

Flipped Classroom and Task-Based Learning Approach Teaching Strategies in Engineering Students Focusing in Electromagnetic Theory Course

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Received 05-03-2025

Revised 07-03-2025

Accepted 01-04-2025



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Abstract:

Nowadays, conventional teaching methods are gradually evolving into innovative teaching and learning techniques to enhance student engagement and understanding in the classroom/ during lecture. The choice of teaching strategies depends on the course requirements and the lecturer's approach. In Engineering courses, Electromagnetic Theory (EMT) is widely known as a challenging subject that requires a strong foundation in calculus and algebra. This course is the core course for second-year undergraduates in the Electronic and Electrical Engineering program in Universiti Malaysia Sarawak (UNIMAS). Every semester, EMT poses significant difficulties for students with weak mathematical backgrounds, often leading to low grades or course failures. The course assessment is structured as: 20% for assignments, 30% for tests, and 50% for the final exam. To address the high failure rate, the flipped classroom approach and task-based learning were introduced and implemented. This method reverses the conventional teaching model by providing students with instructional materials—such as pre-recorded lectures, reading assignments, and interactive modules—before attending class. The e-Learning Enrichment and Advancement Platform (eLEAP) is used to serve as the primary learning management system, delivering course materials to students in preparation for in-class activities. This approach fosters active learning and encourages students to take greater responsibility for this class. This research was conducted over three different semesters: 2019/2020 (conventional teaching), 2021/2022 (first implementation), and 2023/2024 (second implementation), with student enrolments of 94, 110, and 78, respectively. The findings indicate a significant improvement in students' passing rate, increasing from 76.6% to 96.4%, along with a notable rise in the percentage of students achieving grade A, from 8.51% to 30.00%. A comprehensive analysis of the assessment results was carried out to evaluate the effectiveness of this approach.

Keywords: Assessments; Innovative; Electromagnetic; Flipped; Task-Based Learning

1. Introduction:

Electromagnetics Theory (EMT) is widely considered as a very difficult course, and students often get lost at the beginning towards the end of

the course [1]. Thus, leading to higher failure rates.

Topics in EMT cover derivations, integrations, surface, area and many more which related to

Engineering Mathematics (EM). EM is the core course that needs to be taken by engineering students for 4 different semesters and levels. During EMT course (which must be taken in Year 2, Semester 2), students must already have their knowledge in Engineering Mathematics I, Engineering Mathematic II and Engineering Mathematic III. One of the topics in EM that relate to EMT is Vector Calculus which focuses on the basic language of electromagnetics. This topic is an extremely interesting and important branch of mathematics with very relevant applications in physics. It is widely used in calculations of electromagnetic phenomena. The basic operations allow extracting information about the distribution of electromagnetic fields, energy associated with the field, electromagnetic radiation and etc.

Studies such as Bell (1993), Canobi (2005), Hiebert and Carpenter (1992), Mason and Spence (1999) and Yager (1991) showed that students' conceptions of understanding mathematics are important in their success in mathematics learning courses. Research findings indicate that for most engineering students, mathematics has always been one of the most difficult courses to study [2-4]. Prior understanding in Engineering Mathematics is needed for students to be able to understand other subjects related to calculation, one of them is EMT.

Students with poor backgrounds in Engineering Mathematics tend to face difficulties in understanding not only the basic concept in EMT but the rest of the course. This led to low interest in this course and resulted low marks at the end of the semester. One way to overcome these challenges is to understand and investigate their different learning challenges and engaging them

with learning skills which includes knowledge, critical-thinking and generic skills.

Thus, the effectiveness of flipped classroom and task-based learning are examined for three different semesters starting 2019 till 2024. Results were collected during conventional teaching and learning method and after the implementation of these techniques.

2. Literature Review:

2.1. Learning Styles

Students learning styles can be categorize into three main parameters, the development of knowledge, thinking processes and generic. These strategies can help students to empower themselves with their own thinking powers and help them in reconstruction of knowledge and soft skills, particularly communication, team-work and self-directed learning. By implementing mathematical thing process, this will help students to emphasize, specialize, generalize, imagine and expressing, conjecturing, and convincing and organizing and characterizing [5].

