Flipped Classroom Learning Approach for Operating System: Analysis and Pedagogy Insight

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Abstract—**This Study explores the efficacy of the flipped classroom approach. The study makes a comparison between the flipped classroom approach and the traditional approach.The analysis is done where the study shows how the flipped classroom approach helped in better understanding the Operating System Principles and Programming course. The results provide insight into the strengths of the flipped classroom model and offer a better understanding of its impact on student learning outcomes.**

Index Terms—**Operating System Principles and Programming(OSPP), Flipped Classroom Approach(FCA), Traditional Approach(TP).**

I. INTRODUCTION

The National Education Policy (NEP) that aims for India's future educational system has introduced the outcome-based education system. The reform in the education policy has introduced project-based learning and activity-based learning. Therefore the use of technology or e-learning has become prevalent in universities. Further, the principle of traditional teaching to students,expects to provide learning styles suitable for students with significant intelligence. The traditional teaching style is limited to course lecturers and classes. It makes it difficult to achieve instructional goals without bias and teach students according to ability. The e-learning approach is not limited to time and space and could precede individualized teaching. In addition to thinking about teachers' techniques, different countries also consider different levels of student teaching ability. In accordance with current educational goals in the world, it is paramount to cultivate pupils' reading ability, mathematical ability and scientific literacy, encourage cooperation with others,and develop problem-solving abilities. Hence, the new pedagogical approach known as 'flipped classroom' that replaces a traditional learning environment is introduced. It reforms the traditional class room learning approach. Flipped learning introduces, the learning interest in students, it more effectively increases learning efficiency and inspires creativity in transforming passive learners into active learners. Divijak *et al.*, [1] conducted a literature review on research on online flipped classroom methods in higher education during the pandemic 2. The total number of articles analyzed was 205 publications, of which 18 were identified in detail. The article acknowledges that most studies are based on case studies or studies of the use of online instruction with flipped classrooms during the pandemic, and the samples are often not representative. and suggestions for future research. The article also examines international research, research types and methods in related studies. The article also suggests that more research is needed to more comprehensively and rigorously examine various aspects of online teaching in flipped classrooms.

The traditional approach(TP) is an age-old method of education as technologies are evolving many different approaches to learning are introduced one of the methods is the flipped classroom, traditional when compared to the flipped classroom is an old method where face-to-face teaching is done where the students physically attend classes and interact with peers, there is no idea of pre-class activities such as video content, pretest and also post-class activities. In the traditional approach teachers moderate and regulate the flow of knowledge and students are expected to develop the knowledge outside the school in the form of homework or assignments. Conventional approaches follow set of timetables with certain durations and it is mandatory for students to attend classes, they have limited resources and limited flexibility in terms of their learning pace. Sometimes students are in a bad mood, don't want to attend classes, are bored, and have frequent illnesses, they might not be able to attend classes where they cannot cope, as in flipped classrooms there is video content that they can watch in there flexible time.

Passive students or students who do not keep up due to missing classes, teachers introduced a new approach to teaching. This approach aims to adapt students' learning progress to their personal learning pace. Teachers first record full lessons for homeschoolers; the main content of the course is described in the video tutorial. In the classroom, activity-based learning or learning content is preceded by questioning and discussion. Teachers do not lecture as in the formally traditional lessons of the past, but focus primarily on student-teacher interaction. In this way of delivering the course content, a lot of time is allocated for group discussion, homework management and critical thinking in class; in addition to adaptive teaching, it could precede the guidance of slow learners. Such a teaching methodology is known as flipped teaching.

The flipped classroom learning approach (FCA) is a strategy that changes the conventional educational models. This offers a thorough investigation of this approach. Promoting and allowing for customized learning, increasing student and teacher connection, and promoting active learning are some of the benefits. Issues including student isolation, adapting the changes, and technological access must be taken into account.

Several elements, such as instructional quality, instructor skill and student involvement also affect the flipped classroom model.The flipped classroom approach can be applied to various age groups. Its implementation and effectiveness may vary based on several factors which also include the availability of technology, the design of the learning activities, the level of support, help that is provided to the students and the teachers. Yanez *et.al.*, [2] They proposed a paper to compare the traditional versus the flipped classroom with the personality,satisfaction, preferences, and achievements,based on their nursing Department, where 85 percent of students were indulged in study of biostatics,with the flipped classroom approach the study of biostatics is reduced to 50 percent. The study is for only one institute and they haven't compared the outcomes of the previous course as it was unavailable.

