Designing of Flipped Classroom Approach To Teach Heat Transfer Course

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Abstract

In this paper we have designed flipped class room strategy for Heat Transfer course. As a first step towards flipping the class room three lessons are selected in the course. By delivering lecture content of selected topics before coming to class through videos and other media, class time is actively engaged in higher order thinking. The first step attempted is creating required Educational materials to transfer the delivery of content regarding the topics to an out of class environment. The second step is designing of active learning strategies Problem Solving, JIGSAW methods for the in class activity. Currently, limited research exists on the impact of the flipped classroom model in Engineering. A course such as Heat Transfer that involves design aspects and problem solving, requires time to teach concepts in an efficient and effective manner and can be best taught through flipped class approach. This paper would be definitely useful for all Mechanical & Chemical Engineering faculty members.

Keywords : Flipped class room, Designing, Pedagogy, Out of class activity, In class activity, learning, active learning strategies

Introduction

We live in the era of 21st Century. Teaching effectiveness is important because effective teaching helps in student learning. It has become even more important as emphasis on quality in higher education has increased. In this paper we have designed a flipped class room approach to teach a course on heat transfer. The flipped classroom approach has become an increasing popular approach for re-visioning of student learning aspect since many online tools are available for students to access information online and study independently of the traditional classroom [1,2,8,11,12] The key purpose of the flipped classroom is to engage students in Active learning where there is a greater focus on students application of conceptual knowledge rather than factual recall. The **flipped classroom** is a pedagogical model in which the typical lecture and homework elements of a course are reversed. Short video lectures are viewed by students at home before the class session, while in-class time is devoted to exercises, projects, or discussions [3,4,5,14].The video lecture is often seen as the key ingredient in the flipped approach, such lectures being either created by the instructor and posted online or selected from an online repository. While a prerecorded lecture could certainly be a podcast or other audio format, the ease with which video can be accessed and viewed today has made it so ubiquitous that the flipped model has come to be identified with it.

Methodology followed for the flipped class room strategy

A flipped class room is one inwhich students do some preparatory work before coming to class by viewing podcasts or videos or by reading course material that is given to them by their instructor . Instructors guide students to actively and interactively clarify and apply

that knowledge during class by doing lot of active learning on the topic in class. There is increasing evidence that this way of teaching leads to increased levels of student engagement, achievement and interest [6,7,9,10,13]. The main steps involved in the design of a flipped class room are shown in fig.1.Step 1 to 3 are Out of class activity in a flipped mode and Step 4 to 6 are for In Class activity.

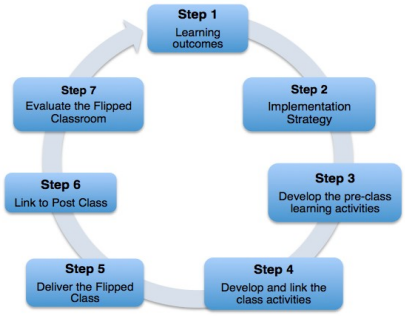

Fig 1: Steps involved in Flipped class room design

Design of Out of Class activity

1. Identifying topics to be designed for flipped class room
2. Creating short videos of lectures max 10 mins length
3. Posting videos & related literature onto a learning management system/Moodle cloud
4. Listing out concepts covered in the video
5. Defining the learning objectives of out of class activity
6. Assessment of students for outclass activity

Design of In Class activity

1. Providing summary that connects Out-of-Class and In-Class activities
2. Selection of active learning method :In active learning student goes beyond listening, copying of notes, execution of prescribed procedures
3. Defining the learning objectives of in class activity
4. Explaining about the active learning strategy
5. Instructor/Teacher guide lines towards the problem/topic to be covered in the class
6. Students work in group to solve the problem: Students working together to solve a problem with discussion, including inquiry based learning, authentic learning and discovery learning. While they each have their unique characteristics
7. Students are required to talk, write, reflect and express their thinking
8. Students are engaged in higher-order thinking (Analyze-Evaluate-Create)
9. Ensuring that students get feedback on their work, either from peers or instructor.
10. Assessment strategy for out of class activity

