

Active learning approach for online teaching of Engine Design course

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Abstract—

Covid-19 has appealed to teachers around the world to adopt a new era of online teaching-learning methods instead of traditional teaching methods. It is a challenge for teachers to engage students in the learning process and measure outcomes with proper tools. The use of online platforms forced every teacher to redesign teaching strategies. A teacher has to think about online learning platforms and design instructional strategies. Different tools are available to make online learning interactive. The selection and application of tools is a skill of the individual teacher. In the present work, outcomes of the course Engine Design (ED) are mentioned. The course is taught online using the MS-Teams platform. During course delivery, various instructional strategies like, Games, quizzes, Discussion forums, Polls, etc. are used. Outcomes, of course, taught using an online platform and active learning tools (batch 2020-21) are measured using attainment of course outcomes CO's and course end survey (CES). A combination of active learning techniques with online teaching is helpful to deliver the subject effectively. The CO attainment and CES indicate improvement in student communication, perspective thinking, design and modeling skills.

Keywords—Course outcomes (CO's), Engine Design (ED), Course end survey (CES).

I. INTRODUCTION

A sudden change of teaching to online mode has added to the stresses and workloads on teachers [1]. Especially it is difficult for fields like Engineering and Medical where practicals are important in student development. All teachers deliver their classes from home; there are many challenges like technical as well as practical [2]. Conventional teaching methods are based on classical components like chalk and talk, homework, tests, etc. The conventional teaching methods received much criticism in recent years. There are different online platforms available for learners which provide certification courses. These platforms are working for the past many years and learners getting benefits from them. The studies show that E-learning is student-centric and flexible [3], and it can also improve interaction with students by using tools such as forms, quizzes, e-mail, discussion forums, chats, video conferences [4, 5]. E-learning platforms offer

advantages to learners like access to content at any time and from anywhere, control over time, control over the content,

spending for learning also courses are generally designed according to learners' needs and objectives of learning [6]. E-learning platforms also have some challenges like decreased motivation in students, delayed feedback to the student by a teacher, feelings of isolation due to lack of physical presence of classmates, a distraction from online lectures because of the surrounding. [7]. These obstacles can be overcome if teachers design their teaching strategies as per the need of students. This paper presents an attempt to use the online platform effectively. Chapter I gives the introduction part and literature survey. Chapter II demonstrates the various activities planned to engage the students. Chapter III discusses course outcomes and overall subject attainment (OSA). Chapter IV shows the results of the course end survey, which measures student satisfaction. Chapter V gives the conclusion and future work to engage the students in online learning.

II. ACTIVITIES PLANNED TO DELIVER COURSE

Cheung and Cable identified and described eight principles that stand at the core of effective online teaching, such as: [8].

- i. encouraging contact between students and faculty
- ii. collaborative learning
- iii. quick feedback
- iv. active learning
- v. task time—encouraging students to allocate more time for completing tasks,
- vi. high-expectations—the teacher should communicate their expectations to encourage and motivate students
- vii. diversified learning and
- viii. technology application

Above eight principles are followed while designing the instructional strategies for a course.

a. Learning contract (LC):-

This is a contract between student and teacher and it is defined early at the start of the course. Generally, teachers discuss course outcomes (CO's) and lecture plans (LP) with students in the first lecture and then start teaching accordingly. For the online platform, the teacher needs to discuss teaching methods and active learning tools that he or she is going to use during delivery along with LP and CO's. For the current course, attempt is made to share the teaching-learning process in detail with students. Students were also asked to suggest modifications in the plan to meet learning objectives. After

iterations, final plan of delivery is made and it is shared with a student as a learning contract (LC) in the first week of the course. LC includes a course plan, active learning plan and in semester evaluation (ISE) plan. All plans were uploaded on MOODLE after finalization. Learning contracts can be extremely effective in the online environment. Because physically meeting with the class to discuss learning goals, objectives, and expectations does not happen online, instructors must be very clear and concise in what they expect from the learner. Likewise, learners must also be clear about what they expect from the instructor. As students are interacted with teachers and peer in the LC process it improves student involvement in the learning process.

b. Online lecture:-

The lecture is a universal method to give and take knowledge. It has its advantages. In a lecture, it assumes the educator is an expert. The role of an educator is to guide students and help them to achieve desired outcomes. Only delivering lecture without the combination of instructional strategies make lecture boring. Good lecturers always deliver lectures as per student's needs. For online mode students were provided with lecture material of ED in advance to review. Lectures were designed by considering the attention span of the learner as 15 minutes. All lectures were recorded and uploaded on the MS-Teams platform and teachers' YOUTUBE channel so that students can assess it at any time.

c. Poll:-

A poll is a very useful technique to record student understanding quickly on the current topic of discussion. For online lecture, poll is used to create a dynamic environment in a classroom. Student's role changes from passive listener to the active participant who provide feedback and discuss with peers and instructors using chatbox Fig.1.shows poll report generated.

