

Flipped Classroom: An Efficient Pedagogical Tool to Teach a Course for Final Year Computer Science and Engineering Graduate Students

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Abstract— New directions are brought into teaching-learning process due to the recent advances in technology and change of students learning styles. As there is increasing in tuition costs and need of time management created space for online courses and flipped classrooms in the education system. Main challenge in teaching a course for Final year is, motivating all students to attend classes regularly and participate in the discussion. As they will be busy with placement activities, project development and training in industries, faculty need to use the class time efficiently and deliver required course contents to the students. A new pedagogical tool flipped classroom is adopted to address these issues, which employs asynchronous video lectures and practice problems as homework, and active, group-based problem solving activities in the classroom. It represents a unique combination of learning theories to teach a course. In this paper authors present a comprehensive method of using flipped classroom to teach a Distributed Computing System to final year Computer Science and Engineering graduate students. This paper focuses on type of in-class and out-of-class activities, the measures used to evaluate different activities and methodological characteristics for each activity defined for the course. Result of students' feedback talks about the positive aspect of the framework adopted.

Keywords—*flipped classroom; learning styles; in-class; teaching-learning; out-of-class; activity.*

I. INTRODUCTION

Research shows that active learning improves students' understanding and retention of information and can be very effective in developing higher order cognitive skills such as problem solving and critical thinking. A key aspect of the flipped classroom model is to find ways for students to actively engage in learning. There is emerging consensus in higher education that the traditional lecture format is ineffective for learning and that students learn best when they actively engage with content and apply concepts. Active learning pedagogies are at the heart of the flipped classroom and many techniques can be applied to online or face-to-face environments or a blend of both. Flipping our class is an opportunity to think about ways to engage students, encourage ownership of learning, promote deeper learner and to equip students for professional practice[4].

The concept of the flipped classroom room is not new which was practiced in Humanities for decades where students have been expected to read novels in their own time while

class time is devoted to exploring symbolism or unraveling complex concepts. Law professors have long used the Socratic method in large lectures, which compels students to study the material before class or risk buckling under a barrage of their professor's questions. The benefits of flipping the classroom[6] have become apparent more recently for the STEM (Science, Technology, Engineering, and Mathematics) disciplines especially where large classes require application of strategies to help monitor whether student are attaining the requisite skills to solve real world problems.

Flip teaching or a flipped classroom is a form of blended learning in which students learn new content online by watching video lectures, usually at home, and what used to be homework (assigned problems) is now done in class with teachers offering more personalized guidance and interaction with students, instead of lecturing. This is also known as backwards classroom, inverted classroom, flipped classroom, reverse teaching, and the Thayer Method[11].

Distributed Computing Systems course being taught for two divisions of students strength 150. First thing is that the course content is too vast, second, it is completely theoretical course and No laboratory is attached for this. In final year, First half that is, in seventh semester students need to identify a problem definition for Capstone project (13 credits) and they need to appear for Campus interviews. Since from last two years it is observed that students are only involved in these two activities and failed to attend the classes regularly which results in poor performance in the Semester End Exams(SEE). To improve the involvement of final year students in learning a course and delivery of course content efficiently we adopted flipped classroom pedagogical tool for the Distributed Computing Systems. The course is made more attractive by defining activities for students which can be done in-class room and out-of-class rooms. More problems are solved in the classroom. Students are given flexibility in listening and learning the course contents at their leisure time. Level of knowledge obtained also increased. Learnability of the course is assessed through quizzes and different activities.

A. Organization of Paper

The paper content is organized in following sections- Section II discusses the advantages and disadvantages of

Traditional Vs. Flipped teaching. Section III explains the implementation details of the course using Flipped pedagogy tool. Section IV discusses the impact of flipped class room teaching by analyzing the feedback taken from students. Last section IV provides conclusion of the framework adopted to teach a course.

II. LITERATURE SURVEY

Flipped classrooms are shifting the way teachers provide instruction by inverting traditional teaching methods to engage students in the learning process. Using technology, lectures are moved out of the classroom and delivered online as a means to free up class time for interaction and collaboration. In order to effectively implement a flipped classroom, teachers must possess a set of requisite technical skills, conceptual knowledge and pedagogical expertise[12].

