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Effect of a Modified Flipped Classroom on Learning Outcomes and Phase II MBBS Students Engagement in Pathology: A Comparative Study

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ABSTRACT

Background: A flipped classroom shifts basic content learning outside of class and reserves in-class time for interactive activities. This study evaluated a modified flipped model for teaching pathology to second-year MBBS students.
Objectives: To assess the knowledge scores following modified flipped classroom teaching, compare learning outcomes with didactic lecture-based teaching, and assess students' perceptions of the modified flipped classroom.
Methods: A comparative educational intervention was conducted among 150 Phase II MBBS students at the Department of Pathology, Ballari Medical College and Research Centre, Ballari, Karnataka. Students were assigned to a didactic lecture group (Group A) and a modified flipped classroom group incorporating classroom teaching and small-group discussion (Group B). Ten-item questionnaire were administered for pre-tests and post-tests. Student perceptions were collected using a structured questionnaire. Pre- and post-test scores were compared using paired statistical analysis, with $p<0.05$ considered statistically significant.
Results: Both groups showcased significant improvement in post-test knowledge scores. The mean score increased from 5.1 to 6.0 in the didactic lecture group (mean improvement 0.9; $p=0.01$), while the modified flipped classroom group improved from 6.6 to 9.2 (mean improvement 2.6; $p=0.001$). Students reported favourable perceptions of the modified flipped classroom: 79.3% felt it helped cover all areas of the topic, 84.7% felt it helped them present the topic, 80.6% reported improved active participation and communication, and 87.3% found it enjoyable.
Conclusion: Compared with traditional didactic lectures, the modified flipped classroom yielded greater immediate knowledge gains and highly favorable student perceptions. However, significant baseline differences between the groups preclude attributing this academic advantage entirely to the intervention. Consequently, further rigorous, well-controlled studies with baseline equivalence and longitudinal tracking are warranted.

Keywords: modified flipped classroom, medical education, didactic lecture

INTRODUCTION

Medical education is undergoing a progressive transition from predominantly teacher-centred instruction toward learner-centred and competency-oriented approaches. Traditional didactic lectures remain useful for delivering structured information to large groups of students; however, prolonged lecture-based teaching may not provide opportunities for active participation, discussion, application of knowledge and higher-order cognitive processing.

The flipped classroom is a hybrid teaching-learning strategy in which acquisition of basic learning material is shifted to the pre-class time, while classroom time is utilized for interactive learning, discussion, problem-solving, application and clarification of concepts. The approach is grounded in active learning and provides an opportunity for the teacher to function more as a mentor than solely as didactic lecturer. **[1-4]**

The concept has gained importance in health professional education because it can provide greater opportunities for student engagement while retaining the knowledge. Flipped classroom research have reported generally positive effects on student achievement, motivation, engagement and interaction, although substantial variation exists in intervention design, learner characteristics and outcome measures. **[2-4]**

Evidence from medical education has also suggested an academic advantage for flipped learning compared with conventional lecture-based teaching. A meta-analysis by Hew and Lo found an overall positive effect of flipped classroom teaching on student learning, while Chen et al. reported better examination scores and course grades in flipped learning compared with lecture-based learning, although the authors highlighted substantial methodological diversity and risk of bias. **[5,6]**

More recent evidence continues to support the potential usefulness of flipped learning. A systematic review of undergraduate medical education involving 45 studies and 8,426 students reported better academic performance and student satisfaction with flipped learning, although the certainty of evidence was low because of methodological limitations and heterogeneity. **[7]** A 2025 systematic review and meta-analysis specifically examining medical education also reported advantages of flipped classrooms in knowledge achievement and student satisfaction. **[8]** A recent 2026 meta-analysis similarly concluded that flipped learning may improve theoretical knowledge, procedural skills, self-directed learning, case analysis and learner satisfaction, while emphasizing that effectiveness is context dependent. **[9]**

Evidence from India, however, has been less uniform. Malhotra and Bhagat reported no statistically significant difference in examination performance between flipped and traditional teaching among first-year medical students, although approximately 80% of students preferred the flipped approach. **[10]** Other Indian studies have demonstrated significant improvements in academic performance, engagement and higher-order learning following flipped classroom interventions. **[11-13]**

Pathology is a conceptually intensive subject in the undergraduate medical curriculum and requires students to integrate basic pathological mechanisms with morphology, clinical manifestations and laboratory findings. Consequently, active and interactive teaching strategies may be particularly useful for promoting understanding rather than simple memorization.