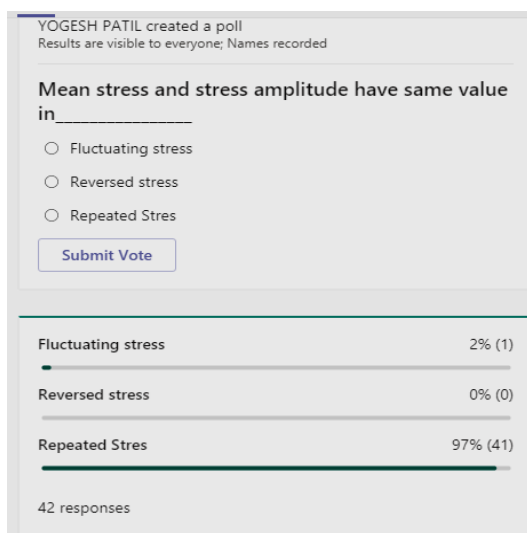


Fig.1.Poll report generated.

d. Chatbox and discussion forum:-

Chatbox in MS-Teams and discussion forum in MOODLE are very good options for implementation of the flipped classroom in online mode. In this method, students are provided with videos and study material before lectures. During the lecture, the teacher asks questions related to the

topic. The chatbox is used to record student answers. The teacher gives oral comments on student answers during live lectures.

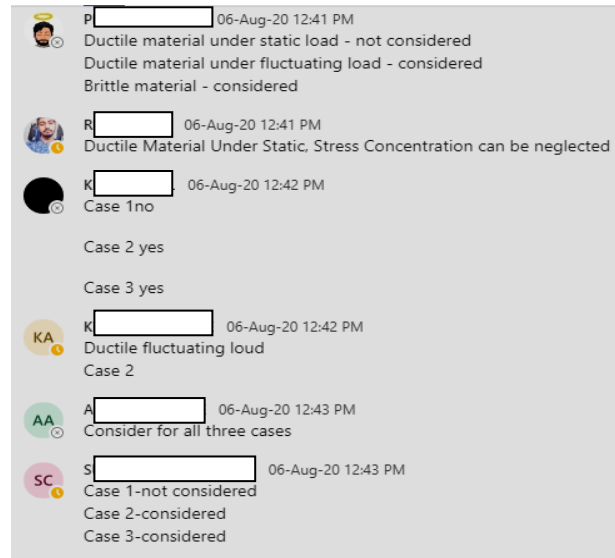


Fig.2. Chatbox screenshot.

e. Quiz by using gaming platform:-

Everyone loves playing games. KAHOOT online gaming platform is being used here for a quiz game. In this platform, ranking is given to students according to correct answers and the time taken by students to record answers. It helps to understand the depth of student learning. At the end of every game, a discussion is held with students on the report generated (Fig.3 and Fig.4.) It helps students as well as a teacher to understand topics that need focus.

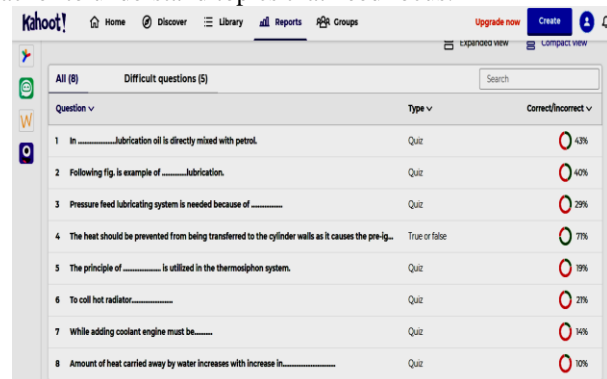


Fig.3:- Report of question difficulty level in KAHOOT after a quiz

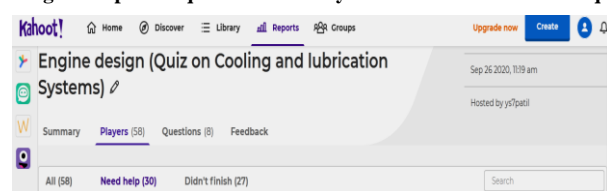


Fig.4:- Student performance report in KAHOOT after a quiz

At the end of a quiz KAHOOT displays a podium with the first three winners. This is a celebration of student success with music.Fig.5. shows one of the podiums.