Research indicates that compared to those in traditional lecture-based classes, students in active learning environments show improved retention and better conceptual understanding of learned material. These results are attributed to the contrasting roles of passive and active learners in the educational process[13]. While passive learners exist solely as receivers, active learners are full participants in the process, allowing them to add to their retentive capabilities through continued self-reinforcement. Following sections explain the differences between the Traditional and flipped teaching and also the advantages of Flipped teaching.

A. Traditional vs. Flipped teaching

The traditional pattern of teaching has been to assign students to read textbooks and work on problem sets outside school, while listening to lectures and taking tests in class. In flip teaching, the students first study the topic by themselves, typically using video lessons prepared by the teacher [5] or third parties. In class students apply the knowledge by solving problems and doing practical work [7]. The teacher tutors the students when they become stuck, rather than imparting the initial lesson in person. Complementary techniques include[10] differentiated instruction and project-based learning[9]. Teachers are blending flipped learning with traditional in-class lecturing through different online tools that keep students accountable to video lessons at home through time-embedded formative assessments[8].

Flipped classrooms free class time for hands-on work[10]. Students learn by doing and asking questions. Students can also help each other, a process that benefits both the advanced and less advanced learners. Flipping also changes the allocation of teacher time. Traditionally, the teacher engages with the students who ask questions — but those who don't ask tend to need the most attention. —We refer to 'silent failers,' " said one teacher, claiming that flipping allows her to target those who need the most help rather than the most confident. Flipping changes teachers from —sage on the stage" to —guide on the side", allowing them to work with individuals or groups of students throughout the session.[2] .

B. Classroom Benefits of Flipping[1]

Flipped classrooms reflect research-based principles of effective teaching and learning. Benefits are:

Improved Student–Teacher Interaction

Education Researchers of the flipped classroom state that this practice promotes better student–teacher interaction. When teacher stand in front of students, some students hesitate to ask questions. They respond better offline, faculty can better understand and respond to students' emotional and learning needs.

Research makes a strong case for the benefits of such interaction. Studies have shown that having teachers who recognize and respond to students' social and emotional needs is as important to academic development as specific instructional practices are, and this is especially true for at-risk students [7].

Opportunities for Real-Time Feedback

Use of flipped classrooms also state that increased student–teacher interactions give teachers more opportunities to provide feedback to students. Teacher can work on feedback and provide better inputs to students which increase their learning ability.

Student Engagement

Another purported benefit of flipped classrooms is that "they speak the language of today's students" [3], who are accustomed to turning to the web and social media for information and interaction. There may also be another, deeper, reason students find video lectures more engaging: Brain research tells us that the novelty of any stimulus tends to wear off after about 10 minutes, and as a result, learners tend to check out after 10 minutes of exposure to new content. After that, they either need a change of stimulus, emotional variety, or an opportunity to step back and process what they're learning [9]. One benefit, then, of placing lectures online may be that they can break down direct instruction into more engaging, 10-minute bites of learning.

Self-Paced Learning

Providing online lectures enables students to pace their own learning according to their needs. Potentially, an inverted classroom allows the teacher to place an entire year or semester's worth of lectures online, enabling students to accelerate through the curriculum if they are ready. It has quoted that [6] synthesis of 800 research meta-analyses, such acceleration has one of the strongest effect sizes (0.88) of any instructional intervention.

More Meaningful Homework

Another purported benefit of flipped classrooms is that they alter the nature of homework by having students practice and apply their learning in the classroom, under the watchful

eye of the teacher [3]. In current practice, homework often appears ineffective in promoting learning. Beesley and Apthorp [2] found that targeted, in-class opportunities for students to practice their skills with corrective teacher feedback had an effect size nearly four times that of homework, in which teachers had few opportunities to monitor students during their practice.

Flipping the Paradigm

Here inverted classrooms means it is not really be flipping just the classroom, but the entire paradigm of teaching away from a traditional model of teachers as imparters of knowledge and toward a model of teachers as coaches who carefully observe students, identify their learning needs, and guide them to higher levels of learning.

