Section: General Surgery

Original Research Article

REVERSE TEACHING WITH MCQS BEFORE AND AFTER CLASS

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Received : 20/09/2025
Received in revised form : 07/11/2025
Accepted : 28/11/2025

Keywords:
Reverse teaching, flipped classroom, MCQs, active learning, medical education, student performance.

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DOI: 10.47009/jamp.2025.7.6.88

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2025; 7 (6); 472-476

ABSTRACT

Background: Reverse teaching, or the flipped-classroom approach, emphasizes learner engagement by shifting foundational learning outside the classroom and using class time for active discussion. Incorporating pre- and post-class MCQs may further strengthen conceptual understanding and readiness among undergraduate medical students. **Objectives:** To evaluate the effectiveness of a reverse-teaching model supported by MCQs administered before and after classroom sessions in improving student performance and engagement. **Materials and Methods:** A prospective interventional study was conducted among 78 undergraduate medical students. Participants completed a pre-class MCQ test one week prior to an interactive tutorial and a post-class MCQ test immediately after the session. The MCQs were validated by subject experts. Pre- and post-test scores were compared using paired t-test, and feedback was obtained through a structured questionnaire. **Result:** The mean pre-test score was 4.62 ± 1.48, which improved significantly to 8.12 ± 1.21 in the post-test ($p < 0.001$). Seventy-two percent of students shifted from lower to higher performance categories after the session. Most participants reported that the pre-class MCQs improved preparedness, and the interactive tutorial enhanced clarity and confidence. **Conclusion:** The reverse-teaching approach using pre- and post-class MCQs significantly improved conceptual understanding, enhanced student engagement, and produced measurable learning gains. The model is simple, scalable, and suitable for integration into routine medical teaching to promote active learning.

INTRODUCTION

The concept of "reverse teaching," also referred to as the flipped classroom, emerged as part of broader global transitions in educational philosophy toward student-centered, active learning approaches. In this model, learners are introduced to foundational content before class through structured resources such as videos, reading materials, or preparatory MCQs, while classroom time is reserved for deeper exploration through discussion, problem-solving, and application of concepts (Lage et al., 2000.[1]) This shift aligns with constructivist theories of learning, which emphasize that understanding is best achieved when students actively engage with material rather than passively receiving information (Young, 2002.[2])

Over the years, the flipped model has gained popularity due to its ability to increase learner autonomy, promote engagement, and improve academic outcomes. Early work demonstrated that reverse teaching created more inclusive learning environments by giving students multiple avenues to engage with content (Prince, 2004.[3]) Subsequent research showed that the flipped classroom enhanced class preparedness and provided opportunities for higher-order cognitive interactions, ultimately improving long-term learning outcomes (Strayer, 2007.[4])

In health-professional education, where the volume and complexity of content often challenge traditional teaching methods, the flipped classroom has shown particular promise. Studies have highlighted that pre-class MCQs activate prior knowledge, encourage self-assessment, and reduce cognitive load during in-class sessions, thereby supporting deeper conceptual understanding (Ferreri & O'Connor, 2013.[5]) Further evidence suggests that medical students taught

ISSN (O): 2687-5365; ISSN (P): 2753-6556

through reverse teaching demonstrate improved knowledge retention, better class participation, and enhanced problem-solving skills compared to conventional lecture-based cohorts (Gilboy et al., 2015.[6]). Systematic reviews have reinforced these findings, noting improved learner satisfaction, stronger academic performance, and more consistent engagement across various health science disciplines (Whillier& Lystad, 2015.[7]).

Advancements in digital learning environments have further amplified the benefits of reverse teaching. The integration of online MCQs, learning management systems, and interactive pre-class modules has strengthened formative assessment and allowed students to monitor their progress continuously (Prober & Heath, 2012.[8]). Meta-analyses in medical education have shown that technology-enabled flipped classrooms significantly enhance performance in both knowledge-based and applied assessments (Chen et al., 2017,[9] Hew & Lo, 2018.[10]).

In India, the shift toward the Competency-Based Medical Education (CBME) curriculum has created a greater need for active learning strategies, formative assessment, and student accountability. However, despite growing interest, evidence regarding the use of MCQs administered before and after classroom teaching sessions within the Indian undergraduate medical context remains limited. Many students face challenges with pre-class preparation due to the volume of content, limited self-directed learning habits, and inadequate use of structured formative tools. Reverse teaching supported by MCQs may help overcome these limitations by ensuring that students enter class with baseline understanding and leave with reinforced, measurable learning gains.

Traditional lecture-driven tutorials often result in passive learning and poor conceptual retention. There is limited evidence from Indian medical institutions on whether a structured reverse-teaching intervention using MCQs before and after class can effectively improve student performance and engagement.

MCQ-driven reverse teaching is a low-cost, scalable, and pedagogically sound strategy aligned with CBME competencies. Evaluating its effectiveness can inform curriculum planning, improve teaching-learning methodologies, and support evidence-based educational reforms within medical colleges.