Fig.5. Winners Podium

f. Guess What (GW)? Game:-

GW is a guessing game where one player thinks of a word, sentence or phrase and the other or team tries to guess it by suggesting letters within a certain number of guesses. The word to guess is represented by a row of dashes, representing each letter of the word. If the guessing player suggests a letter that occurs in the word, the other player writes it in all its correct positions. If the suggested letter does not occur in the word, the other player draws one cross on the screen. Every team gets a chance to float one question and answer one question. The end score of teams are decided based on the number of correct answers and wrong attempts. Some weightage is also given to the question set by a team. The assessment table of the game is given below

Table 1:- Assessment table for GW

Sr. No.	Assessment Criterion	Weightage %
1.	Question designed	40
2.	Answer given	60
	1 st attempt	100
	2 nd attempts	80
	3 rd attempt	60
	4 th attempt	30
	5 th attempt	20

g. Learning Together (LT) activity (Component Design and assembly)

The LT is a collaborative learning activity where students work in a group to achieve common objectives. The component design and assembly is a design and drawing performance where the student has to design, draw and assemble the components for the given statement or problems. SOLIDWORKS software is used for component drawing and assembly. Through this activity the student's teamwork made them learn better about design, modeling and cognitive skills are improved.

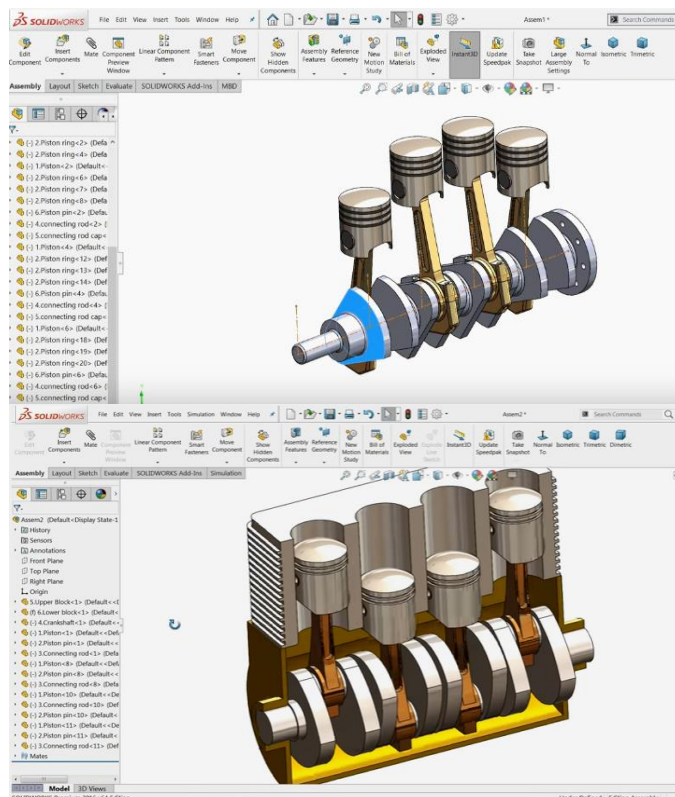


Fig.5.Four-cylinder engine subassemblies made by groups during LT.

III.COURSE OUTCOMES RESULTS AND DISCUSSION

The strategies discussed in chapter II are implemented to deliver a course. In-semester evaluation (ISE) and End Semester Evaluation (ESE) are carried out and it is mapped with course outcomes (CO's). The CO's of the subject are given below.

