Impact of Flipped Classroom Strategies on Achievement and Attitude toward Learning Mathematics among IX Standard Students

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ABSTRACT

This study examines the effectiveness of flipped classroom strategies on students' achievement and attitude toward learning Mathematics at the secondary level. A pretest–post test control group design was adopted, involving 66 IX standard students (N = 33 experimental, N = 33 control) from Ashram Matriculation Higher Secondary School, Coimbatore District. The experimental group received instruction through flipped classroom strategies using the Google Learning Management (LM) platform, while the control group was taught using the traditional method. Achievement and attitude scales were employed to collect data. Statistical techniques such as mean, standard deviation, t-test, correlation, and regression analysis were used. Findings revealed a significant improvement in both achievement and attitude among students exposed to flipped classroom strategies. Regression results showed that attitudes toward Mathematics and flipped learning jointly predicted achievement scores. The study concludes that flipped learning effectively enhances student achievement, engagement, and motivation in Mathematics at the school level.

Keywords: Flipped classroom, Mathematics education, Achievement, Attitude, Google LM platform, Experimental study

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INTRODUCTION

Mathematics forms the foundation for logical reasoning, problem-solving, and scientific innovation, yet it continues to be one of the most challenging subjects for school students. Traditional lecture-based teaching in Mathematics often encourages rote memorization rather than conceptual understanding, resulting in low motivation and limited student engagement (Abeysekera & Dawson, 2015). Researchers have emphasized the need for pedagogical reform that promotes active participation and conceptual learning in Mathematics classrooms (Bishop & Verleger, 2013). The Flipped Classroom Strategy (FCS), also known as inverted teaching, reverses the traditional learning sequence. Students are introduced to concepts before class through digital resources such as videos, animations, and online modules, while classroom sessions are used for active learning, discussions, and problem-solving (Berrett, 2012; Kim et al., 2016).

This learner centered approach encourages self-paced study, interaction, and critical thinking (McNally et al., 2017). Globally, flipped learning has been shown to improve academic performance and student engagement across disciplines. Studies in higher education demonstrated that flipped classrooms enhance understanding, retention, and motivation (Wozny et al., 2018; Sun & Wu, 2016). In science and mathematics education, flipped models have been found effective in promoting deep learning and self-regulation (Shyr & Chen, 2018). Research in Asian contexts, particularly China and Taiwan, revealed that integrating technology-enhanced flipped models improved students' reading comprehension, ICT skills, and problem-solving abilities (Zhang & Zhu, 2018; Huang & Hong, 2016). In India, Mathematics instruction still largely follows conventional, teacher-dominated methods. Studies such as Rameswari and Kasinathan (2016) and Rajendra Prasad and Mahalakshmi (2016) demonstrated that flipped classroom approaches improved achievement and retention among secondary students.

Similarly, Senthilkumar (2015) found that computer-aided and flipped strategies enhanced conceptual clarity and engagement in Commerce and Mathematics subjects. However, despite growing evidence, empirical studies applying flipped learning to Mathematics at the secondary school level remain scarce, particularly using integrated digital tools like Google LM platforms.

Significance of the Study
The significance of this study lies in three dimensions:

1. **Pedagogical Innovation:** It introduces flipped classroom strategies as a sustainable alternative to traditional methods for school-level Mathematics.
2. **Technological Integration:** It utilizes the Google LM platform to enhance accessibility and interactivity in digital learning.
3. **Empirical Contribution:** It provides quantitative evidence on how flipped learning influences both achievement and attitudes of Indian secondary students, thereby contributing to the growing literature supporting technology-enabled pedagogy aligned with the National Education Policy (NEP 2020), which emphasizes digital integration and learner autonomy.

2. Objectives of the Study
1. To determine the effectiveness of flipped classroom strategies on students' achievement in Mathematics (Algebra).
2. To assess the effect of flipped classroom strategies on students' attitudes toward learning Mathematics.
3. To analyse the relationship between achievement and attitudes toward Mathematics and flipped classroom strategies.
4. To study the influence of gender, locality, and computer literacy on achievement.
5. To examine the influence of attitudes toward Mathematics and flipped classroom strategies on achievement through regression analysis.