Learning styles and techniques affect the understanding of students in every course in higher level education. Not only that, entry qualifications also one of major concern towards analysing the students' level of understanding. Engineering students' entry qualifications basically coming from different background such as Diploma level, Matriculation (Pre-U) and STPM level. This analysis will be carried out at the beginning of the semester to understand the groups of students taking EMT. Figure 1 shows students background with majority of the students are from Pra-University (37.5%), Diploma (34.4%), and Matriculation (28.2%).

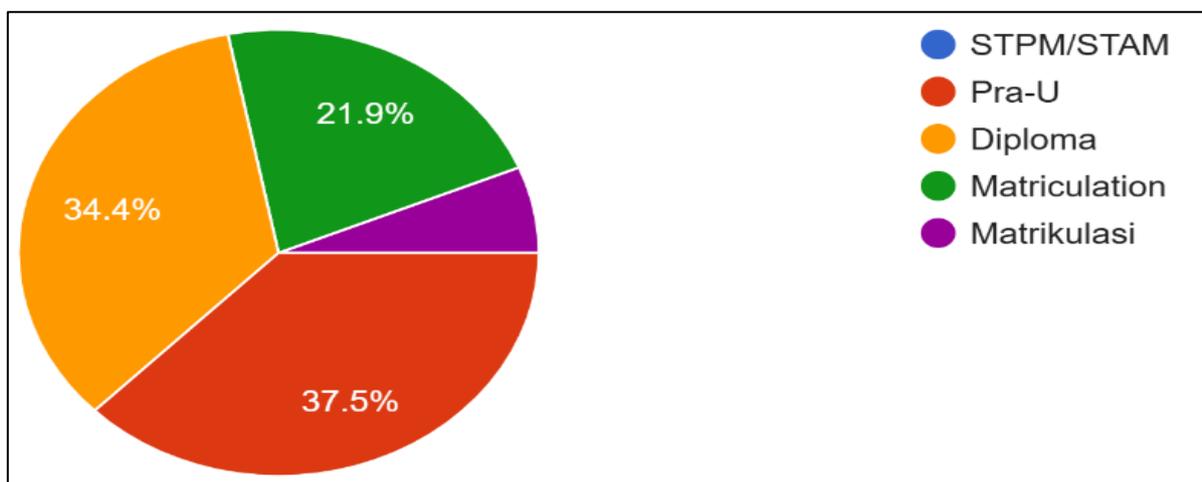


Figure 1 Students' background

Electrical engineering is considered to be one of the toughest Engineering courses by students, mostly because of the abstract thinking involved. One of the courses is KNR2433 Electromagnetic Theory that must be taken for all Electrical & Electronics Engineering students in Year 2. This course introduces student the definitive basis of electromagnetism, which will enable them to distinguish the major principles and theories in the area of Electrostatic, Magnetostatic and Electromagnetic fields. These include Biot-Savart law, Ampere's law, vector magnetic potential,

Faraday's law, Maxwell's equations for time varying fields and plane wave propagation. Students must have basic skills on Mathematics to be able to score the subject successfully.

Every early semester, VARK [6] is used to examine students' learning styles before the lecture begin. From total of 110 students (for Semester 2 Session 2023/2024), the results indicates that 57.5% students are more kinesthetics learners compare to other criteria as shown in Figure 2.