Table 2:- CO's of subject Engine Design

Sr. No.	CO code	Course Outcome statement	Blooms level
1.	CO1	Apply fluctuating stress theories for real-life problems	Apply
2.	CO2	Select the proper type of engine for a given requirement.	Analyze
3.	CO3	Design engine components like a cylinder, cylinder block, piston, connecting rod, crankshaft etc	Create
4.	CO4	Design cooling and lubrication systems for a given engine specification.	Create
5.	CO5	Select proper bearings for automobile applications.	Evaluate

These five-course outcomes (CO's) are mapped with twelve program outcomes (PO's). The mapping is as given below.

Table 3:- CO to PO mapping

CO s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
1	H		H	L	H		L		L			
2		L	H	L	H	L	H	L	L			
3	H		H	L	H		L		L			
4	H		H	L	H		L		L			
5			H	L	H		H	L	L			

H: - High mapping

L: - Low mapping

Subject ED has a high correlation with three POs (1, 3 and 5) because three or more H are present in correlation. It has a moderate correlation with PO7 because there are two H and three L in mapping. The subject also has a low correlation with POs (2, 4, 6, 8 and 9). It doesn't contribute to PO10, 11 and 12. Attainment of COs is based on the performance of students. There are two major contributors in the calculation of CO attainment, first ISE and second ESE. There is a 50% weightage to each ISE and ESE.

- ISE is conducted as per the plan shared with students in the learning contract. It is a continuous evaluation process that reflects the participation of a student in learning activities.
- ESE is an open book test designed on the entire syllabus and it is conducted at the end of the course.

Threshold-based Attainment of CO's

There are two methods available to calculate CO attainment average-based and threshold-based. Here threshold-based attainment method is used because the subject is in the syllabus for the last three years and its previous data is used to set the threshold. The threshold set for ISE is 70% and for ESE 50 % (Table 4). IONCUDOS software is used for mapping CO-PO and to calculate attainment of CO's (Table 5 and Fig.5).

Table 4:- Threshold set for CO attainment

Sr. No.	CO Code	ISE Threshold	ESE Threshold
1	CO1	70.00 %	50.00 %
2	CO2	70.00 %	50.00 %
3	CO3	70.00 %	50.00 %
4	CO4	70.00 %	50.00 %
5	CO5	70.00 %	50.00 %

Table 5:- Overall attainment of CO's

C O	Actual ISE Attainment %	Actual ESE Attainment %	After Weightage ISE Attainment %	After Weightage ESE Attainment %	Overall Attainment % (ISE + ESE)
1	94	42.00 %	47.00 %	21.00 %	68.00 %
2	70	65.57 %	35.00 %	32.78 %	67.78 %
3	87	63.93 %	43.50 %	31.97 %	75.47 %
4	98	96.77 %	49.00 %	48.38 %	97.38 %
5	98	56.90 %	49.00 %	28.45 %	77.45 %

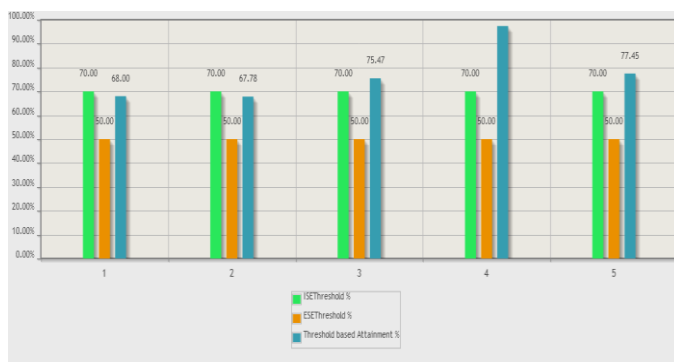


Fig.5. Threshold-based CO attainment from IONCUDOS

$$\text{Overall Subject Attainment (OSA)} = \frac{CO1 + CO2 + CO3 + CO4 + CO5}{5}$$

$$OSA = \frac{68 + 67.78 + 75.47 + 97.38 + 77.45}{5} = 77.22 \%$$

Active learning strategies are being used for the subject for the last three years. As per the CO attainment average, the OSA of a subject is 70%. The difficulty level of the subject is high as it is design-oriented. In the academic year 2020-21, it was a challenging task to maintain OSA but because of proper implementation of active learning techniques, the OSA of a subject is improved by 7 %.

IV. COURSE END SURVEY (CES) RESULTS AND DISCUSSION

This survey provides an opportunity for students to express their opinion about the course and the way it was taught. It is an opportunity to express how this course directly affected students learning. Results of this survey will be used by the instructor, a faculty mentor, and administrators to analyze the instructor's effectiveness in the classroom as well as the overall quality of the course. The CES questions are designed in relation to CO's.