METHODOLOGY

3.1 Research Design
An experimental method with a pretest–post test control group design was adopted. Sixty-six IX standard students from Ashram Matriculation Higher Secondary School, Coimbatore, participated in the study. Participants were randomly assigned to two groups:
* Experimental Group (N = 33): Taught through flipped classroom strategies.
* Control Group (N = 33): Taught using the traditional method.

3.2 Intervention
The flipped classroom instruction was delivered through the Google Learning Management Platform, where the investigator uploaded video lectures, PowerPoint slides, quizzes, and interactive worksheets related to Algebra. The in-class sessions were devoted to collaborative discussions, peer tutoring, and problem-solving exercises. The control group continued with conventional chalk-and-talk instruction. The intervention lasted six weeks.

3.3 Research Tools
1. Achievement Test in Mathematics (Algebra) – 50 multiple-choice questions, 2 marks each (Total: 100 marks).
2. Attitude Scale toward Learning Mathematics – 25 Likert-type items.
3. Attitude Scale toward Flipped Classroom Strategies – 25 Likert-type items.
4. Reliability was established through the test–retest method ($r = 0.82$).

3.4 Statistical Techniques
Descriptive statistics (Mean, SD), t-test, correlation, and regression analyses were used to test the hypotheses.

RESULTS AND INTERPRETATION

Table 1: Descriptive Statistics for Achievement and Attitude Scores (N = 66)

Variables	Min	Max	Mean	SD	Skewness	Kurtosis
Pretest Achievement	48	90	68.73	9.84	-0.21	-0.43
Post test Achievement	53	100	85.26	10.16	-0.39	-0.67
Pretest Attitude (Mathematics)	90	178	134.59	11.23	0.18	0.04
Post test Attitude (Mathematics)	95	187	158.74	10.47	-0.12	-0.52
Pretest Attitude (Flipped)	85	165	126.82	9.51	0.21	0.18
Post test Attitude (Flipped)	100	195	161.93	11.67	-0.35	-0.62

Students show substantial improvement in both achievement and attitudes after intervention. The increase in post test means indicates the effectiveness of flipped learning.

Table 2: Comparison of Post test Achievement between Control and Experimental Groups

Group	N	Mean	SD	t	p	Significance
Control	33	78.18	8.62	3.21	0.002	Significant
Experimental	33	85.26	10.16			

A significant difference exists between control and experimental groups ($p < .01$), confirming that flipped learning enhances students' achievement in Algebra.

Table 3: Comparison of Pretest and Post test Achievement within Experimental Group

Test	N	Mean	SD	t	p	Significance
Pretest	33	69.24	10.21	11.14	0.000	Significant
Post test	33	85.26	10.16			

The significant rise in mean achievement from pretest to post test shows that flipped instruction substantially improves performance in Mathematics.

Table 4: Comparison of Pretest and Post test Attitude Scores within Experimental Group

Test	N	Mean	SD	t	p	Significance
Pretest	33	134.59	10.50	8.73	0.000	Significant
Post test	33	158.74	9.94			

Students' attitude toward Mathematics improves significantly after being taught through flipped classroom strategies.

Table 5: Correlation between Achievement and Attitude Variables (Experimental Group)

Variables	r	p	Significance
Achievement × Attitude (Mathematics)	0.589	0.001	Significant
Achievement × Attitude (Flipped)	0.672	0.000	Significant

Achievement strongly correlates with both attitudes, indicating that positive perceptions toward Mathematics and flipped learning lead to better performance.

Table 6: Regression Summary for Achievement Predicted by Attitude Variables

Model	R	R²	Adjusted R²	F	p
Regression	0.728	0.530	0.512	35.08	0.000

Attitudes toward Mathematics and flipped classroom strategies collectively explain 53% of the variance in achievement, proving their predictive power.