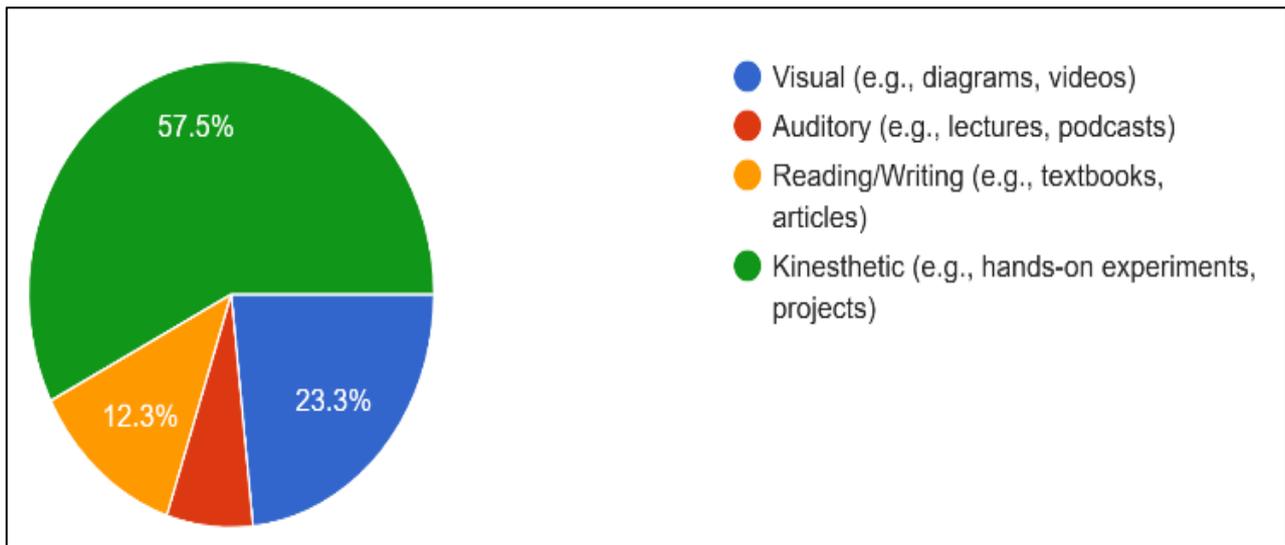


Figure 2. Learning Styles

2.2. Flipped Classroom:

Being introduced as a novel teaching and learning innovation, flipped learning becoming more popular nowadays. Flipped classroom can have a great influence in teaching and learning where students are directly involved in activities organized by the lecturers. According to [7], engagement of students plays important roles in making the students understand well in class compared to non-engaged students. Flipping lets the students to be able to enjoy face-to-face classroom time for interactive learning and can provide them opportunities to actively collaborate in class, doing discussion, inquiry and problem solving. Besides, these activities will inspire their critical thinking. Anecdotal evidence show that student learning is enhanced in the flipped classroom in comparison with traditional classroom [8-10].

2.3. Task-based Learning:

Task based learning offers an alternative teaching method to students. In a task-based lesson,

lecturer will introduce the topic and gives clear instruction on what they will have to do at the task stage and might help the students in recalling important terms/subtopics related to the given tasks. The steps included planning, report or oral presentation, analysis, and practices. Unlike a normal teaching method, the students are given opportunities to explore the information and practicing with their own group members before presenting to the class or lecturer. Students also will improve their communication skills when communicating within the group members or in class. Of course, the lesson will be enjoyable and motivating.

3. Methodology:

This research consists of an analysis of three semesters of undergraduates taking KNR2433 Electromagnetic Theory. Data is collected during conventional teaching and learning process and after flipped classroom and task-based learning approaches introduced for the other semesters. The outcome is based on their achievements in

tests, assignments, and final exam. Two methods introduced for the course is flipped classroom learning and task-based learning. In flipped classroom, students are given lecture notes to be prepared during the class. Students then will be divided into groups where each of the group will be assign a task-based on the selected topic. An overview of the topic will be given by lecturers as briefing and guideline for them to proceed with the activities. Students are given 10 minutes to

form the groups consist of 5 students per group. Every group will be given a task where they need to discuss based on the readings and information they collected before entering the class. Discussion not only must be conducted in groups, but also with other groups. At the end of the class, groups will be presenting or being assessed by the lecturer either in term of oral presentation, quizzes, or tests. Figure shows the summary of methodology implement in this course.