We have designed the heat transfer lesson activities that are useful as out of class activity while flipping the classroom. There are 3 lessons as part of this flipped class (room), each deals with an aspect related to

1. Content decisions
2. Pedagogic decisions
3. Technology decisions

As a first step towards flipped class room strategy for selected topics mentioned above, learning objectives of topics are written and required videos related to the topics were done through screencast and vimeo. The out of class activity mainly covers the Blooms lower levels ***remembering, Understanding and applying***and in class activity students are engaged in higher-order thinking (Analyze-Evaluate-Create) as shown in the figure 2.

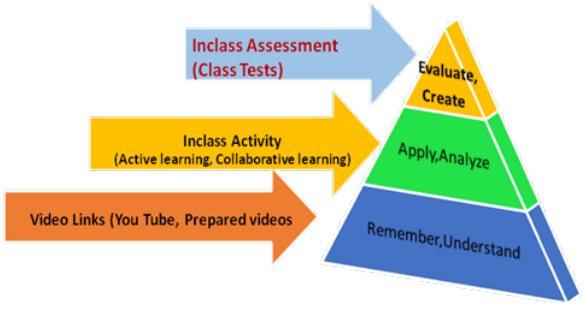

Fig.2: Blooms levels for Out of Class & In class activity

Content Decisions:

The content decisions related to:

1.**Lesson wise : Areas to be covered were identified-**

Decided on Heat Transfer Basics & Heat Exchangers ,Its Effectiveness of different types of heat exchangers, with phase change and LMTD

2.Decided on the Videos /PPTS to be provided for Out of class activity and in class activity

3.NPTEL& Other resources on the topic ,Question bank

Pedagogic decisions:

Typically in a flipped classroom strategy, there are two segments – Out-of-class segment and In-Class segment. Decisions were taken on the material to be provided for the out class activity. (Videos/PPTS) to understand/ to get an overview on the topic to be covered in the class.

In terms of concept marking the pedagogic decisions that were taken for the Out-of-class segment related to:

a. Cognitive Levels of Questions to be asked along with the resources – Mostly Recall to Apply level question for out of class and Create Level question for In-class activity covering the Blooms higher level :Analyze, Create & Evaluate

Step:1	**Students are divided into a group of 4 or 5. The group should be diverse in terms of gender, ability and skill.**
Step:2	Lesson is divided into 4–5 segments (one for each member)
Step:3	Each student is assigned one segment to learn. Each student should only have direct access to their own segment.
Step:4	Students should be given time to read their segment to become familiar with it.
Step:5	Temporary experts groups should be formed in which one student from each JIGSAW group joins other students assigned to the same segment. Students in this expert group should be given time to discuss the points of their segment
Step:6	Students come back to their JIGSAW group and present their segment to the group

b. Assessment Strategies: Through assignments to meet the learning outcomes

Lesson 1
Basics of Heat Transfer

1.Explain the theory behind different modes of Heat Transfer

2.Fouriers law of conduction/derive the equation for any surface

3.Heat Transfer through conduction and sample problem in a furnace to understand the concept

4.Tool used : Screencast Video : http://screencast-o-matic.com/watch/cDhTFIihuJ

5.Basics PPT : Conduction,Convection,Radiation with simple questions & Answers

Lesson 2
Heat Exchangers & Applications

1.Heat Exchangers and applications of Heat Exchangers

2.Overall Heat transfer coefficient in a heat exchanger

3.Screencast Video : http://screencast-o-matic.com/watch/cDhTbkihtI

Lesson 3

Effectiveness of different types of heat exchangers

1.Understand the effectiveness of different types of heat exchangers
2.Calculate NTU and minimum heat capacity and calculate effectiveness from the graph
3.Understand the effectiveness of Heat Exchanger with phase exchangers (Boilers/Condensers)
4.Annalyzing the effectiveness of different types of heat exchangers
5.Evaluation of effectiveness and LMTD and their composition
6.Screen cast video :https://vimeo.com/168082481
7.Screen cast https://vimeo.com/168083145

