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Enhancing Student Engagement and Learning Outcomes through Machine Learnings Cloud-Based Flipped Classrooms



Abstract: Pedagogically, the flipped classroom is based on students' real classroom experiences. One method of flipped classroom, that of Student Centric Flipped Classroom, is presented in this article along with its theoretical foundations. To enhance their own learning, students act as co-creators in this approach and create flipped classroom activities. Through identification of connections between students' views, learning strategies, and learning theories, the article investigates the usefulness of the approach as well as learning that was achieved by students. A mixed-methods approach was employed by the researchers where they gathered information both qualitatively and quantitatively. To understand the perception of the method by the students, the data was thoroughly analyzed. Following the accomplishment of the approach, students have ambivalent attitudes towards it, based on the findings. But over time, people observe how the method assists with advanced topics in making them easier and more applicable. The study also points to the possibility of using Machine Learning (ML) methods to analyze cloud-based LMS student interaction data to predict engagement patterns and tailor flipped classroom activities. The succeeding version of the approach ought to involve both flipping and lectures more proportionately, with lectures being used to expound the subject matter and language of the course.

Keywords: Flipped classroom; student-centered approach; VARK Model; LMS; Machine Learning; Learning analytics

1 Introduction

The flipped classroom concept has grown admiration as an exciting new approach to educational technology, especially at universities, in the last several years. The best way to motivate students to perform their best is to use modern pedagogical techniques using technology. One definition of a "flipped classroom" is a conventional classroom that has been "flipped" on its head. Students can actively study new material outside of class via independent study using recorded lectures and readings. The expectation is that students will hold on assessing course content (Bachiller & Badía, 2020). After that, they'll put what they've learned in class into practice by working in groups to address real-world challenges, with the help of their peers. The result is a deeper understanding of the subject and a more satisfying educational experience for the students. This better, more participatory, and student-centered approach to teaching is superior to the old-fashioned lecture style. The flipped classroom concept offers numerous aids to students, including increased hands-on experience, greater agency over their own education, and higher levels of academic preparedness and intrinsic desire. Students' self-esteem, ability to think critically, classroom participation, and comprehension can all take a hit as a result. Students with limited time can study at their own pace in flipped classrooms. Teachers that use recorded lessons allow students the flexibility to learn whenever it is most convenient for them. As a result, both teachers and students may become more proficient in using technology. A flipped classroom promotes teamwork and peer interaction while also increasing possibilities for building teacher-student relationships at different steps in the Learning Journey

The rising cost of higher education and the prevalence of systemic problems that order faculty research over student learning have prompted some to propose flipped classrooms as a student-centered, cost-effective solution., teamwork, and critical thinking. Employers are always on the lookout for students who not only do well in school but also have a wealth of practical knowledge, skills, and abilities. Businesses want someone that can think outside the box and aren't afraid to put their ideas into action. The foundational principles of traditional education—an antiquated model centered on the teacher—have rendered them ineffective in imparting the knowledge, abilities, and character traits sought for by employers. The common belief is that teachers should not encourage students to discover their own interests and passions but rather concentrate on teaching them specific facts and techniques. Students do not have the hands-on experience that is essential for applying what they learn in the classroom to

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real-life situations. All of the problems with traditional education that have been mentioned above could be solved if flipped learning were to be used.

Many significant topics have been covered in the abundance of published systematic review studies on flipped classrooms. There is a lack of breadth in the articles covered by these review studies, or they focus on a single academic discipline or student demographic. Huang et al. (2023) recommended utilizing video tutorials in a flipped classroom scenario to captivate students' interest in learning systems programming. A learning style inventory developed by Fleming is known as the VARK (2001). It is an acronym for "kinesthetic," "visual," "auditory," and "read/write" learning modes. "Visual, auditory, read/write, and kinesthetic learning styles" are the four main categories of learning preferences. Kinesthetic learners, on the other hand, learn best through doing things like experiments, manipulating objects, or engaging in physical activities. Individuals' results in different contexts informed the development of the VARK questionnaire's components. There are four options for each of the sixteen questions, and they all relate to different ways of learning. Whichever learning style the responder ranked highest in is likely their preferred method. Those who do similarly on more than one style of learning are considered to have a mixed style of learning. In addition to VARK's trustworthy and proven findings from earlier studies (Fitkov-Norris and Yeghiazarian, 2015).