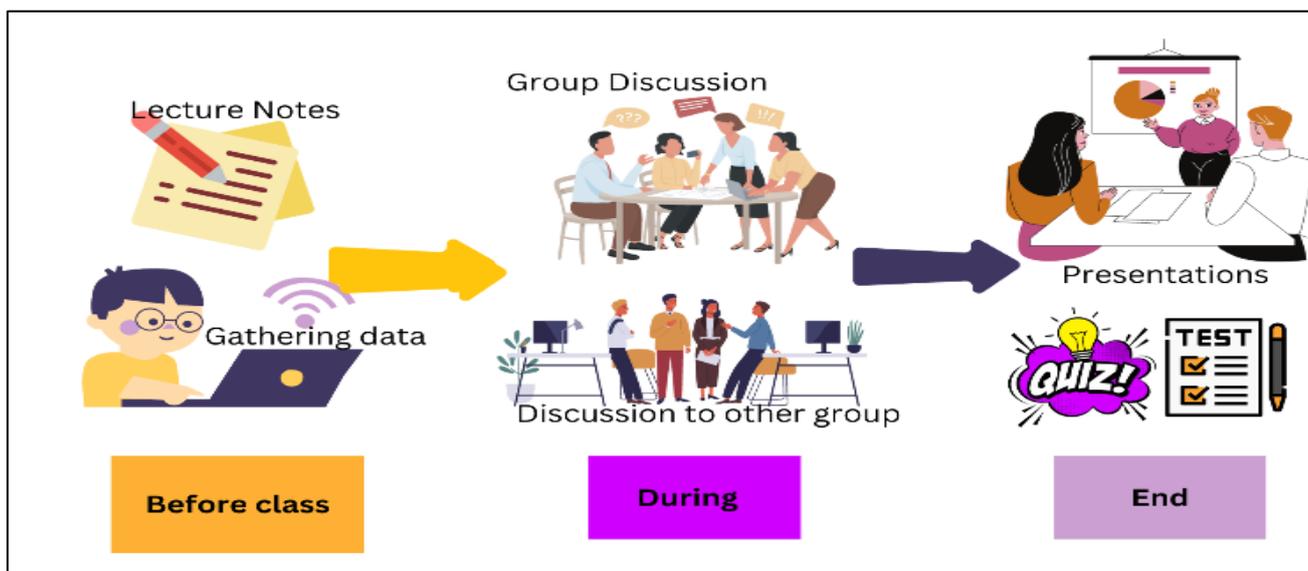


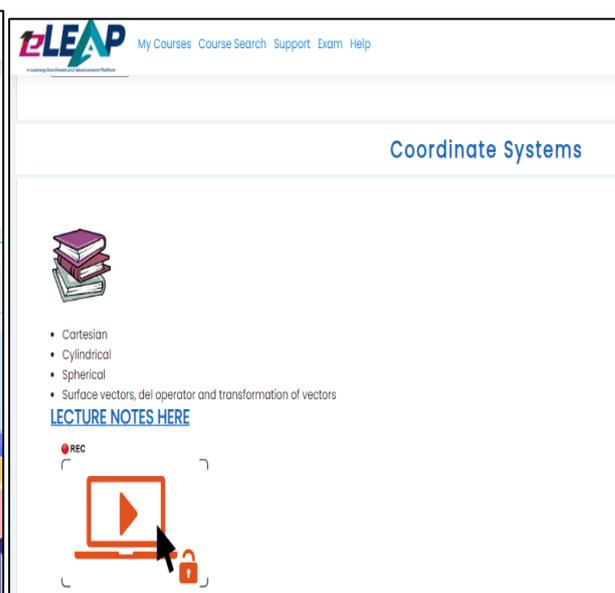
Figure 3. Course Implementation

Online audio/video materials are crucial in flipped learning as students need to access lecturers video used in teaching. For this, the use of e-Learning Enrichment and Advancement Platform (eLEAP) is used to deliver all the information to students as

shown in Figure 4 (a). All instruction and information given to students via the eLEAP platform. Example of instruction given to students are all delivered via eLEAP as shown in Figure 4 (b).



