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Applying Machine Learning to Understand the Student Perceptions and Learning for the Effectiveness of the Flipped Classroom Approach

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Abstract: The flipped classroom system has attracted substantial interest from educational theorists. The concept here is to reverse the focus from lectures to active learning during class with the expectation that students will be more focused throughout the day. Students' perceptions of the flipped classroom model are examined in this article, and it also considers the relationship between the learning styles chosen by students and their performance in the flipped classroom. The study combines both qualitative and quantitative approaches in establishing whether flipped classes enhance students' learning outcomes or not. In addition, the research identifies the possibility of using Machine Learning (ML) methods to investigate student interaction and performance information so that learning difficulties may be identified early and flipped classroom activities personalized.

Keywords: Learning Styles; Student Perceptions; Flipped Classroom; Higher Education; Machine Learning; Learning Analytics

1. Introduction

Traditional educational methods are under fire for supposedly promoting rote memorization at the expense of critical and creative thinking among its pupils **(Deslauriers, et al 2019).** The flipped classroom model is an innovative and exciting new way to teach that puts students in charge of their own learning and helps them to better understand the content. In this style, students work on assignments and problems in small groups during class, after having prepared for the day by reading or watching recorded lectures **(Abeysekera, & Dawson, 2015).**

A number of learning and pedagogical theories can be utilized to analyze the flipped classroom model, and more specifically, the student centric flip, from a critical perspective. The student-centered flipped classroom is based on a number of theories, including;

1.1Self Determination Theory (SDT)

According to the idea, our motivation to learn is influenced by three fundamental human wants: autonomy (the desire to be free from external influences), relatedness (a sense of being part of a group), and competence (the ability to know and do things well). In a student-centered flipped classroom, students have greater say over the flip's design and execution, and they have more chances to collaborate in groups to find solutions to issues and participate actively in their own learning **(Barszcz et al., 2022).** Self-Determination Theory (SDT) also distinguishes between two types of motivation—intrinsic and extrinsic—and how each relates to learning. An effective student-centered flipped classroom will empower students to take initiative (through flip design), take ownership (through extensive pre-flip meetings with student groups to fill conceptual gaps), and feel more connected (by working in groups they self-select)—all of which are known to enhance students' intrinsic motivation.

1.2 Latent Learning Theory

Learning, according to this view, doesn't require incentives or rewards. Gaining knowledge leads to improved performance. Unless there is some kind of external incentive, learning will not take place. The behavior of learners does not reveal their learning until it is put into practice. The student-centered flipped classroom model relies on latent learning theory to have students do independent study on course material (i.e., definitions, concepts, etc.). Kids develop mental maps based on their prior knowledge and experiences at this stage of development. Students are motivated to learn and improve their behavior when they work in groups to answer questions or solve issues in a flipped classroom. Cognitive maps pertaining to the subject are either confirmed or updated by the new experience. These mental models might be useful in the future, whether for an internship or a job. Latent learning may also occur for leaders whose classrooms are flipped. Because of this responsibility, leaders are more likely to design and carry out in-class activities that showcase their knowledge **(Haider, et al., 2021).**

This hypothesis provides an explanation for learning through internalization. A learner's encounters with more educated individuals provide the social context necessary for the concept or behavior to be internalized. Before incorporating it into their thoughts and internalizing it, learners actively process and modify this experience based on their prior knowledge. This approach to education is consistent with student-centered flipped classrooms. The role of the more knowledgeable others is played by the instructor and leaders who implement flips. Students get valuable social experience working in small groups as a result of the classroom flip **(Kurthakoti, 2019).** Collaborative learning is thus made possible through socialization and interaction with specialists. Debriefing is a great opportunity for students to share their ideas and the reasoning behind their choices throughout the exercise. Actively analyzing the flip through comparison to prior experiences and internalization is facilitated by debriefing **(Wang, & Hayden, 2021).**