In Class activity: (Blooms level : Analyze ,Create& Evaluate)

The topic is divided into 4 subtopics and the teacher divides the students as per the following:

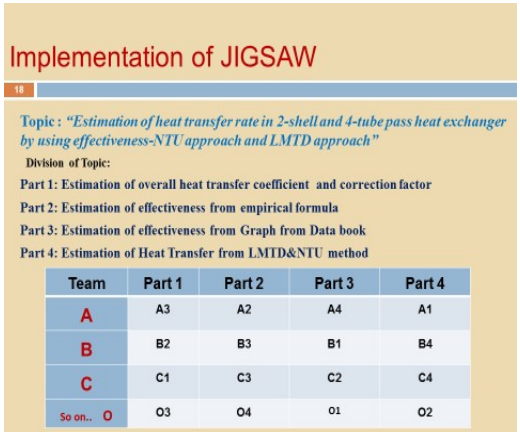

Table 1: Methodology of Grouping

Category	Very Poor (Rating :0)	Poor (Rating :1)	Good (Rating :3)	Excellent(Rating :5)
Usage of empirical correlations for modeling of a problem.	Student was unable to use the required equations to solve the problem.	Student was able to use the required equations partially to solve the problem.	Student was able to use the required equation to solve the problem but unable to simplify the solution	Student was able to use the required equations to solve the problem and able to obtain a correct simplified equation.

Role of a student and a Teacher

1. Student tries to understand the segment of the problem and discusses the topic with temporary expert group to master the concept
2. of the problem.
3. Teacher monitors the temporary groups and clarifies the doubts and motivates the students for active participation.
4. Students present their learning to Home group and try to learn the other segments from the other team members. Sharing of knowledge takes place.
5. All the teams are asked to present their learning .Teacher discusses about the learning and justifies. Group discussion take place.

Technology used

While developing the Out-of-Class and In-class activities, the major technology used are

a. Tool used for creating screencast – http://screencast-o-matic.com/
b. vimeo
c. MOODLE Lesson Activity for setting up Out-of-Class segment as it allowed guided self-learning through moodlecloud.com and Byndr learning management system
d. Cloud link : https://padmajavjit.moodlecloud.com/

The authors would like to implement the proposed design in II semester of III year B.Tech 2017(Curriculum common to mechanical engineering and Chemical Engineering students)

Rubrics

Rubric was designed for the assessment of the student as shown in the table below:

Category	Very Poor (Rating :0)	Poor (Rating :1)	Good (Rating :3)	Excellent(Rating :5)
Usage of formulated data	Student was unable to use the data book.	Student was able to use the data book and unable to get the proper solution.	Student was able to use the data book and able to get the perfect solution by using interpolations.	Student was able to use the data book and able to get the solution and tried solution for different cases of the problem.
Evaluation	Student was unable to compare the numerical and chart solutions	Student was able to compare but unable to model the problem properly.	Student was able to compare	Student was able to compare and model a different problem for the anlaysis

Table 2: Rubrics for Assessment

The above methodology was designed as out of class and in class with example problems related to the lessons in heat transfer. If anyone is interested you can contact the authors.

Conclusions

The flipped classroom which has become very popular in 21st Century teaching practice which has grown popular across all the disciplines of teaching and also at all age levels. The Flipped Classroom offers a great use of technology – *especially if it gets lecture out of the classrooms and into the hands and control of the learners.* The focus is more to utilize the class time effectively which in turn leads to and accommodates different learners engages with problem based learning, increases student teacher interaction and allows students to take the responsibility for learning. Current literature shows limited papers in heat transfer area to teach flipped class approach. The proposed designed model described in this paper would definitely results in higher learning capabilities, critical thinking and problem solving which ensues the student for better performance.

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