(a)



(b)

Figure 4. (a) eLEAP dashboard (b) Instruction to student in eLEAP

4. Results and Discussions

An awareness of Flipped Learning among the students is a pre-requisite for Flipped Learning to be successful. From 110 respondents, 53% of

students are aware of flipped learning implementation while 57% responded as NO. This data is summarized in Table 1.

Table 1. Flipped Learning Readiness

Are you aware of Flipped Learning		
Answer Options	Response	No. of students
Yes	48.18%	53
No	51.82%	57
Total	100.00%	110

When Flipped Learning is implemented with Task-based learning in Semester 2 Session 2023/2024 (110 students) the results of assessments are shown in Figure comparing to conventional teaching method in Semester 2

Session 2021/2022 (78 students) and Semester 2 Session 2019/2020 (94 students). These results are collected from assignments, tests and final exam with the following percentage shown in Figure 5.

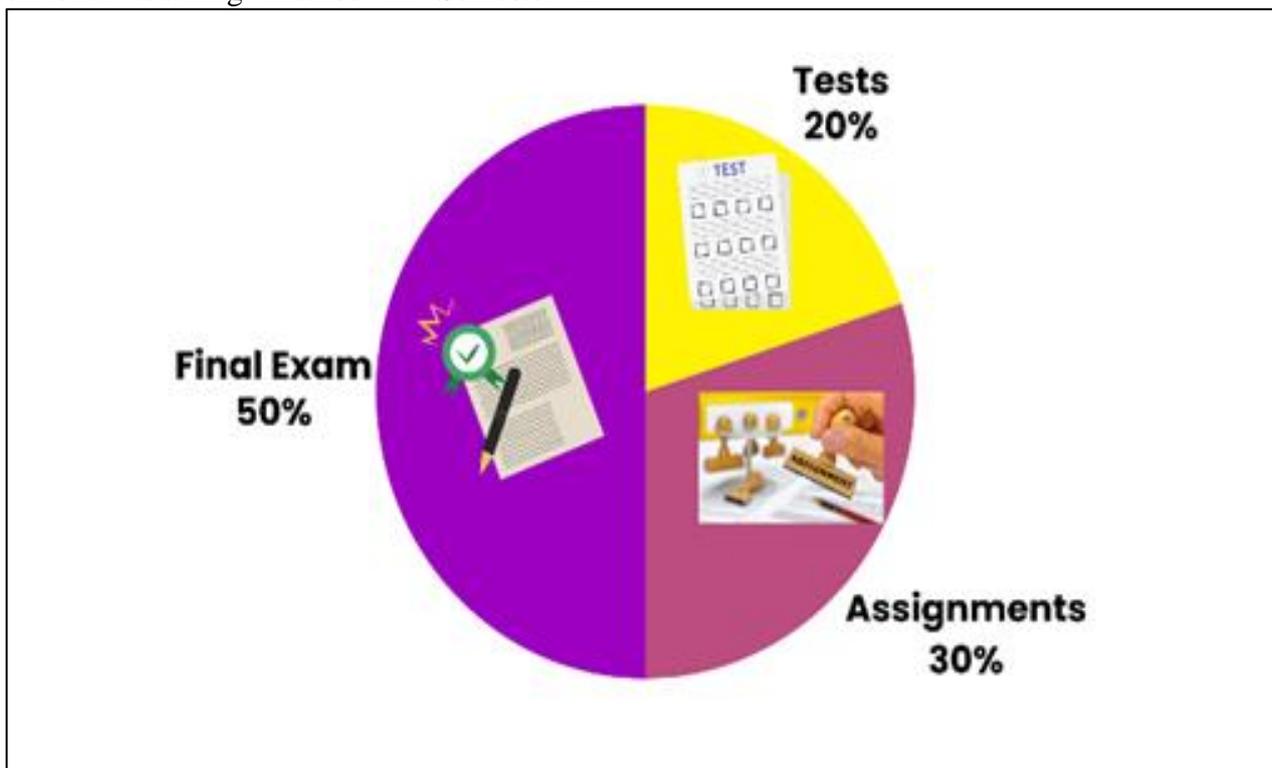


Figure 5. Assessments for Electromagnetic Theory Course

The results collected and compared with both semesters between conventional method and implementation of flipped learning and task-based learning in the course as shown in Figure 6. It shows the increase of passing rate from 76.6% to 96.4% and with highest percentage of grade A

from 8.51% to 30.00% from 2019 to 2024. The analysis of the results is examined in every aspect of assessments such as tests, assignments and final exams. It shows the increase of the results due to their level of understanding is higher compared to previous method.