1.3 Experiential Learning Theory

The main idea behind experiential learning is that knowledge is created via actively absorbing and making sense of one's own experiences. The theory is structured around four steps: direct experience, introspective observation, theoretical development, and practical application. Two dimensions can be noticed in this four-step process. Comprehension, including the phases of ideation and practical application, is addressed in the first dimension. Change, including the phases of contemplation and experimenting, is addressed in the second dimension. It is via the transformation of prehension information through meaningful experience that learning and knowledge creation take place. In a student-centered flipped classroom, the students in charge of the flip are responsible for developing an understanding of their topic through hands-on experience, building on their prior conceptualization of the concepts that will be covered in the flip. Students contribute to the transformation of knowledge by testing their own and others' grasp of the concepts during the flip's implementation and reflecting on their experiments through debriefing **(Ferreira, 2020).**

Based on a comprehensive case study of the flipped classroom method with undergraduate students, this essay presents the findings. Despite initial resistance, many students eventually grew to appreciate the method's value in enhancing their critical thinking and problem-solving skills, according to the results.

2. Methodology

To increase the level of analysis, performance data and student feedback can be analyzed using elementary Machine Learning (ML) oriented approach. These can be used to spot patterns between performance and learning styles and enable teachers to predict which students will require extra support in the flipped classroom format.

3. Results

According to the methodology, the performance data and student feedback collected were also analyzed for underlying patterns in between learning styles and flipped classroom experiences. Although elementary

descriptive statistics such as means, standard deviations, and correlations were employed, this method of analysis is in synergy with the principles of Machine Learning (ML) that also seek to discern underlying patterns and relationships within datasets. Therefore, below-represented statistical trends provide the bottom-up layer of ML-focused learning analytics and reflect how data-driven information can shape flipped classroom design.

3.1 Student Feedback immediately after each flip

Table 1 (below) reports the findings of a survey that asked about students' views. Asked about the effects of their learning, the students were neutral or faintly negative, but overall were happy about the opportunities for creativity and fun offered by the flipped classroom.

Table 1.1 Immediate feedback from students following each flip

Question	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 clarified concepts	2.52	1.120
Flip enhaced learning experience	2.79	1.050

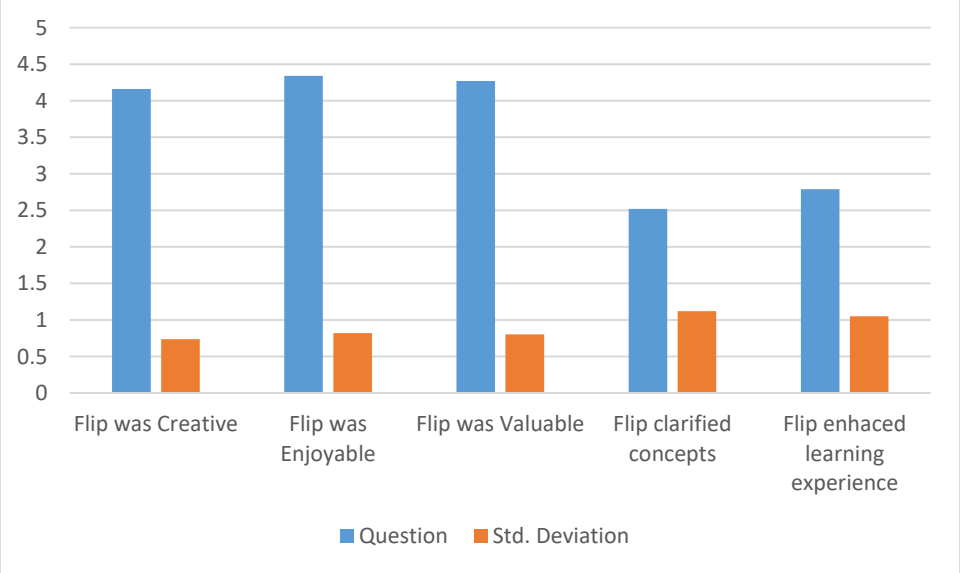

Figure 1.1 Student Feedback immediately after each flip

The flipped classroom approach was rated as innovative by students with a mean value of 4.16 and fun by 4.34 (Table 1). On perceived learning value and clarity of concepts, mean ratings fell to 2.5–2.8, reflecting a more negative or apathetic reaction. These patterns provide data-based insights into early engagement levels that can be used as input features for any future ML-based prediction models.

3.2 Mean feedback on flipped classrooms and different learning styles

Table 2 shows the correlation between learning styles and flipped classroom feedback. Determining such correlations is like the manner in which ML models search for correlations and clusters in student data in order to predict learner performance.