II. LITERATURE SURVEY

A. Tradtional Approach

Sarker *et.al.*, [3] The research consisted of 79 participants, where 67 students were regular and 12 were irregular, and they did correlation between students engagement and correlation was 0.881, they also checked the active students were 72 students and 7 were inactive. For student engagement the highest and lowest scores of students in the traditional classroom were 29.87. As 7 students are inactive it is difficult to attend classes and may lack in their studies.

Dzobo *et.al.*, [4] The research consists of 71 participants. Students who experienced the traditional classroom model were taken as the control group. Conducted tests based on modules and the results of these modules as test A1, A2 for module 1 and TestB1, B2 for module 3. For modules 1 A1 and A2 the mean is 26.14 and 50.30. For module 2 B1 and B2 the mean is 32.51 ans 58.58.

Mitre *et.al.*, [5] The research consist of 90 students.. The evaluation of the traditional classroom occurs in a punctual and summative way, using two exams, one in the middle of the semester and the other at the end, in addition to other exercises throughout the semester and lectures.Analyzing the student's perceptions through the answers of the questionnaires applied (SPAT). They assigned values (scores) from 1 to 4 for the answers to the questions about each method (1 - totally disagree, 2 - disagree, 3 - agree and 4 - totally agree) were the average was 2.75 and the students preferred active methods to the traditional one

Woo *et.al.*, [6] The research consists of 48 participants. students who took a class in a traditional classroom (M = 3.41, SD = .60) on Student Cohesiveness.Students from the traditional classroom (M = 3.50, SD = .95) on Attitude toward the Classroom. Students from the traditional classroom (M = 3.92, SD = .82) on Perception of Physical Classroom Features. They also consider how these comparisons can help us adapt more traditional classroom spaces to reap some of the learning and community development benefits of more flexible spaces.

B. Flipped Classrrom Approach

Divijak *et.al.*, [1] conducted a literature review on research on online flipped classroom methods in higher education during the pandemic 2. The total number of articles analyzed was 205 publications, of which 18 were identified in detail. The article acknowledges that most studies are based on case studies or studies of the use of online instruction with flipped classrooms during the pandemic, and the samples are often not representative, and suggestions for future research. The article also examines international research, research types, and methods in related studies. The article also suggests that more research is needed to more comprehensively and rigorously examine various aspects of online teaching in flipped classrooms.

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Bhul *et.al.*, [7] The implementation involves how the effect of the study of the flipped classroom, their final grade and pass rate of 933 students and 11 teachers, and used two iterations of randomized field. They put forward a plan to increase in-class activity while keeping the lectures as usual. They randomized measures to impact this placing each student split the treatment into seven tutorial classes, and the tutorial class level was randomized. Complexity in these is a small number of teachers limit and it's for only higher education.

Cabi *et.al.*, [8] author proposed concept and benefits behind the flipped classroom, an instructional concept that changes the order of tasks students typically complete in class. The use of video lectures, online quizzes, and classroom activities to enhance student learning and engagement in computer graphics courses is known as the "flipped classroom." Research on flipped classroom strategies has compared students' learning outcomes and problem-solving skills and shown that flipped classrooms can increase instructional effectiveness.

Ferrer *et.al.*, [9] The study looks into how education student's opinions of learning and motivation of the epidemic are affected by the model of flipped classrooms.The data is gathered by the authors via surveys, and they utilized nonparametric tests and descriptive statistics. The analysis the pre and the post test results showed statistical significant differences , experienced students the are performing better on the average in latter. Stage the majority of student's expressed favorable opinions of the flipped classroom, emphasizing the benefits of more student autonomy and practical in-class activities.

Chou *et.al.*, [10] This study of flipped learning effect as how the high school students' motivated and their behavior towards language acquisition. The authors studied about 390 school students in chungli (Taiwan). They found that the students participation in flipped instructional model has the better understanding of the content due-to changed learning and behavior, thus improving their academic performance. According to the authors, flipped instruction may encourage active learning in underachieving students and hence improve

the efficacy of instruction. In general, the paper offers insights into how the technique might be applied to the teaching of language and related subfields.