Main issues in teaching higher semester students are:

- Poor attendance in the class as lot of information available on internet.
- Lack of creating an interest for theoretical courses in the classroom.
- Difficult to manage a described hours for teaching, problem solving and conducting activities.
- Students are involved in many co-curricular and extra-curricular activities when they move to higher semesters.

So Flipped class room pedagogy tool is being followed in many universities, IITs, colleges to address these issues. The problems faced by authors are similar to the one listed in issues. The authors are using Flipped class room to teach a course on Distributed Computing Systems to Final year students of Computer Science & engineering graduation Program.

III. IMPLEMENTAION

A framework adopted to teach a course is shown in fig.1. Frame work consists of three main components. 1. In-class activities 2. Out-of-class activities and 3. Discussion forum. In-class activities involve tasks which they do it in class by applying theoretical knowledge obtained by watching videos given by instructors. Out-of-class activities involve tasks that students can do it at their own time within the deadline given. Out-of-class activities are conducted through moodle. (moodle.bvb.edu). Students are supported with forums for students interaction.

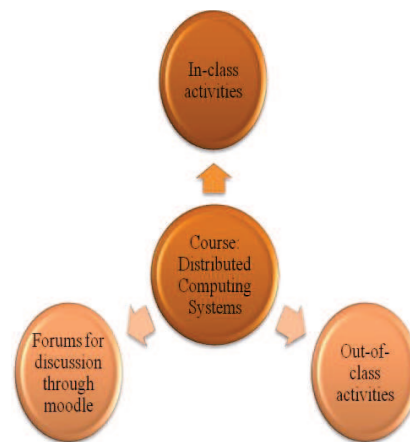


Fig1. Frame work for Flipped class room

Moodle accounts have been created for each student. Students need to update their knowledge by login into a system and spend minimum of two hours in learning a course. In-class activities are defined to create a interest in the course and apply their knowledge to solve a problem. Following activities are defined in the class room to engage them in the active learning:

- Problem solving
- Pair activity
- Group activity

Problem solving: Exercise problems are given to students to solve in the class. Faculty assists them in solving the problems. Instead of giving home work for students to solve at home, students are made involved in solving different types of questions in the class.

Sample questions are given below:

1. Student is asked to compare R, RR, and RRA protocols of RPCs with suitable diagrams. Give a real time example in which each type of protocol may be the most suitable one to use.

2. A distributed system uses the following IPC primitives:

- (a) send(receiver_process_id, sender_process_id, message)
- (b) receive(sender_process_id, message)

The primitives are synchronous in the sense that the sender blocks if the receiver is not ready to receive the message and the receiver blocks until a message is received from the sender. What is the minimum number of communicating processes for communication deadlock to occur in the system? Give reasons for your answer and give an example of a communication deadlock that involves a minimum number of processes.

Pair activity: Some problems need discussions with their friends. So tasks are defined to solve by pair. Sample pair activity is given below:

1. Students need to devise a mechanism for implementing Consistent ordering of messages in each of the following cases:

- One-to-many communication
- Many-to-one communication
- Many-to-many communication

2. Write the pseudo code of an algorithm that determine whether a given resource allocation graph contains a deadlock. Illustrate with example.

Group activity: Group activities are defined where students need to work together and involve some practical implementation. Two group activities are defined on process management—First activity involve students to present different process migration policy and showing the visualization of the same. Second involve practical implementation of different user level thread concepts.

Out-of-class activities are defined to learn theoretical concepts of the course at their own time. Following strategy is adopted.

- Faculty uploads power point presentations or relevant videos on each chapter at least 10 days earlier. Also reference material (pdf) is loaded.
- Students watch power point presentations or videos at their own time either in the department or at their hostels.
- Faculty announces a quiz on chapter after first week of the chapter material uploaded. Depending on the complexity of chapter it can after first week or second week. Deadline is given for completion of the quiz. Usually each quiz consists of 10 questions
- Students can answer the quiz from anywhere in the campus. Students get score for their answers. Here quizzes are used as to assess their knowledge obtained by watching power point presentations or videos.