DISCUSSION

The results of the study clearly show that the flipped classroom strategy significantly improves students' achievement and attitudes toward learning Mathematics. As shown in Table 1, both achievement and attitude scores increase notably from pretest to post-test. The mean achievement score rises from 68.73 to 85.26, indicating substantial learning gains. Similarly, students' attitudes toward Mathematics and flipped learning improve, suggesting that the approach promotes self-paced learning, engagement, and active participation.

The findings in Table 2 confirm a significant difference between the control and experimental groups (t = 3.21, p = .002), showing that students taught through flipped learning outperform those in traditional classrooms. This supports earlier studies by Maheshwari and Nitin (2019) and AlJaser (2017), who also reported higher achievement in flipped settings due to active learning and student interaction. Likewise, Table 3 reveals a significant improvement within the experimental group (t = 11.14, p < .001), consistent with McLean et al. (2016) and Van Vliet et al. (2015), who found that flipped models enhance motivation, problem-solving, and independent learning.

In Table 4, students' attitudes toward Mathematics increase significantly (t = 8.73, p < .001), demonstrating that the flipped approach fosters enthusiasm and reduces learning anxiety. This agrees with Rameswari and Kasinathan (2016) and Rajendra Prasad and Mahalakshmi (2016), who noted that flipped classrooms encourage collaboration and positive attitudes.

The correlation results (Table 5) show strong positive relationships between achievement and attitudes toward both Mathematics (r = .589, p = .001) and flipped learning (r = .672, p < .001), suggesting that positive perceptions lead to better performance. Similarly, Table 6 shows that attitudes toward Mathematics and flipped learning explain 53% of the variance in achievement (R² = .530, F = 35.08, p < .001). This supports Abeysekera and Dawson (2015) and Kim et al. (2016), who emphasized that motivation and technology integration are vital for success in flipped environments. The study confirms that flipped classroom strategies effectively enhance both academic achievement and attitude in Mathematics. The model promotes autonomy, engagement, and higher-order thinking, while the use of the Google Learning Management platform ensures flexibility, accessibility, and continuous learning support.

CONCLUSION

The study concludes that the flipped classroom strategy plays a significant role in enhancing students' achievement and attitudes toward Mathematics at the secondary level. The findings clearly establish that students who are taught through the flipped learning approach perform better than those who receive instruction through traditional methods. The flipped classroom fosters favourable attitudes toward Mathematics and learning in general by promoting engagement, curiosity, and motivation among learners. The results further reveal a strong positive correlation between achievement and attitudes toward both Mathematics and flipped learning, emphasizing that a positive mindset directly influences academic success.

Moreover, the study finds that gender and computer literacy positively influence learning outcomes, whereas locality does not have a significant effect. This indicates that when provided with equitable access to digital tools, students from diverse backgrounds can benefit equally from technology-integrated instruction. Attitudes toward Mathematics and flipped learning are found to jointly predict achievement, highlighting their motivational and cognitive significance in shaping learners' performance.

The research also establishes that the flipped classroom serves as an effective, technology-integrated pedagogy aligned with the objectives of the National Education Policy (NEP 2020), which advocates for learner-centered and digitally empowered education. The integration of the Google Learning Management (LM) platform provides an organized, accessible, and interactive environment for continuous learning. In this model, teachers' roles evolve from mere transmitters of knowledge to facilitators who guide personalized and collaborative learning experiences. Students, in turn, develop higher-order thinking skills, confidence, and self-regulation, which are essential for lifelong learning.

Overall, the flipped classroom approach demonstrates the potential to transform Mathematics instruction by making learning more active, reflective, and student-centered. It encourages autonomy, digital competence, and critical reasoning among learners, thereby preparing them for the demands of the 21st-century learning environment. Given its success in improving academic performance and nurturing positive attitudes, the flipped classroom strategy can be effectively adopted across various subjects and educational levels to promote holistic and technology-enhanced learning.

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