Dogan *et.al.*, [11]The study evaluates the effective of flipped classrooms around science education, through analysis of the thirty studies that included variables such as class size, academic level, time spent, and multiple science courses. The author also analyzed metathematic-based qualitative research data to clarify the basic features of the method, its impact on the learning dimension, and its contribution to thinking and the classroom. The result shows that the use of flipped classroom, positive mean for student's academic achievement in science classes (g = 0.727).

Yoko *et.al.*, [12]The article talks about a system of expanding opportunities for students. There are participants with 53 undergraduate students and the course is examined for computer programming that will be of 3 hours class per week over 15 weeks. With procedure survey,student survey and according to 15 users.The system is more focused on CS and want to expand the learning and complement the practical learning opportunities.

Induet *et.al.*, [13] examine how the flipped classroom model impacts student learning in the post-pandemic environment. Three hundred students from public schools in Pakistan participated in the study. The findings show that the flipped classroom concept is effective and has positive impact on student's motivation, engagement and interest in learning. The survey also revealed that lack of internet connection, stress and time management are some of the challenges faced by students in the flipped classroom. This study introduces a hybrid machine learning approach combining Pearson correlation coefficient, random forest (RF), and logistic regression (LR).

Jiang *et.al.*, [14] The system is based on single-chip micro-computer course.This is helpful for students to reduce their stress ,not to feel boring for micro-lesson used in flipped classroom should not be a complete class ,but is in service of link of collection in several teaching activities.The better improvement of the teaching so that it should be favorable to students.

Asad *et.al.*, [15] used multiple survey and survey methods to collect data from 73 high school students at Sukkur Public School, Pakistan. The survey was modified by Awidi and Paynter (2019) and divided into three sections: support and motivation for the use of the flipped classroom, cooperation and collaboration, evaluation and feedback. data are analyzed using SPSS software and non dependent sample t-test. The article acknowledges that the study has some limitations, including small sample size, lack of quality data, possible bias in self-reported data, limited findings, and that more research on flipped classrooms in different contexts is needed.

Nourii *et.al.*, [16] used a flipped model using video lectures, interactive learning, digital monitoring, and learning management (Moodle) in a university research classroom. The author evaluates students' knowledge and behavior through flipped classrooms, videos, Moodle, and other methods, using surveys and qualitative analysis. The authors acknowledge the study's limitations, including the lack of a control group, the novel effects of flipped classroom, and the reliance on self reported data.

Wang *et al.*, [17] report on a quasi-experiment conducted in an inorganic ,chemistry classroom to examine the effect use of mooc based upon flipped learning and clarify guide lines for the reuse of ,mooc's in education in schools. The results displayed that students in the mooc implimented flipped classroom performe in the middle of students in the traditional classroom. So, no changes in self-efficacy and self-control were observed after the course. In addition, the integration of quantitative data and results showed that most of the students had a positive experienced with the flipped classroom based on student interaction, student to student, existing curriculum, and effective learning outcomes.

Yildirim *et.al.*, [18] The authors used the flipped classroom model in a four-hour network system test with 25 students studying in 34 university courses. Teachers upload videos, course materials, and assignments to the MOODLE platform and guide students to complete classwork. The authors acknowledge that the study is limited by the limited sample size, short and intervention period and the lack of a control crew. They suggested that further research should use larger, more diverse, longer-term, and comparative group samples to test the effectiveness of flipped classroom models.

Wei *et.al.*, [19] Academic press and learning achievements of students based on flipped classroom and traditional approach. The scores on the academic press from students in both blended and traditional instruction groups were slightly more. It is important to note that the measure of academic press in this study was focused on students' perceptions of the instructor's behavior where the study was only for three months and also for only one subject,they further want to explore more on the blended technique.

Amashi *et. al.*, [20] The authors analyzed based on the video content, which contains rewatch status, percentage of video watched, and time duration, they have done classification based on topic, and engagement of topic, overall 125 students 90 were low engaged 35 were high engaged and also 47 students have linked the concept of sustainability to engineer design. For this paper number of participants was less and lack of grades for students reflections,next time for video resources they will assign grades for students for motivation.

C. Traditonal approach versus Flipped classroom approach

Sarker *et.al.*, [3] The research 79 and 61 participants for traditional and flipped classroom apporach.The highest and lowest scores in the traditional classroom were 28.61 (for regular student) and 27 (for inactive students) while in the flipped classroom that increased to 39.69 (for regular students) and 35.20 (for inactive students). This result indicates that students who were more regularly engaged in the flipped classroom and those who were more active learners had higher levels of satisfaction active students had higher mean satisfaction scores compared to their counterparts in the flipped classroom. The study had limitations of only honors psychology students,being limited to one institution.