Table 1.2 perceptions of the flipped classroom approach by students

Learning Styles	Mean	Correlation with flipped classroom	% rating 4 or more
LS Example	4.06	Strong positive correlation	81.80
LS Talking through discussion	4.19	Strong positive correlation	87.50
LS through lectures	3.97	Moderate negative correlation	30.30
LS through Reading	2.77	Weak negative correlation	69.70

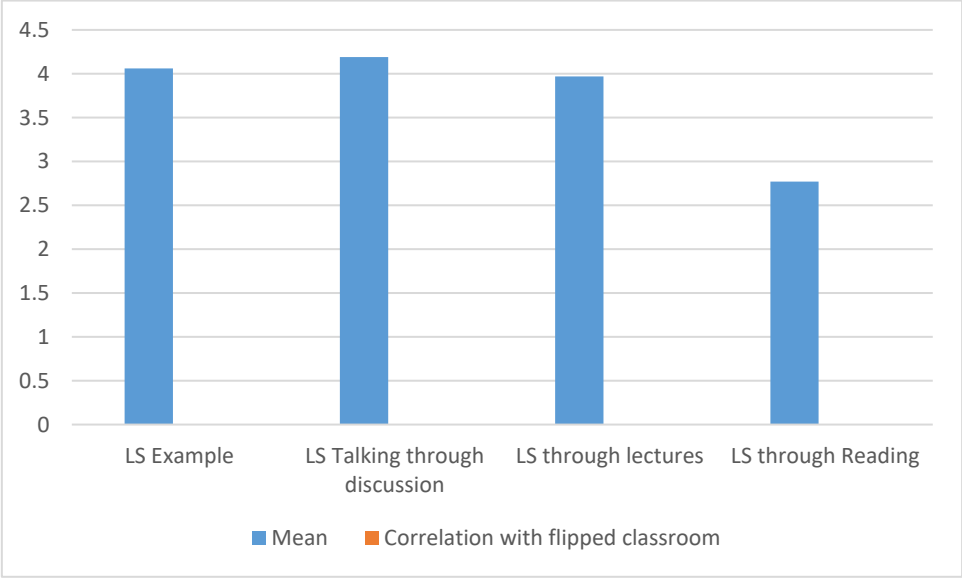

Figure 1.2 students' reactions to the flipped classroom model

In the flipped classroom approach, students' likes of learning via examples (4.06) or discussions (4.19) were strongly correlated with their performance. As there was a moderate negative correlation for learners preferring lectures (3.97), the flipped model could possibly not be the best fit for them. The above correlations highlight how even simple descriptive trends can serve as a starting point for ML-inspired analysis to aid in personalized instructional planning.

4. Discussion

The students initially opposed the flipped classroom approach since they were accustomed to lecture-oriented learning, especially the direct feedback that they obtained from the teachers. Most students were not satisfied with the change in responsibility as it involved them spending more time outside the classroom to accomplish set duties.

However, over the course of the semester, students came to appreciate the model's value, particularly in facilitating active learning through group projects and discussions. Patterns emerged in the analysis of student feedback: students who favored example- and discussion-based learning scored the flipped model more favorably, while students with a lecture-based preference demonstrated lower levels of engagement. Identifying such trends through descriptive statistical analysis also serves to exemplify the central mission of ML methods—to identify data trends that will inform instructional methodologies. The implications of these results are that the learning styles of students play a major role in determining how successful they become at adopting the flipped classroom model, and that ML-oriented analytics has the capability to inform teachers which students are likely to need intervention.

5. Conclusion

As a replacement for conventional teaching techniques, the idea of the flipped classroom is promising in educating students to think and apply their learning. The research indicates that the individual learning styles of students and how well they can conform to a more autonomous learning environment are key in making this method work. By presenting student feedback and learning style statistical analysis within the context of an ML-focused strategy, the research shows how even basic patterns in data can be utilized to inform data-driven decision-making in educational design. Particularly at the beginning of the semester, instructors can assist learners in adapting to the new way of learning through a combination of flipped lectures alongside more conventional lecture techniques while leveraging such data-driven findings to increasingly personalize learning experiences.

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