The present educational intervention was developed as a modified flipped classroom strategy for Phase II MBBS students in pathology. The intervention incorporated the flipped classroom approach with classroom teaching and small-group discussion. The study evaluated changes in knowledge scores and students' perceptions of the modified flipped classroom compared with didactic lecture-based teaching.

MATERIALS & METHODS

Aim

To evaluate the effectiveness of a modified flipped classroom as a teaching-learning strategy among Phase II MBBS students in pathology and compare its educational outcomes with the traditional didactic lecture method.

Objectives

1. To assess the change in pre-test and post-test knowledge scores following modified flipped classroom teaching.
2. To compare the academic performance of students exposed to modified flipped classroom teaching with that of students exposed to didactic lecture-based teaching.
3. To assess students' regarding the modified flipped classroom with respect to topic coverage, presentation, active participation, communication, enjoyment and overall learning experience.

Study design and setting

This was a comparative intervention conducted among Phase II MBBS students attending pathology classes at the Department of Pathology, Ballari Medical College and Research Centre (formerly VIMS), Ballari, Karnataka, India.

Study participants and sample size

A total of 150 Phase II MBBS students were included in the project. Students attending the scheduled pathology teaching sessions during the study period were eligible.

Teaching interventions

After obtaining the ethical committee clearance ((letter no- 31/2023, dated 7th November 2023),

Students were divided into two groups, Group A was designated for traditional didactic lectures, Group B for a modified flipped classroom consisting of lecture and small-group discussion.

Assessment of learning

Each teaching-learning session was planned to include a 10-item multiple-choice question pre-test and a 10-item multiple-choice question post-test. Feedback also collected from students and faculty as well using google form.

Assessment of student perception

Student perception was assessed using structured response categories comparing the flipped classroom with didactic lecture. The available questionnaire included items assessing whether the flipped classroom:

1. Helped students cover all areas of the topic.
2. Helped students present the topic.
3. Helped students actively participate and communicate.
4. Was enjoyable and fun.

Responses were categorized as strongly agree (SA), agree (A), disagree (D), strongly disagree (SD)

Statistical Analysis

Data were analyzed using IBM SPSS version 26. Continuous variables will be summarized using mean and standard deviation. Categorical variables were expressed as frequencies and percentages.

- Paired comparison of pre-test and post-test scores within each group: paired t-test
- Effect sizes with 95% confidence intervals where possible.
- Statistical significance set at $p < 0.05$.

RESULT

Academic performance

The available results demonstrated improvement in post-test scores in both groups. Group A, which was treated as the didactic lecture group, increased from a mean pre-test score of 5.1 to a post-test score of 6.0, representing a mean increase of 0.9 marks (p=0.01).

Group B, treated as the modified flipped classroom group, increased from a mean pre-test score of 6.6 to a post-test score of

9.2, representing a mean increase of 2.6 marks (p=0.001).

The reported between-group comparison was statistically significant for both pre-test scores (p=0.01) and post-test scores (p=0.001). Thus, the flipped classroom group had higher scores both before and after the intervention.

Table 1. Comparison of pre-test and post-test knowledge scores

Teaching method	Pre-test mean	Post-test mean	Mean improvement	Within-group p-value
Group A – Didactic lecture	5.1	6.0	0.9	0.01
Group B – Modified flipped classroom	6.6	9.2	2.6	0.001

Between-group comparison: Pre-test p=0.01; Post-test p=0.001.

The absolute improvement in the modified flipped classroom group was approximately 2.9 times that observed in the didactic lecture group (2.6 versus 0.9 marks). However, interpretation of this difference requires caution because the groups were already significantly different at baseline.

Student perception

Students reported predominantly favourable perceptions of the modified flipped classroom. For the item regarding coverage of all areas of the topic, 119 of 150 responses (79.3%) were either strongly agree or agree.

For presentation of the topic, 127 of 150 respondents (84.7%) selected strongly agree or agree.

For active participation and communication, 116 of 144 respondents (80.6%) selected strongly agree or agree. Six responses were not represented in the supplied distribution for this particular item.

For enjoyment and fun, 131 of 150 respondents (87.3%) selected strongly agree or agree.

Table 2. Student perception of modified flipped classroom compared with didactic lecture

Perception item	SA n (%)	A n (%)	D n (%)	SD n (%)	U n (%)	Positive responses SA+A
FCR helped me to cover all areas of the topic	39 (26.0)	80 (53.3)	7 (4.7)	6 (4.0)	18 (12.0)	119/150 (79.3%)
FCR helped me to present the topic	52 (34.7)	75 (50.0)	4 (2.7)	4 (2.7)	15 (10.0)	127/150 (84.7%)
FCR helped me to actively participate and communicate	46 (31.9)	70 (48.6)	6 (4.2)	2 (1.4)	20 (13.9)	116/144 (80.6%)
FCR was enjoyable and fun	57 (38.0)	74 (49.3)	5 (3.3)	4 (2.7)	10 (6.7)	131/150 (87.3%)

FCR: flipped classroom; SA: strongly agree; A: agree; D: disagree; SD: strongly disagree; U: category labelled "Unknown".