Dzobo *et.al.*, [4] The resrach consist of 71 students for traditional and 44 students for flipped.In the flipped classroom model students were instructed to watch pre-recorded videos before the lecture and during lecture time interactive learning was used to discuss the lecture content. The students performance on four tests were compared between the two groups using t-test analysis.The student performance scores in flipped classroom model are greater than in traditional classroom model.

Mitre *et.al.*, [5] The research study is for three years with 90 students.The Flipped Classroom obtained a high approval rate (above 90 percent).The results of this study show too that 90 percent of the students assessed the significant contribution of the Concept Map with the Flipped Classroom to the development of the competencies worked on in the Health Policy course.On the other hand, 48 percent of the students did not feel motivated in the Traditional Classroom.

Woo *et.al.*, [6] students who took a class in an innovative classroom showed a higher level of student cohesiveness (M = 3.81, SD = .75) than students who took a class in a traditional classroom (M = 3.41, SD = .60) Students from the innovative classroom had more positive attitudes toward the classroom (M = 4.11, SD = .96) than students from the traditional classroom (M = 3.50, SD = .95) Students from the innovative classroom liked the classroom features more (M = 3.21, SD = .79) than students from the traditional classroom (M = 3.92, SD = .82). While these spaces can erode traditional classroom norms, we need to continue to challenge whether these expectations of order and control are beneficial to student learning.

The summary of the literature survey on flipped classroom analysis reveals that several authors have examined how the flipped classroom approach and traditional approach are different and how learning interest has been increased among the students with flipped classroom learning.

III. PROBLEM STATEMENT AND BACKGROUND

A. Problem Statement

This study closes the gap between the traditional teaching approach and flipped teaching methodology for a better understanding of operating system Principles and programming (OSPP) classes. Although the flipped classroom approach to learning has been shown to improve student motivation, engagement, and comprehension of difficult concepts, more research is required to determine how well it works in a variety of educational environments and with different age groups. There is a knowledge gap on the best way to use these technologies to enhance the flipped classroom concept. The efficacy of the flipped classroom learning strategy and its implementation are still not well understood in the context of the Operating System Principle and Programming course.

B. Purpose of study

The main purpose of this study is to explore the five following research questions.

- *Have the students understood the concepts of process, memory, and file management concepts of the operating system?*
- *Have students explored different algorithms and implemented the same in open challenges?*
- *Are students able to solve Bloom's taxonomy-based questions?*
- *To analyze whether the students have understood the topics in OSPP.*
- *To showcase the importance of the flipped classroom approach.*
- *Have students learned from tutorials?*

C. Background

The flipped classroom learning approach is a strategy that changes the conventional educational models. This offers a thorough investigation of this approach. By offering instructional information outside of the classroom through recorded lectures or online resources, the flipped classroom changes the traditional framework of learning and uses in-class time for interactive exercises, and knowledge application. This evaluates the flipped classroom approach's overall efficacy. Promoting and allowing for customized learning, increasing student and teacher connection, and promoting active learning are some of the benefits. Issues including student isolation, adapting the changes, and technological access must be taken into account. The traditional approach is an age-old method of education, As technologies are evolving many different approaches to learning are introduced, One of the methods is the flipped classroom, traditional when compared to the flipped classroom is an old method where face-to-face teaching is done where students physically attend classes and interact with peers, there is no idea of pre-class activities such as video content, pretest and also post-class activities. In the traditional approach teachers moderate and regulate the flow of knowledge and students are expected to develop the knowledge outside the school in the form of homework or assignments.