Above said activities address different learning styles as in fig 2. The activity based learning address different learning styles such as Cooperative learning, Collaborative learning, Peer Tutoring, Problem based learning and Peer assisted learning

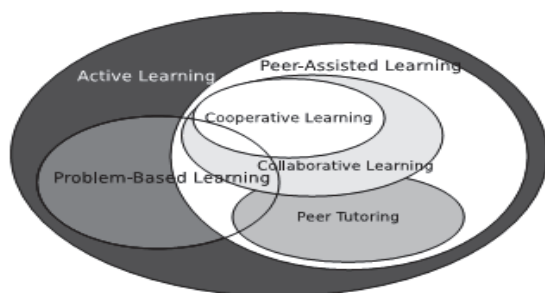


Fig 2. Venn diagram of learning styles

IV. DISCUSSION & RESULTS

At the end of the course a feedback is conducted with following questionnaires to know

- What are the students' perceptions of the flipped classroom?
- Whether students understand that the flipped classroom supports their learning?
- How flipped classroom can be improved?

Different questions used in the feedback are listed in the Table I. It also provided students to give their suggestions for the improvement in the flipped classroom method.

Majority of students enjoyed the flipped classroom experience. Each questionnaire item that examined student engagement and enjoyment showed positive responses. 80% of students agree that they:

- Enjoyed the flipped classroom teaching method.
- Find greater opportunities to work at own pace.
- Get more choice to demonstrate their learning.
- Find flexible access to course material and instruction.
- Are able to engage themselves in critical thinking and problem solving.
- Teacher could concentrate on student's interests, strengths, and weaknesses.

Only 10% students felt that flipped classroom was less engaging than a more traditionally instructed classroom. Only 8% of students did not like the self-paced nature of the course and the students indicated that the learning on their own was difficult on their own pace. But most students responded positively that the flipped classroom supported their learning.

Feedback was included with three questions that asked students about flipped classroom improvements. There were some interesting points made:

More in-class learning activities – Students responded that they would like to have additional in-class learning activities. As we have conducted only three in-class activities, they felt that these activities should be more frequent because of the value they gained from them[5].

Different ways of assessment process – Students liked the self-pacing and mastery aspects that were ingrained in the assessment strategy, but felt that having more of the assessments as paper-and-pencil rather than computerized assessments. This allows them to better demonstrate their work and have a chance to receive partial credit where parts of an answer are correct[5].

Quality videos – Students found that the videos could be improved. Better sound quality, more examples, and slower paced instruction were some of the most common responses. A number of students also suggested that the videos be created so that they were more interactive. As it was difficult for us to

prepare videos we had used relevant videos from YouTube and prepared power point presentations for some chapters[5].

TABLE I. Feedback questionnaire

Sl. No	Questionnaires
1	Enjoyed the flipped classroom teaching method?
2	Do you find greater opportunities to work at own pace?
3	Do you get more choice to demonstrate your learning?
4	Do you find flexible access to course material and instruction?
5	Did you engage in critical thinking and problem solving?
6	Does Teacher take into account students' interests, Strengths, and weaknesses?
Suggestions for flipped classroom to be improved : Class room learning activities : Changes to the assessment process : Quality of course material :	

This method also improved the students' performance in the Semester End Exams. The Table II shows the results of two consecutive years being compared with results of students where we have adopted Flipped Class room. In the Table II first two years shows the performance with traditional method of teaching, third year shows the performance using flipped class room.

TABLE II. Performance in SEE

Sl No	Academic year	SEE results (%)
1	2011-2012	86%
2	2012-2013	88%
3	2013-2014	97%

V. CONCLUSION

Student perceptions of the Flipped Classroom indicate that majority of students enjoyed the flipped classroom experience. Most of the students responded positively that the flipped classroom supported their learning. Students found that they had further opportunities to communicate with their classmates and teacher, finish their homework in class and engage in meaningful classroom activities. Also students' learning is improved by the flipped teaching compared to traditional classroom. As preparing course material is time consuming, authors suggest that the flipping class can be done for few topics where more theoretical content is there instead of doing for whole course. We can appreciate the flipped classroom if educators interested in trying to flip their class should have enough time to do the things in class, spend a significant amount of time lecturing and have eager to meet the diverse needs of learners. So the flipped classroom should be viewed as a mindset rather than pedagogy.

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