in min)**
Scheduling Criteria, Scheduling Algorithms	Video 1	11 min
More examples	Video 2	7 min

Table 1: Mapping Concept to Video Source

We shared two video lectures which included one from existing content and one recorded content. The lecture along with the slides describing the topic Process Scheduling and Scheduling Algorithms– First Come First Serve (FCFS), Shortest Job First (SJF), Round Robin (RR), Shortest Remaining Time First (SRTF), was recorded. Once the material was ready, we uploaded it to the classroom. Along with the two video lectures and one pdf for lecture slides was also shared.

The students were asked to go thoroughly through the material shared. The thought for uploading these videos is to provide students with the ability to access, study and understand these learning materials anytime and anywhere before the actual lecture. The advantage of sharing these videos is students can watch these videos any number of times to get a more clear understanding of these topics. Also if students are having any doubt, they can note down those points in advance i.e. before the in-class phase of this activity.

For the evaluation part, we conducted an online quiz using Google Form, in which we asked questions based on shared material as shown in the following table. It was shared with the students. They were supposed to take a quiz as a part of Out-class Activity.

Learning Objective	**Assessment Strategy**	**Expected Duration (in min)**	**Additional Instructions (if any)**
Understand the process scheduling criteria	Q 1. Which of the following is not the purpose to perform scheduling? Q.2 The interval from the time of submission of a process to the time of completion is termed as?	10 minutes	Watch V1 and V2 and then answer Q1 to Q5
Understand preemptive and non-preemptive algorithms	Q.3 Shortest Remaining Time First Algorithm falls under which category – preemptive and non-preemptive? Q.4 Time quantum is defined in which algorithm?		
Able to apply scheduling algorithms for the given problem	Q.5 Consider following set of processes with the given arrival time and burst time Process Arrival Time Burst Time P1 0 3 P2 2 6 P3 4 4 P4 6 2 Calculate average waiting time using SJF		

Table 2: Aligning Assessment with Learning Objective

The following graph represents the scores of the students.

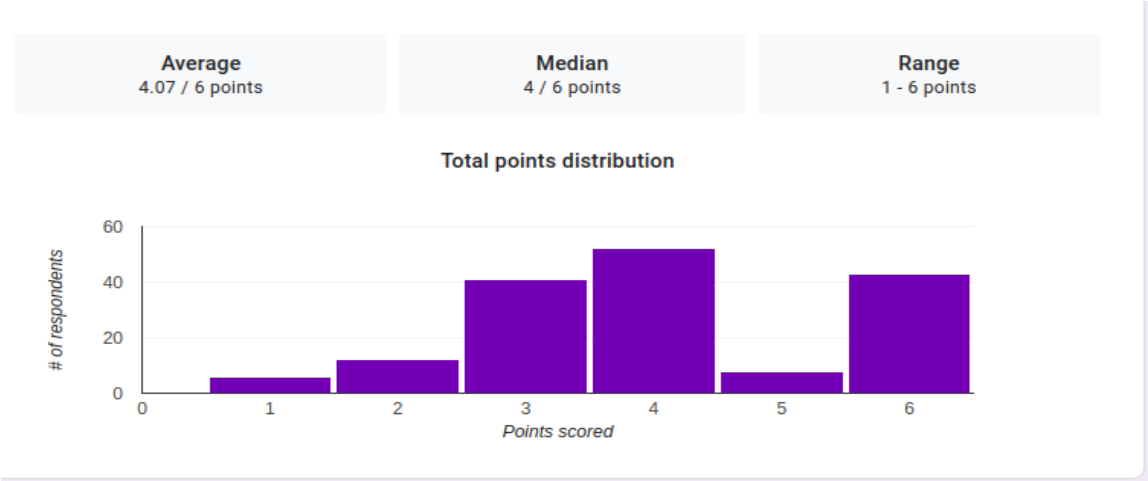

Fig. 2 Score of the students in Out-class activity quiz

It was used to learn the perception of the students for the topic based on the understanding they gained from the material shared to them. Based on this learning, we designed the In-class Activity.

4.2 In-Class Activity:

It was planned in two phases again. First a quick revision of the entire topic and secondly, making students' practice a given set of problems based on the same topic using Think-Pair-Share (Bewoor 2019).

During the revision phase it was observed that the activity boosted the confidence of the students in terms of their individual understanding of the topic. In-class activity was more of an active learning environment. It was a lively, interactive and deep discussion on all the topics and subtopics. This was followed by the in-class practice questions using Think-Pair and Share method

Think Pair Share Activity: To understand CPU Scheduling Algorithms – First Come First Serve (FCFS), Shortest Job First (SJF), Round Robin (RR), Shortest Remaining Time First (SRTF)

Think Phase: (5 Min)

Teacher do:

1. Divide class into 4 groups (FCFS, SJF, RR, SRTF)
2. Ask students to solve the following problem in their Notebooks –

Calculate Average Turnaround Time and Average Waiting Time using FCFS/SJF/SRTF/RR (Q=2). Write advantages and disadvantages of the algorithm you are using.