D. Methodolgy

1) Traditional approach: This study is implemented for undergraduate students of Bachelor of Engineering Degree of KLE Dr. M.S.Sheshgiri College of Engineering and Technology, Belgaum. A total of 111 students participated in the study for the academic year 2017-2018,are divided as follows 20 internal marks and 80 external total 100 marks. and In this approach, teachers moderate and regulate the flow of knowledge and students are expected to develop the knowledge outside the school in the form of homework or assignments.From fig 1 before classes students just preview the topic they are going to learn and which teacher going to lecture on, and during class teacher presents the knowledge to the students after the class,students understanding of the topic is evaluated by giving assignments to students and the score process goes. Students follow a set of timetables with certain durations and it is mandatory for students to attend classes, they have limited resources and limited flexibility in terms of their learning pace.
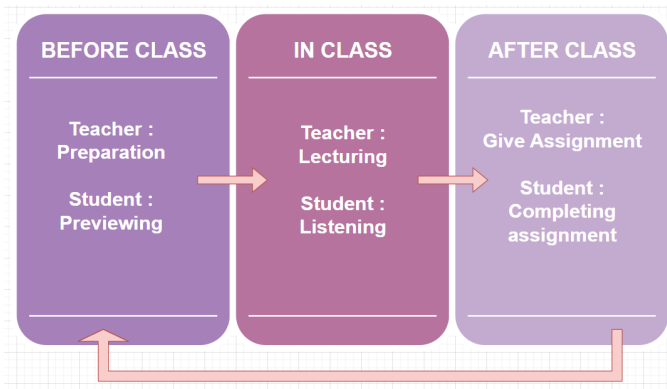
Fig. 1. The framework of the traditional approach.

For the flipped classroom approach ,pre-class and post-class activity are done, and pretest and postest are conducted.The questions are predicated on Bloom's taxonomy.Levels are employed in our dataset. From fig 2, we see that all the levels are involved for the flipped classroom approach, where we have video lectures, pre-tests, Post-tests, tutorials and open challenges.All the results of these levels can be seen in section IV. In this OSPP course, only three levels are used. Below is the bloom's taxonomy.
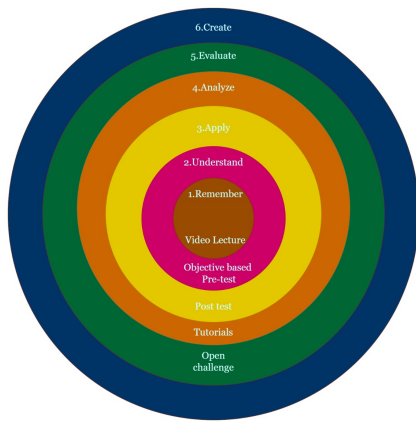
Fig. 2. Bloom's taxonomy.

2) Flipped classroom approach: The present paper focuses on the perceptions of a flipped classroom approach forthe Operating Systems Principles and Programming course. This study is implemented for undergraduate students of Bachelor of Engineering Degree affiliated to KLE Technological University, Hubballi. The purpose of this quantitative study is to describe undergraduate students' experiences with a flipped operating systems course. A total of 136 students participated in the study during the even semester of the academic year 2022-2023. The operating system course is framed as 50 contact hours of theory for four credits and 26 hours of tutorial for one credit. The instructors are uploading the video consisting of 5-10 minutes prepared by ekLakshya transformations. Totally 50 videos are uploaded on every chapter

namely process management, memory management, deadlock, and file management, etc. The students watch online videos and read lecture notes on the course portal, before the class. The students complete the weekly tutorial and open challenge in the laboratory under the guidance of their instructor. The students are given five attempts of pretest on every chapter to access their understanding of the chapter. All participants are presented with the same learning resources and pre-tests are used to determine whether students have watched videos or read lecture notes. In order to understand the learning environment of the operating systems course, data is collected in two distinct steps.

- Students are allowed for five attempts at the pre-test for each chapter.
- The post-test for each chapter is taken by an individual student after completing a discussion of that chapter in a regular class.

Data is collected from 132 students to better understand the experience of undergraduate students during the operating systems course. which is divided into internal(internal marks, flipped classroom marks, open challenge, tutorial) that is 50 marks, and external 50 marks. From fig 3 the students are given video content so that they learn the concept and tests are taken which are called pretests. In class, teachers do problem-solving for students and post-class they are given a test called posttest for better understanding and also some assignments. The pretest questions are designed to identify students' perceptions of the model and how the flipped model affected their learning, as well as ideas for course improvement.
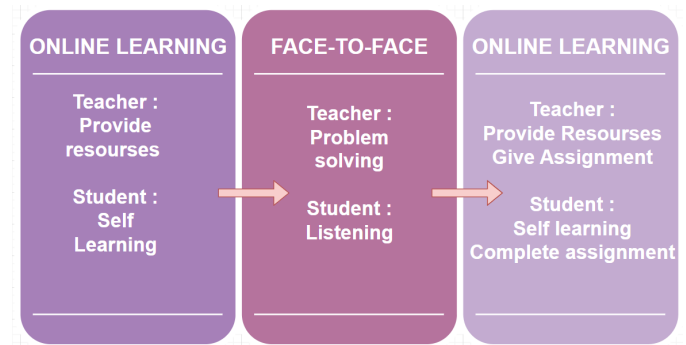

Fig. 3. The framework of the flipped classroom approach.