2 Integration of technology in flipped classrooms

- **Digital content creation tools**

Prior research has used a variety of video editing programs. It was found in the study by Park et al. (2018) that Camtasia was used to create the videos. The Camtasia software suite was created and distributed by TechSmith. It is a plug-in for Microsoft PowerPoint that allows users to record screencasts directly from the program. You have the option to add background narration and voice tracks separately or in conjunction with other audio and video recordings.

The course lectures created by Steen-Utheim and Foldnes (2017) were based on video screencasts. Educational videos that combine voiceover narration with screen recording—typically a digital recording of a computer screen—are called screencasts. Screen capture films, sometimes called screen recordings, are great for teaching or conveying ideas because they look a lot like screenshots.

Researchers from the majority of studies said they made movies and posted them to YouTube and a course website so students could see them. Thanks to the free video-sharing network YouTube, watching videos online has never been easier.

- **Virtual learning environments (VLEs)**

A LMS allows students to easily access and organize all of their course materials, featuring video lectures, written materials, exercises, and supporting resources. Zou et al. (2020) conducted their study using Moodle, a platform for online course management. Moodle is a learning management system (LMS) used for online education and training. Among the several LMS platforms available, Moodle stands head and shoulders above the others. Moodle is the platform of choice for many forms of online education, including flipped classrooms, hybrid and remote learning, and many more. Movies and educational materials are produced by Bachiller and Bada (2020) and Ng and Lo (2022), and students have access to them through Moodle.

In their study, Mortaza Mardiha et al. (2023) demonstrated how the "BigBlueButton software" enables online learning. One excellent digital classroom tool for remote education is BigBlueButton. The program gives data and engagement tools, and it's accessible through a number of LMSs, so professors may talk to their students from anywhere.

According to Lopes et al. (2019), MatActiva was utilized. Motivating students to overcome barriers through individual study, increasing their self-confidence, and sparking an interest in mathematics are the key goals of the MatActiva mathematics project, which is built on Moodle..

- **Digital evaluation platforms**

Automated evaluation, report generating, and grading functionalities are all part of online assessment technologies that aim to shorten the usually time-consuming marking procedure. Research by **McLaughlin et al. (2016)** shows that clickers were used for in-class evaluation. A clicker is an interactive technology that allows teachers to quickly collect and analyze student replies to questions. Teachers use clicker software or present the questions orally and have students choose the correct answer. Students use handheld transmitters to key in their answers. Teachers have the ability to instantly access and preserve the results thanks to the technology.

Hao et al. (2016) utilized an instant response system. In order to quickly provide a report outlining the results, this system may assess the students' responses using previously saved answers. Students responded instantly using mobile devices, computers, and tablets.

3 Problem statement

There is a dearth of research evaluating the effects of ML based flipped classrooms on students' engagement and the variety of learning styles they exhibit in higher education, while traditional lecture-based teaching frequently fails to engage students adequately, reducing their capacity to retain information and apply it in the real world.

4 Objectives

1. To evaluate student perceptions of the ML cloud-based flipped classroom approach and its effectiveness in enhancing engagement, knowledge retention, and self-directed learning.
2. To analyze the relationship between ML based-learning styles and flipped classroom effectiveness by assessing how different student preferences impact their academic performance and classroom experience.

5 Research Methodology

Students' perceptions of and progress toward learning outcomes from the cloud-based flipped classroom model were evaluated using a multi-method strategy. The study integrates quantitative and qualitative approaches to provide a comprehensive view of students' experiences, engagement, and academic performance. This section provides a full account of the study methodology that was utilized for data collection and analysis. To further understand the flipped classroom model, we employed a qualitative approach to gather student feedback. Introspective interviews were conducted with students who had previously engaged in flipped learning. The goal of these interviews was to hear their thoughts and feelings about the pedagogy as well as their experiences with it. We also surveyed students who had taken part in flipped learning at different stages using semi-structured interviews to learn more about their perspectives and experiences in order to limit bias and increase diversity of thinking. All of the interviews were recorded, transcribed, and analyzed using theme analysis. Data acquired from LMS logs, student response and engagement polls, and post-tests can be analyzed using an ML-centric approach to detect trends in participation and learning. Pattern analysis has the potential to predict students likely to demonstrate weaker engagement and aid instructors in planning more tailored flipped classroom content delivery.