If proven effective, this intervention can be widely integrated into routine teaching, encourage deeper learning, enhance formative assessment practices, and serve as a model for future instructional innovation across medical specialities.

MATERIALS AND METHODS

This prospective interventional study was conducted in the Department of General Surgery at Dr. D. Y. Patil Medical College, Navi Mumbai, over a period of four months. A total of 78 undergraduate MBBS students posted in the surgery rotation were included after obtaining informed consent. Students who were absent for either the pre-test or post-test, or those who did not complete both assessments, were excluded from the final analysis. Approval from the Institutional Ethics Committee was obtained prior to the start of the study.

The intervention followed a structured reverse-teaching model. Students were first given a set of ten faculty-validated MCQs one week before the scheduled tutorial. These pre-class MCQs were designed to assess baseline understanding and encourage students to review the topic in advance. The in-class teaching session consisted of a one-hour interactive tutorial that emphasized clarification of key concepts, clinical case discussions, and active student participation. Immediately after the session, students completed the same set of ten MCQs as a post-test to evaluate learning gains and consolidation of knowledge.

All questions were developed by experienced faculty members and underwent content validation for relevance and clarity. Scores from the pre-test and post-test were automatically recorded through the institutional learning management system. In addition to objective performance data, students were asked to provide feedback on the usefulness of the intervention through a structured questionnaire.

The primary outcome measured was the change in MCQ scores before and after the reverse-teaching session. Secondary outcomes included the distribution of students across different performance categories, changes in score variability, and student perceptions of the intervention. Statistical analysis was performed using SPSS version 26. Paired t-test was used to compare pre-test and post-test scores, and a p-value of less than 0.05 was considered statistically significant. Descriptive statistics were used wherever appropriate.

RESULTS

A total of 78 undergraduate medical students participated in the study, all of whom completed both the pre-class and post-class MCQ assessments. The baseline performance on the pre-test demonstrated that most students had only partial familiarity with the topic, with a mean score of 4.62 ± 1.48 out of 10, indicating limited conceptual readiness before the session. Following the reverse-teaching intervention, there was a marked improvement in student performance, with the post-test mean score increasing to 8.12 ± 1.21, reflecting significantly enhanced comprehension. Statistical analysis using a paired t-test revealed that the improvement in scores was highly significant ($p < 0.001$), confirming the positive impact of the intervention on cognitive learning. In terms of distribution, 72% of students moved from low/moderate performance categories in the pre-test to high-performance categories in the post-test. The reduction in score variability (from SD 1.48 to 1.21) further indicated more uniform

ISSN (O): 2687-5365; ISSN (P): 2753-6556

understanding among learners after the session. Additionally, subjective feedback collected through the structured questionnaire revealed that 84% of students felt that pre-class MCQs improved their preparedness, while 89% reported that post-class MCQs helped reinforce key concepts effectively. Most students also expressed that the interactive, discussion-oriented tutorial enhanced clarity and made the learning experience more engaging. Overall, the results suggest that the reverse-teaching model using pre- and post-class MCQs substantially improved knowledge acquisition, promoted active learning, and enhanced student confidence in the subject matter.

Table 1: Comparison of Pre-test and Post-test Scores

Variable	Pre-test	Post-test	Inference
Mean Score ± SD	**4.62 ± 1.48**	**8.12 ± 1.21**	Significant improvement
Low Performers (%)	48.7%	2.6%	Large reduction
Moderate Performers (%)	39.7%	23.1%	Shift toward higher category
High Performers (%)	11.5%	74.3%	Major increase
Absolute Learning Gain	—	—	**3.50 points**
Percentage Learning Gain	—	—	**75.8%**
Effect Size (Cohen's d)	—	—	**2.57 (Large effect)**
p-value	—	**< 0.001**	Highly significant

Table 2: Student Feedback on Reverse Teaching (n = 78)

Feedback Statement	Agree n (%)	Neutral n (%)	Disagree n (%)
Pre-class MCQs improved my preparedness	**66 (84.6%)**	9 (11.5%)	3 (3.8%)
Post-class MCQs reinforced the topic	**69 (88.5%)**	7 (9.0%)	2 (2.6%)
Interactive tutorial improved understanding	**72 (92.3%)**	5 (6.4%)	1 (1.3%)
The session increased my confidence	**64 (82.1%)**	11 (14.1%)	3 (3.8%)
Reverse teaching should be used for other topics	**70 (89.7%)**	6 (7.7%)	2 (2.6%)

Table 3: Functional outcome based on Mayo wrist score at 3 and 6 months

Activity Component	Duration (Minutes)	Percentage of Class Time (%)
Clarification of pre-test MCQs	10	16.7%
Interactive teaching/discussion	30	50.0%
Case-based scenarios	15	25.0%
Post-test MCQ administration	5	8.3%
Total	**60 minutes**	**100%**