IV. IMPLEMENTATIONS AND PERFORMANCE ANALYSIS

A. Experimental Setup

- First collection of data set, we have a data set of flipped classroom as well as traditional approach, where in the traditional approach the dataset consist of only three attributes and in the flipped classroom the dataset 14 attributes,we have collected this dataset from same university.
- The programming language used is python,and the libraries are pandas,numpy, and matplotlib
- The machine configuration utilized in this project is hosted on the Google Colab Framework.

- We proceeded to perform all the exploratory analysis that begins with preprocessing, extracting all the relevant features, and dropping irrelevant columns like name, emailid, and finished attempts(yes/no).

B. Results

1) Pretest: In this section, the test type is the Pretests: These consist of five pretest scores corresponding to the five chapters in the OSPP course: Process Management, Memory Management, Process Synchronization, Deadlock, and File Management.
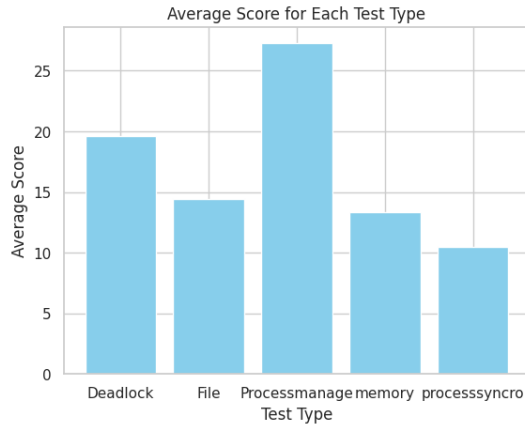

Fig. 4. This plot shows the average score of all the students in Test Types.

Fig 4 provides detailed information about the pretests, indicating whether students understand the concepts of process management, file management, and memory management. As observed, process management has the highest average score, indicating better understanding, while process synchronization has a lower average score compared to other topics.

2) Postest: In the posttest, questions are categorized into different difficulty levels, as shown in fig1. These levels are based on Bloom's Taxonomy, and students can prepare themselves accordingly.

Fig 5 illustrates the difficulty levels associated with each chapter in the posttest. In level 1 we can analyse that memory management topic secured less average score.In level 2 deadlock topics average scored comparatively low, level 3 in this process synchronization is comparatively lower. Based on Bloom's taxonomy bottom to high, level 3 is the moderately hard level based on that the process synchronization has scored an average score less compared to other topics.

3) Open challenge and flipped class: Fig 6 average which is out of 5, shows that most of the students have explored different algorithms and implemented them in their open challenge as the average score is 4.22 out of 5. Then we can see that the flipped class marks which are the marks of all the pretest and posttest scored out of 5 , the plot showcases that most of the students have watched the videos, and taken the tests as an average score of 3.99 out of 5. And we have tutorials which out of 10 and the average scored by students
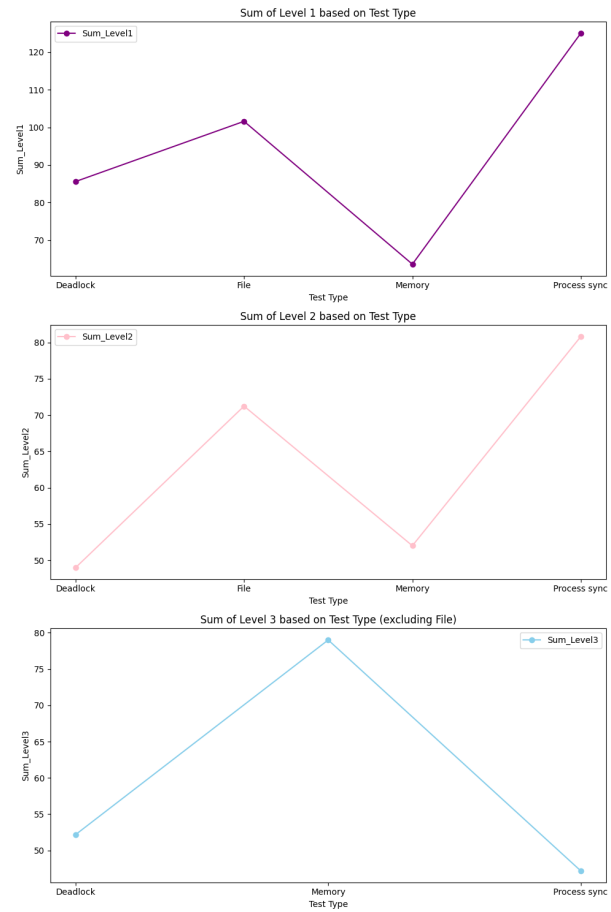