Process	AT	BT
P1	0	7
P2	2	4
P3	4	2
P4	8	1

Students do: Think, Recall and solve problem in their notebooks

Pair Phase: (5 Min)

Teacher do: Ask students to discuss their answers with their group members and come up with more clear solution

Students do: Discuss with their team and verify their answers, may add new points to their answer.

Share Phase: (10 min)

Teacher do: Ask a representative of each group to share their answer in front of the entire class.

Student do: Summarize their answer and select a representative to share it.

The students enthusiastically got involved in the process. They had peer-to-peer discussions, interacted with the instructor and came up with the solutions quickly.

At the end, we took feedback from students how they like this method of teaching-learning. We got a very good response for it. With this method, we gave more time to individuals to solve their doubts.

4. ANALYSIS AND DISCUSSION

Since there is a paradigm shift from traditional learning methods to the innovative and more interactive learning approaches, it comes along with its own set of challenges for the instructor and students as well. There were challenges that were well thought out before going ahead with the flipped classroom activity.

The challenge of overcoming the student resistance to have the shift from the old school approach to self-learning process. The way to overcome this was to provide them with a platform that makes them comfortable to interact with their peers and the instructor in a smooth and efficient manner. The availability of many user friendly learning management systems helps us sail through this. The LMS platforms provide students with out-of-class communication and also ensured increased one-on-one interaction opportunities.

A thought was given to, what if the students are unfamiliar with the instructional approach. For this there needs to be a strong teacher-student communication before flipping. We guided the students through the entire process of the flipped class before starting with the same. The students were well aware of the way the process would be and what would be their role in the entire process. This also ensured that there was no disengagement of the students during the out-class activities. It was also made sure that the activity does not overwhelm the workload for students. We tried to retain the workload of traditional classrooms by keeping the duration of video to be short and to the point.

Sometimes it can become overwhelming work for Instructors as well. Content creation becomes a challenging task. The approach to prepare materials progressively helps to overcome this.

The point discussed above comes under the preparation and execution of the entire flipped classroom activity. To understand how the students perceived the activity we designed a feedback form and asked the students to fill the same. The following graphs represents the feedback of the students for the flipped classroom activity.