Quantitative data was collected using two primary approaches:

1. **Immediate Student Feedback Polls:** To administer a 5-point Likert scale to students after every flipped classroom session to gauge their level of satisfaction. The flipped sessions' leadership, value, engagement, and innovation were evaluated with a series of questions.
2. **Post-Assessment Survey:** A structured survey was given to students at the conclusion of the semester to gauge their thoughts on the flipped classroom model's efficacy, their preferred methods of learning, and their perceived learning results. The poll also looked for connections between students' engagement and their learning styles, using the VARK Model.

The collected quantitative data was analyzed using mean comparisons, to determine the statistical significance of student responses.

6. Results and Analysis

• **Student Feedback immediately after each flip**

After each flipped classroom session, students provided feedback on their experience. Table 1 summarizes the mean responses and significance levels for various aspects of flipped learning.

Table 1 presents the average responses and corresponding significance levels for different aspects of flipped learning.

Questions	Mean	Std. Deviation
Flip was Creative	4.16	0.736
Flip was Enjoyable	4.34	0.820
Flip was Valuable	4.27	0.803
Flip Leaders did a good job in leading the flip	4.21	0.781

- All scores were significantly above neutral (3.0), indicating positive perceptions of the flipped classroom sessions.
- The highest-rated aspect was “Flip was Enjoyable” (Mean = 4.28), suggesting that students engaged well with the interactive format.
- Creativity and leadership also received high scores, highlighting active student participation in designing and leading sessions.

Table 2 presents the average responses and corresponding significance levels for topic-specific variations in student perception

Question	Sum of Squares	Mean Square
Creativity	15.32	3.06
Enjoyable	12.14	2.43
Valuable	5.21	1.04
Leadership	0.72	0.14

- Creativity and Enjoyability varied significantly across topics ($p < 0.05$), with some topics being more interactive than others.
- Topics with quantitative elements (e.g., statistical concepts) received lower ratings for creativity.
- The perceived value of learning and leadership effectiveness did not differ significantly across topics.

Table 3 presents the post-assessment survey findings

Question	Mean Score	Std. Deviation
Flipped classroom enhanced my learning	3.75	0.82
Improved my ability to apply concepts	4.02	0.76
Encouraged critical thinking	4.10	0.74
Helped retain knowledge long-term	3.98	0.79
Was more engaging than traditional lectures	4.22	0.81

- **Summary of findings**

- **Higher engagement levels** compared to traditional lectures (Mean = 4.22).
- **Significant improvement** in knowledge retention and conceptual application.
- **Students developed stronger critical thinking skills** (Mean = 4.10).

Table 4 presents the correlation between learning styles and flipped classroom effectiveness

Variables	Mean	Std. Deviation	% rating 4 or more
LS Example	4.06	0.772	81.80
LS Talking through	4.19	0.749	87.50
LS Reading *	2.77	1.117	30.30
LS Writing	3.87	1.024	69.70
LS See patterns	3.68	0.945	57.50
LS Teaching	3.55	1.060	57.60
LS Group	2.87	1.204	33.30
LS Alone	3.26	1.064	43.80
LS Lectures	3.97	0.706	75.80
Flipped Classroom (Average of 8 items)	3.12	0.760	0.760

- Students positively perceived the flipped classroom approach, particularly for engagement, knowledge retention, and conceptual application.
- Interactive topics led to better engagement, while complex, quantitative topics needed better structuring.

- Learning styles influenced effectiveness, with visual and kinesthetic learners adapting best to flipped learning.
- Future improvements should focus on enhancing digital content for reading-based learners and optimizing interactive activities for all students.

7. Conclusion

According to the research, students' engagement, critical thinking, and ability to retain information are all greatly improved by using flipped classrooms in the cloud. Students' responses were varied at first, but after the test, they showed signs of greater flexibility and comprehension. The results highlight the need of combining traditional lecture methods with more modern, interactive flipped learning strategies for the best possible student results. Further investigation is required into issues including digital accessibility, the availability of structured learning tools, and the ability to adjust to self-paced learning. Improving adaptable learning strategies to meet the requirements of diverse students and make the most of flipped learning should be the focus of future research.

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