Fig. 5. This plot shows the average score of all the students in Test Types based on the levels.

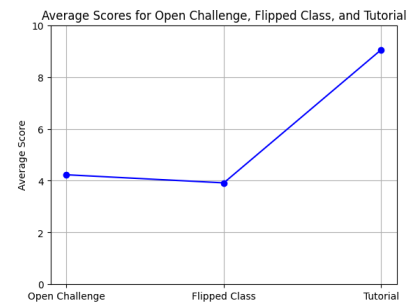is 9, shows that most students have learned the concepts in tutorial.

Fig. 6. This plot shows the open challenge and flipped class,average score of students .

4) Flipped classroom approach VS Traditional approach: In the flipped classroom approach the distribution is 50 for internal and 50 for external, and in traditional approach the distribution 20 for internal and 80 for external. we have analyzed to showcase how the flipped classroom approach is beneficial in students learning.

Fig 7 showcases that the final total score is of 100 marks for traditional but for the flipped approach it is 10,10 is compared to 100. To showcase the difference between traditional and
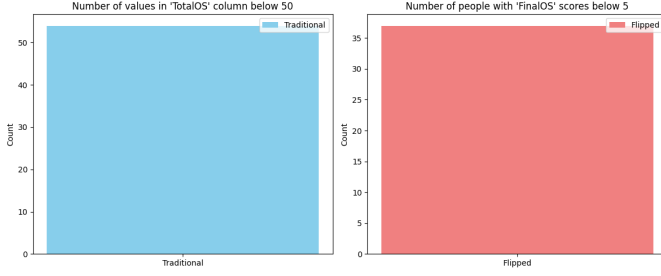
Fig. 7. This plot shows the traditional approach and flipped class scored below 50 percent .

flipped approaches, how many students scored below 50 we have taken and analyzed it, such that for the traditional approach 54 students average score is below 50 in the OSPP course and flipped classroom 37 students are below 5. This gives us an understanding that the flipped classroom approach has made students to score more compared to the traditional approach
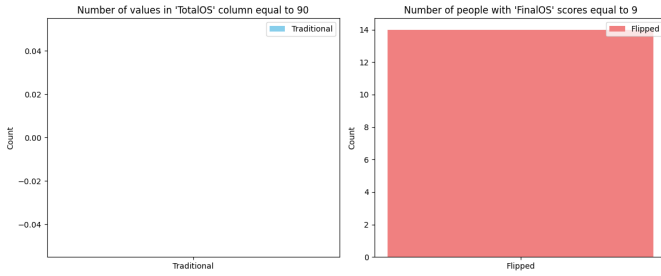

Fig. 8. This plot shows the traditional approach and flipped class scored below 90 percent.

Fig 8 showcases how many students have secured above 90 percent in OSPP, where we can see the flipped classroom approach out of 133 students 14 students above 90 percent when compared with the traditional approach out of 111 students no one has secured above 90 percent.

TABLE I
PERFORMANCE METRICS

Approaches	Total	Final Average Score
Traditional Approach	111	41.22
Flipped Classroom Approach	133	5.24

Table I provides comprehensive details regarding the two methods, for flipped classrooms it is out of 10, and for the traditional approach it is out of 100, when compared flipped classrooms have a high average score.

V. CONCLUSIONS

We conclude that based on our analysis of the flipped classroom approach for OSPP course,we have solved all the problems by flipped classroom,which helps students to secure more marks also learn things on their own and they can clear their doubt,with all the pre-class,in-class, and post-class

activities. Also when compared to the traditional approach we conclude that a flipped classroom is more convenient for students to learn and score. Given the relatively smaller dataset for the specific subject of operating systems, Future efforts should focus on expanding and exploring larger datasets to enhance the analysis of flipped classroom approach. It is important to note that this analysis specifically pertains to the operating systems course.

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