The overall perception data indicate that the strongest positive response was for the statement that the modified flipped classroom was enjoyable and fun (87.3%), followed by its usefulness in presenting the topic (84.7%), promoting active participation and communication (80.6%), and helping students cover all areas of the topic (79.3%).

DISCUSSION

The present educational study demonstrates a favourable association between modified flipped classroom teaching and immediate academic performance among Phase II MBBS students. Both teaching methods produced statistically significant improvement between pre-test and post-test scores, but the numerical improvement was greater in the modified flipped classroom group.

The mean score in the didactic group increased from 5.1 to 6.0, whereas the modified flipped classroom group increased from 6.6 to 9.2. The larger improvement observed with the flipped approach is

consistent with the conceptual basis of flipped learning, where students are expected to engage with learning material before or around the classroom session and classroom time is subsequently used for active processing and application.

A major strength of flipped learning is the redistribution of classroom time from passive information reception toward interaction and active learning. Persky and McLaughlin emphasized the importance of appropriate pre-class preparation, meaningful in-class activities, metacognition, critical thinking and appropriate assessment when implementing flipped learning in health-professions education. **[4]**

The findings of the present study are broadly consistent with the meta-analysis by Hew and Lo, which reported improved learning outcomes with flipped classroom approaches in health-professions education. **[5]** Similarly, Chen et al. found that flipped classroom learning was associated with better examination scores and course grades than lecture-based learning, although they highlighted substantial heterogeneity and methodological limitations across studies. **[6]**

The systematic review by Naing et al. involving 45 studies and 8,426 undergraduate health-professions students reported an overall standardized mean difference of 0.57 favouring flipped learning for academic performance and 0.48 for student satisfaction. However, the certainty of evidence was considered low because of methodological limitations and heterogeneity. **[7]**

More recent evidence further supports the educational potential of the approach. The 2025 systematic review and meta-analysis by Spaic et al. reported improved knowledge achievement and student satisfaction with flipped classroom approaches in medical education. **[8]** A 2026 systematic review and meta-analysis by Wu and Cheng, based on 18 eligible studies, similarly reported advantages across theoretical knowledge, procedural/technical skills, self-directed learning, case analysis/problem-solving and learner satisfaction, while emphasizing that implementation effects are context dependent. **[9]**

Table 3. Interpretation of the present findings in relation to selected literature

Evidence	Principal finding	Relevance to present study
McLaughlin et al., 2014 **[14]**	Flipped course redesign promoted learning and engagement in health-professions education	Supports the use of active classroom time
Hew & Lo, 2018 **[5]**	Meta-analysis demonstrated improved learning with flipped classroom approaches	Consistent with greater score improvement in Group B
Chen et al., 2018 **[6]**	Flipped learning was associated with better examination outcomes, although methodological heterogeneity was substantial	Supports academic benefit but emphasizes cautious interpretation
Malhotra & Bhagat, 2023 **[10]**	No significant difference in marks, but approximately 80% preferred flipped teaching	Demonstrates that learner perception and academic performance may not always move together
Naing et al., 2023 **[7]**	Academic performance and satisfaction favoured flipped learning, but certainty of evidence was low	Supports the direction of the present findings while highlighting evidence limitations
Mohapatra et al., 2025 **[11]**	Flipped groups demonstrated greater post-test improvement and better knowledge retention	Closely parallels the present improvement in post-test performance
Spaic et al., 2025 **[8]**	Systematic review/meta-analysis supported improved knowledge and satisfaction	Provides recent medical-education evidence supporting the intervention
Najan et al., 2026 **[12]**	Flipped teaching produced greater knowledge gain and positive perceptions among Indian MBBS students	Strongly comparable Indian undergraduate evidence
Thirumurugan et al., 2026 **[13]**	Flipped classroom improved engagement, interest, comprehension and logical reasoning	Supports the present perception findings
Wu & Cheng, 2026 **[9]**	Meta-analysis found benefits across several educational outcomes, with context-dependent effects	Supports cautious, context-specific implementation

The perception findings of the present study were particularly encouraging. More than four-fifths of respondents reported positive responses regarding topic presentation and active participation, while 87.3% considered the flipped classroom enjoyable and fun. This supports the view that learner engagement is an important potential benefit of flipped classroom methodology.