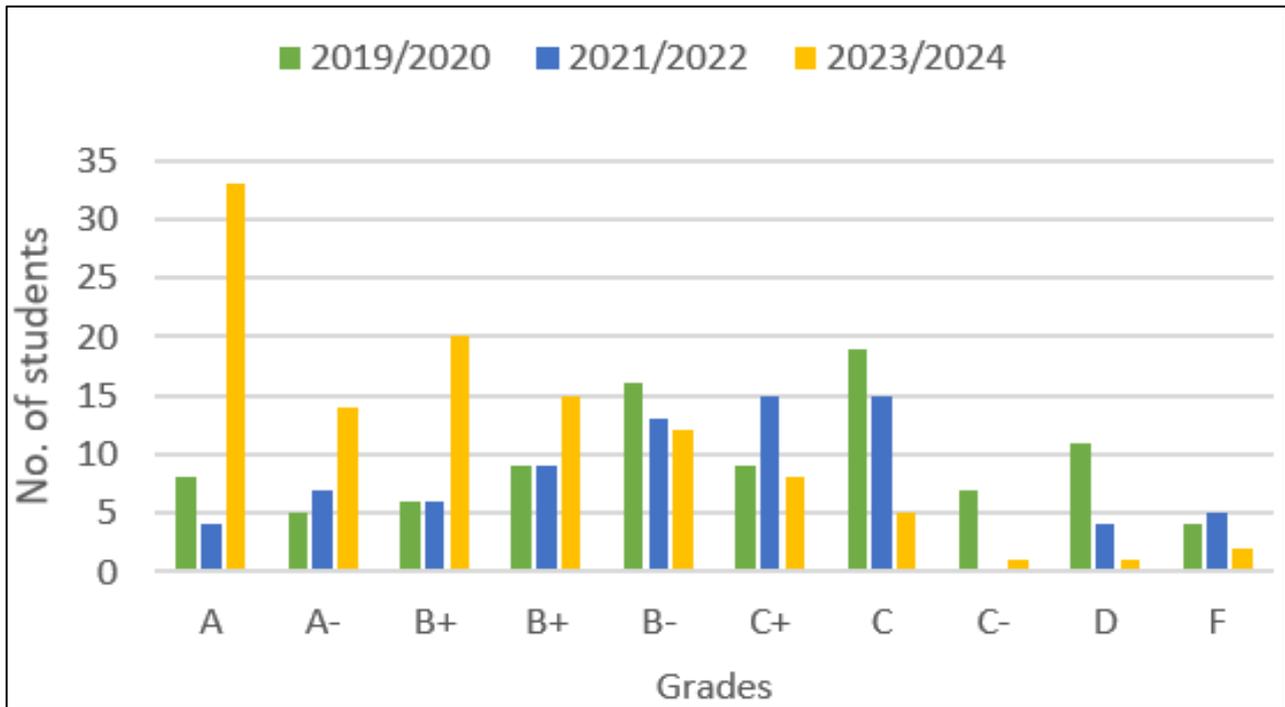


Figure 6. Student's performance for three different semesters

5. Conclusion:

From this research and analysis, students show an improve of understanding in learning process when new techniques are implemented in the course. Although the course is quite challenging to score A previously, after flipped classroom and task-based learning are introduced, learning process become enjoyable where students are more ready and well-prepared before the class. Learning in groups via task-based learning also enhances not only their understanding also their communication between other members.

Acknowledgement:

The authors would like to thank Universiti Malaysia Sarawak for supporting this research. This research is fully funded by Scholarship Teaching and Learning (SoTL) grant with grant number SoTL/FK/2023(8)/008/.

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