Table 6:-CES student responses

S. N	CES statement	Related CO	Strongly agree %	Fairly agree %	Agree %	Disagree %	TOTAL
1	You can apply fluctuating stress theories for real-life problems	CO1	30.8	42.3	26.9	0	100
2	You can select the proper type of engine for a given requirement.	CO2	57.7	19.2	23.1	0	100
3	You can design engine components.	CO3	53.8	30.8	15.4	0	100
4	You can design cooling and lubrication systems.	CO4	50	30.8	19.2	0	100
5	You can select proper bearings.	CO5	50	19.2	30.8	0	100

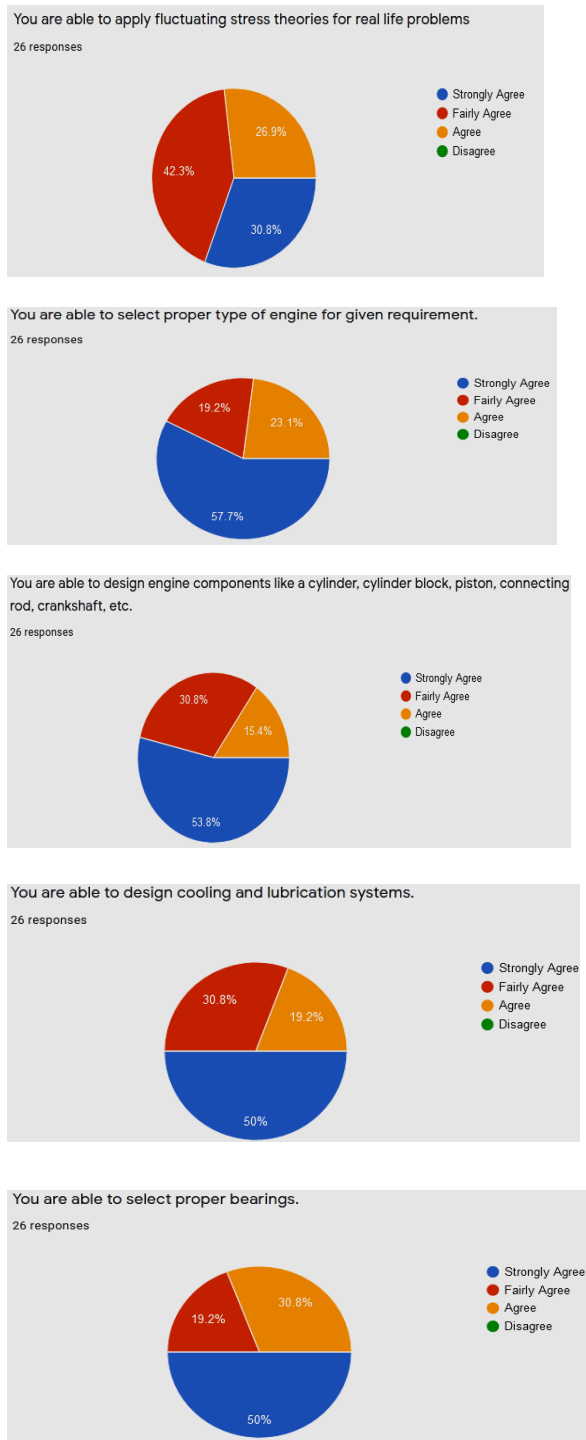


Fig.6. CES response

Student satisfaction index after completion, of course, is good and it matches with CO attainment calculated by using student performance in ISE's and ESE.

V.CONCLUSION

The paper shared the experience of handling Engine Design online courses with students through active learning techniques. These techniques encourage the students to gain knowledge and actively participate in online sessions. The overall subject attainment of the course (OSA) increased by

these activities. Activities like GW provided a platform for students to interact with classmates it helped to improve students' communication skills. Through LT activity most of the students participated in team and developed critical thinking, design, and modeling skills. Overall, a combination of well-planned instructional strategies with active learning techniques made the students interested in the course. It is also reflected through CES. In the future the implementation of new techniques, online activities and peer learning techniques will improve the students learning towards the course. Also, the identification of slow learners in the classroom is more important. It is a challenge to involve them in activities. In the future, some advanced learning tools will help in this regard.

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