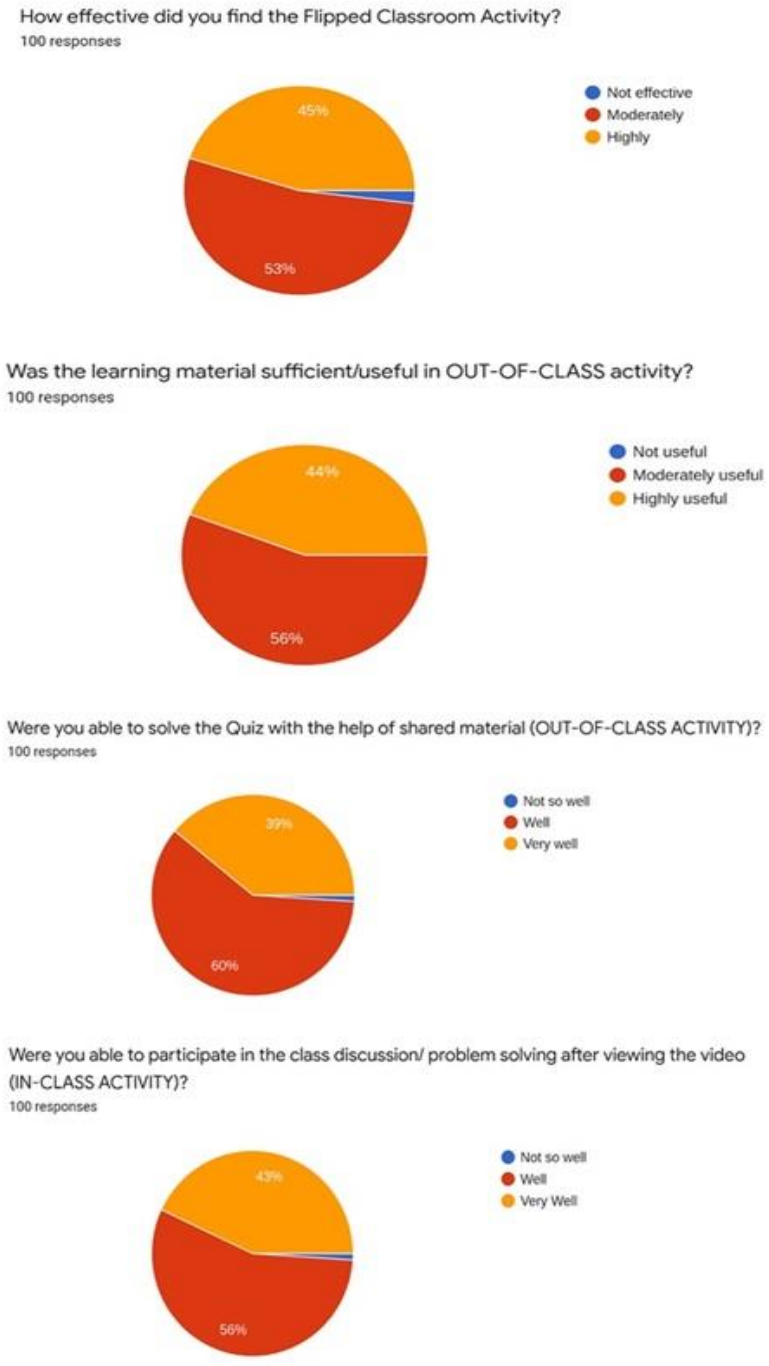

Fig. 3 Feedback of the students for Flipped Classroom Activity

With the successful implementation of the Flipped classroom activity and inline with the changing scenarios for different ways of teaching that are adapted; there arises a new debate on conventional classroom teaching vs online teaching methodology. The crux for any teaching methodology is to provide a great learning experience. Herein we provide a slight insight into the teaching and learning process for both the above said methodologies.

The conventional teaching methods have classroom teaching at its core. The presence of a teacher physically in a classroom keeps the students vigilant and energized throughout the lecture. It benefits the teacher to understand the interest of the students during the lecture and modify the teaching style based on the visual feedback and type of students in the lecture. It aids the teacher to get an idea of whether the students have understood a particular topic or more in depth discussion is required for the same.

The in-class learning increases the involvement by adding a human element. This ensures students to remember more of what they have learned during a lecture. The face-to-face communication eases the problem solving and doubts to be clarified at the same time. It encourages a collaborative learning environment by motivating students to become self aware and keen learners. It is especially favorable for students who might not feel self-sufficient; by building a peer-to-peer learning environment. Classroom learning provides a prospect for students to utilise their thinking skills in peer discussions and develop team spirit.

Irrespective of the fact that classroom teaching is the most popular approach, it possesses its own constraints. It's sticking to a time table and fixed schedule approach makes things a bit inflexible. Teachers usually can't choose their working hours as once the timetable is drawn up, it's quite challenging to modify it. Only on some rare occasions, there can be any rescheduling done. However, in such cases, the difficulty would not be only to find a mutually convenient time but also a free classroom. The communication about such arrangements also has its own challenges.

In today's scenario, Online teaching is becoming the new normal. WIth the easy and cheaper availability of the internet and the comfort it provides to the learners, it has created a whole new perspective for the teaching-learning process. The inflexibility and logistics constraints no longer exist. The teachers can develop the content at their convenience, which can be shared with the learners at various platforms as discussed earlier. Learners have an option to study at the comfort of their own time without having to follow a fixed slot for lectures. During these sessions, more time can be utilized to focus on learning and understanding the concepts instead of taking notes; as they are all saved and accessible online anywhere and anytime.

The online teaching may increase the teacher-students interactions in cases where the student may feel shy to have a direct face-to-face interaction with the teacher. This results in personalized attention to the students and enhances their learning experience.

As a matter of fact, everything comes with its own pros and cons. The online teaching provides a limited range of teaching methods. We need to rely on audio and visual methods. The teachers would face a challenge in delivering the sessions as there is a lack of visual feedback. In such scenarios, a

more skillful presenter would make optimal use of the tools that are available to get feedback; but that also is in a limited manner. The interactions are not face-to-face. This approach may tend to focus on theory rather than practice.

The online learning requires discipline and strong self-motivation to make the learning process smooth. It lacks peer-to-peer communication and may lead to social isolation in learners. It may improve the academic knowledge of the learners but could affect communication and soft skills.

Looking into the teaching and learning process for both classroom teaching and online teaching, each of them have their own importance and relevance. A proper combination of incorporating classroom teaching with the online teaching approach may lead to a great learning experience for the teachers as well as the learners.

The Flipped classroom technique as an experiment in line with the combination to both the approaches, helped us understand the scenario more closely. It provided us with more insight into the advantages and disadvantages of both approaches and led to finding a fine balance between them.

5. CONCLUSION

In this paper, we presented Flipped classroom and Think -pair-Share (T-P-S) approaches in which students learned the basic concepts of Process Scheduling algorithms beforehand (out-class) and utilized the class time (in-class) for learner-centric activities such as group discussions, exceptional cases and doubt-solving. The student feedback shows that flipped classroom and T-P-S had a positive impact on student learning capabilities i.e. their involvement, interaction and discussion.

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