Student Perception on Online Flipped Classroom in Engineering: A Case Study of Thermodynamics

Manoj Ranaweera*

Department of Mechanical Engineering, Faculty of Engineering, University of Moratuwa, Sri Lanka

manoj@mech.mrt.ac.lk*

Abstract – Flipped classroom pedagogical approach was adopted to teach the thermal sciences module in the second-year electrical engineering curriculum of the University of Moratuwa. All the core teaching materials for each topic were provided in video format. Formative assessments were conducted for each sub-topic, covered in a video, to assess the level of learning. Synchronous learning was facilitated via Zoom each week. Asynchronous learning of the self-learning material was facilitated through the University adapted standard Learning Management System (Moodle). Student perception of their learning experience was surveyed through a questionnaire distributed as a Google Form. The surveyed students were in good agreement on the positive impact of flipped classroom approach on their deep learning, mastering learning through self-paced learning, and lifelong learning. However, they have perceived the workload of the module as high due to weekly formative assessments. Nevertheless, their mean likelihood of recommending flipped classroom approach for other modules was 8.45, where the value of 10 reflects highly likely, and 0 reflects least likely.

Keywords: engineering education, mastery learning, deep-learning, lifelong-learning, flipped classroom

I. Introduction

The effectiveness of flipped classroom pedagogy has been researched in different subject domains. Karabulut-Ilgu, *et al* [1] present a comprehensive review of literature on these prior works. Due to a lack of research in the engineering/ technical domains, a key recommendation in this review is to research the suitability of flipped classrooms in engineering. This study attempted to fill this gap.

Basic Thermal Sciences and Applications is a three-credit module offered by the Department of Mechanical Engineering to Electrical Engineering undergraduates in their fourth semester. The module largely covers engineering thermodynamics and their applications with little exposure to heat transfer. The author is the sole examiner and the lecturer of the module. Due to social distancing restrictions imposed under the COVID19 pandemic, all synchronous lectures were conducted online via the Zoom platform. The following sections describe and discuss the methodology and the survey responses on student perception of their learning experience in a flipped classroom.

II. Materials and Methods

A. Video Lesson Making

Video lessons were created for each topic of the module. Generally, the content of one video lesson covered the content that could typically be covered in a two-hour slot in conventional delivery. Thus, smaller topics required only one video and broader ones required a series of episodes of video lessons. For each broader topic, an introductory video was also created to provide an overview of the topic creating the big picture. The duration of an introductory video was between 5 to 10 minutes while a video covering a two-hour lecture content usually varied from 20 to 50 minutes.

The video creation phase was the most time-consuming stage mainly because the author, who did it alone, is not an expert in video editing. Nevertheless, the videos were in high quality as perceived by the students. Doodly software and Microsoft PowerPoint were used to create cartoon-animated videos and presentation slides. The lecturer does not appear on videos. A Nikon D32 DSLR camera was used to record voice because the sound quality of the laptop used was low. BOYA® BY-WM4 Mark II wireless microphone, connected to the camera, was used to record. This helped record the voice clearly without requiring the presenter to speak unusually loud. Flashback Express free screen recorder captured the screen when PowerPoint slides were presented. The free version of DaVinci Resolve 16 was the video editing software used. The free version of Flixpress, a web-based video creation tool, was used to create an animated title segment for each video lesson. Royalty-free music downloaded from the web was incorporated at 30% of the full volume to provide background music in each video. A script guided the presentation delivery to ensure it was smooth enough for a recorded video.

B. Flipped Classroom Design

The module had three hours of lectures per week on the timetable over the semester. Moodle was the Learning Management System (LMS) used to set up the module online. Video lessons relevant to a topic were added to LMS allowing approximately three days for students to complete their self-learning of the material. The three-day duration was a practical constraint because videos were prepared while the semester was going on, and it took nearly 13 hours to complete one video. Formative assessment was also provided, for each video lesson, in the form of a quiz on Moodle. The quizzes mostly contained a collection of multiple-choice questions (MCQ), gap-filling, and short answer types. They mainly aimed at judging the degree of the attainability of low-order learning, such as understanding and applying the concepts to simple problems. In addition, one essential question in each quiz was to list the three most confusing aspects of the content (if a student had such) or any other specific questions they have on the content. Participation in the formative assessment was compulsory and the deadline of completion was usually set several hours before the lecture slot allowing the lecturer to review the answers.

The lecturer (the author) scrutinized the responses giving high priority to any specific questions raised by students and on the indicated most confusing sections. The responses to this question were grouped based on their contextual similarity to improve response efficiency. Responses to MCQ and short answer questions were scrutinized to identify common gaps in understanding and application.

Every lecture (synchronous learning session) via Zoom was in the form of a discussion rather than a conventional lecture. The lecturer first focused rectify any poor performances identified in understanding and applications revealed through MCQ and short answer questions.

Then, the discussion led to responding to any questions students raised during the discussion as well as in the quiz. Finally, any common confusing sections, as indicated by students, were further clarified. Any unique issues that could not be put into common groups in the grouping were dealt with individually at the end of the discussion. After completing all major issues, the discussions were then directed toward the high-order learning domain. The higher-order learning process consisted of an appropriate mixture of discussion of a complex problem, linking the learning to the industry standards and global developments such as SDG, climate change, etc. Usually, the discussions spanned over more than one lecture slot depending on the time allocated per topic in the lecture plan.