The finding that 80.6% of respondents perceived improved active participation and communication is educationally important. The classroom component of a flipped model provides opportunities for students to articulate their understanding, clarify doubts, discuss concepts with peers and receive immediate feedback. These features are consistent with the broader goals of learner-centred medical education.

The results also compare favourably with the recent Indian study by Najan et al., in which flipped classroom teaching resulted in a greater mean knowledge gain than traditional teaching, with positive perceptions regarding engagement, conceptual clarity and self-paced learning. **[12]** Similarly, the 2026 pharmacology study by Thirumurugan et al. reported significantly greater engagement, interest, comprehension and logical reasoning with flipped classroom teaching. **[13]**

However, the present study has an important methodological consideration: the groups were significantly different at baseline. Group B had a mean pre-test score of 6.6 compared with 5.1 in Group A, with a reported p-value of 0.01. Consequently, the higher post-test score and larger improvement in Group B cannot be attributed solely to the teaching intervention with certainty. The baseline imbalance may indicate differences in prior knowledge, group composition or other uncontrolled factors.

This issue is particularly important when interpreting educational intervention studies. Bishop and Verleger previously noted that much early flipped-classroom research relied on single-group designs and subjective perceptions, emphasizing the need for controlled studies using objective learning outcomes. **[2]** The present study contributes objective pre-test and post-test data, but stronger methodology would include randomization, equivalent baseline characteristics, standardized assessment instruments and reporting of variance measures.

Another consideration is that the available results do not provide standard deviations, confidence intervals, exact test statistics or individual-level data. Consequently, it was not appropriate to calculate a post hoc standardized effect size. Future analyses should report mean ± standard deviation, mean difference, 95% confidence intervals and an appropriate standardized effect size.

The original project protocol also proposed evaluation using a broader Kirkpatrick framework, including reaction, learning, behaviour and longer-term results such as examination performance and clinical confidence. However, the available results primarily document immediate knowledge scores and student perceptions. Therefore, claims regarding long-term retention, examination performance or clinical competence should not be made from the present dataset.

Strengths

The study has several practical strengths. First, it was conducted in the real undergraduate teaching environment rather than in an artificial experimental setting. Second, it used objective pre-test and post-test assessments in addition to student perception data. Third, the sample included a complete MBBS class of substantial size. Finally, the intervention was designed to be incorporated into routine pathology teaching without requiring extensive additional infrastructure.

Limitations

The study was conducted at a single medical institution and within one undergraduate subject, which limits generalizability. The method of allocation of students to groups was not documented in the available data.

Baseline knowledge differed significantly between the groups. The intervention description available in the results does not provide sufficient detail regarding the exact pre-class learning materials or duration of student preparation.

The available dataset does not contain standard deviations, confidence intervals or individual-level observations, limiting the depth of statistical analysis. The assessment focused on immediate learning rather than long-term retention or clinical performance. Student perception data may also be affected by response and social-desirability bias.

Importantly, the original project protocol described three groups, whereas the supplied results contain only two groups. The third group's outcome data are therefore not available for analysis. This discrepancy should be resolved and transparently documented before submission to a journal.

Implications for medical education

The findings suggest that a modified flipped classroom may be a feasible strategy for pathology teaching in Phase II MBBS. Rather than completely replacing lectures, a blended approach can retain concise faculty explanation while using classroom time for active participation and discussion.

The approach may be particularly useful for pathology topics requiring integration of morphology, mechanisms and clinical application. Future implementations should standardize pre-class resources, use clearly defined learning objectives, include short pre-class quizzes and reserve classroom time for application, discussion and problem-solving.

CONCLUSION

The modified flipped classroom was associated with greater improvement in immediate knowledge scores than didactic lecture teaching in the available Phase II MBBS pathology results. Students also reported favourable perceptions, particularly regarding enjoyment, presentation of the topic, active participation and communication.

The findings support the feasibility of incorporating modified flipped classroom strategies into undergraduate pathology teaching. However, the significant baseline difference between groups and limitations in the available statistical dataset require cautious interpretation. The intervention should therefore be considered a promising learner-centred strategy rather than conclusively superior to traditional teaching on the basis of the present data alone.

Future studies should use randomized or well-controlled comparative designs, standardized teaching materials, equivalent baseline groups, validated assessment tools, effect-size reporting and longitudinal assessment of knowledge retention and clinical application.

Declaration

Ethical Approval: Approved (letter no-31/2023, dated 7th November 2023)

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Conflict of Interest: The authors declare no conflict of interest.

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