C. Survey Method

The survey had seven questions focused on different aspects where the first six questions were MCQ type containing six choices to select one from (i) Strongly Disagree, (ii) Disagree, (iii) Neutral, (iv) Agree, and (v) Strongly Agree. The last question asked about students' likelihood of recommending flipped classroom approach for other modules of their course. The response was collected on a point scale from 0 to 10 where the value of 10 reflects highly likely, and 0 reflects least likely.

The survey questions were set up on a Google Form as an anonymous survey. The target population was the final year electrical engineering undergraduates (N=100) who followed this module in their second year of study. The field representative (the group leader) distributed the questionnaire via their informal WhatsApp group. The field representative sent three reminders to students to participate in the survey. The lecturer made one request from students to participate in the survey via a Moodle message. No further attempts were made to increase the participation as that would yield distorted responses due to pressure.

III. RESULTS AND DISUCSSION

Out of the population of 100 students, 53 responded to the survey. Since the survey was done one academic year after the participants followed the module, the responses could be considered as deep-rooted perceptions which were not influenced by the excitement (positive or negative) of the new learning experience. The degrees of freedom of 53 participants could sufficiently converge the responses to a normal distribution. According to equation (1), a sample size of 53 for a population of 100 yields an approximate confidence interval of 91%.

$$n = \frac{NZ^2}{Z^2 + 4Ne^2} \qquad \cdots\cdots\cdots (1)$$

where n is the sample size, N is the population size, Z is the Z-score at the given confidence interval, and e is the margin of error[1].

As shown in Fig. 1, 96.2% of participants are in agreement (agree or strongly agree) with the fact that flipped classroom approach facilitated deep learning. Meanwhile, 98.1% confirm that video-recorded lessons facilitated self-paced learning. However, while 81.1% strongly agree with the facilitation of self-paced learning, only 50.9% strongly agree with its support for deep learning. Meanwhile, student performance records show that only 56.3% of students had scored over 65 marks for the module. According to the assessment design, to earn 65 or over, a student must have undergone some level of deep learning. Thus, the responses show that even if a student could not experience deep learning, the approach has facilitated their self-paced learning. In response to lifelong learning, 92.5% have, at least, agreed that flipped classroom approach facilitated it. Workload due to formative assessment appears to be the cost they had to pay for the advantages they gained, where 56.6% of them at least agreed that the workload had increased. However, compared to the higher agreement with the positive aspects, this proportion is relatively small. This may indicate that benefits may have outperformed the costs. Meanwhile, 28.3% of the students have not felt any difference in the module workload. Perhaps, the effort that would be put into last-minute exam preparation might have been reduced due to the smooth progression of the module. Students' response to their likelihood of recommending flipped classroom approach for their other modules has an average rating of 8.45 out of 10 where one student rated 5, 9 students rated 7 and 10 each, and 16 and 18 students rated 8 and 9, respectively. Despite the little concern about the workload, the students still prefer to experience flipped classroom approach for their other modules.

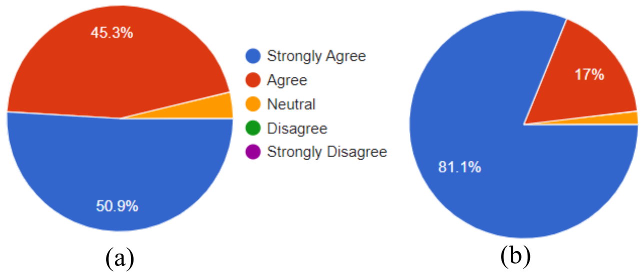

Fig. 1 (a) facilitation of deep-learning and (b) facilitation of self-paced learning

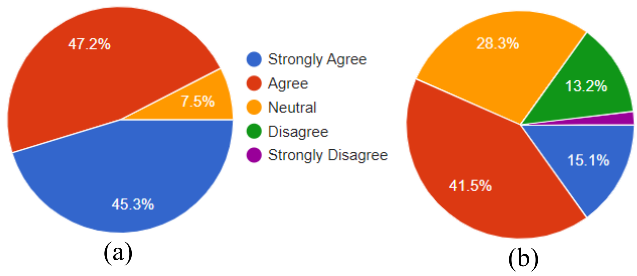

Fig. 2 (a) facilitation of lifelong-learning and (b) increase of overall workload of the module

IV. CONCLUSIONS

This study proves that the generic advantages of the flipped classroom approach are equally valid for highly technical and practical subjects like engineering thermodynamics. Also, the equal validity of the advantages in an online delivery setup is proven. The students were in very strongly agree that the approach facilitated their self-paced learning and a great agreement with its support for deep learning. Student agreement with the facilitation of lifelong learning is also very high. These aspects are essential attributes of a modern-day engineer as identified by the Washington Accord and other multinational bodies. Therefore, the wider adoption of modern pedagogical approaches like flipped classroom teaching should be seriously considered by faculties.

References

[1] Almeda, J., Capistrano, T, and Sarte, G., "Elementary Statistics", University of Philippine, p. 273-478, 2010.

[2] A. Karabulut-Ilgu, N. Jaramillo Cherrez, and C. T. Jahren, "A systematic review of research on the flipped learning method in engineering education," *Br. J. Educ. Technol.*, vol. 49, no. 3, p. 398–411, 2018.