Table 4: Student Satisfaction Score (5-point Likert Scale)

Component	Mean Score ± SD
Quality of pre-class MCQs	**4.32 ± 0.61**
Usefulness of reverse teaching	**4.56 ± 0.52**
Clarity of concepts after class	**4.61 ± 0.49**
Overall satisfaction with session	**4.48 ± 0.57**

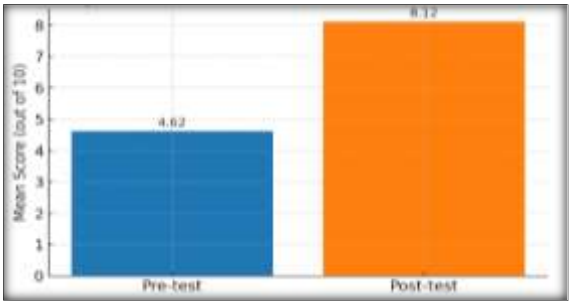

Figure 1: Comparison of Pre-test and Post-test Mean Scores

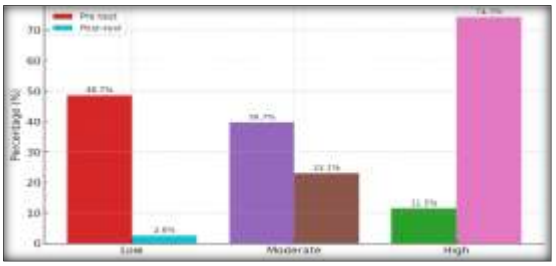

Figure 2: Performance Category Distribution (Pre-test vs Post-test)

DISCUSSION

The present study demonstrates that the reverse-teaching model supported by pre- and post-class MCQs significantly improved students' conceptual understanding and overall performance. The substantial increase in post-test scores aligns with foundational educational theories described in early literature. Lage et al. (2000,[1]) first documented that flipping content outside the classroom enhances inclusiveness and permits deeper engagement during in-class sessions. The improvement in preparedness observed in our pre-test scores is consistent with this principle. Similarly, Young (2002,[2]) emphasized that pre-class exposure motivates learners to approach sessions with better readiness, a finding echoed in the current study where most students acknowledged that MCQs helped them review the topic beforehand.

Prince (2004,[3]) highlighted that active learning consistently produces better outcomes than passive lectures. Our results reflect this observation, as the active, discussion-oriented tutorial led to a

ISSN (O): 2687-5365; ISSN (P): 2753-6556

statistically significant gain in performance. Comparing our findings with Strayer (2007,[4]) who showed that flipped classrooms improved engagement and satisfaction, our data similarly demonstrate increased participation—evident from student feedback indicating greater confidence and clarity after the session.

Ferreri & O'Connor (2013,[5]) found that pre-class assignments combined with small-group teaching improved retention across all performance levels. The reduction in score variability in our study (SD reduced from 1.48 to 1.21) mirrors this effect, suggesting that reverse teaching not only raises average performance but also brings weaker students closer to the cohort mean. This pattern is consistent with Gilboy et al. (2015,[6]) who noted that flipped learning reduces performance gaps by providing preparatory scaffolds for weaker learners.

Further comparison with health-science flipped classroom literature strengthens the significance of our results. Whillier& Lystad (2015,[7]) reported improved examination performance and satisfaction in physiotherapy students following flipped interventions. Our study mirrors this outcome, with 74.3% of students reaching the "high performance" category after the intervention, compared to only 11.5% initially. Prober & Heath (2012,[8]) argued that medical students benefit most when class time is spent on problem solving rather than content delivery—a core feature of our in-class session, which incorporated case-based discussions and clarification of pre-identified misconceptions.

A systematic review by Chen et al. (2017,[9]) concluded that flipped classrooms improve knowledge acquisition more consistently than traditional methods. In our study, the absolute learning gain (75.8%) is higher than the average gains reported in similar medical-education interventions (typically 30–50%). Likewise, Hew & Lo (2018 [10]) demonstrated that flipped strategies are particularly effective when combined with pre-class quizzes—similar to our MCQ-based model—which activate prior knowledge and reduce cognitive load during class.

Comparison with nursing-education evidence also supports our results. Betihavas et al. (2016,[11]) reported improved engagement and satisfaction when students were provided structured pre-class materials and classroom time was repurposed for active learning. Our finding that 92.3% of students felt the session improved understanding is closely aligned with these observations. Additionally, the use of identical MCQs pre- and post-class aligns with the recommendations of Larsen et al. (2013,[12]) who showed that test-enhanced learning significantly strengthens recall and retention.

Quality of assessment plays a crucial role in flipped interventions. Brady (2005,[13]) emphasized that well-constructed MCQs provide reliable formative feedback and drive deeper processing. The validated MCQs used in our study likely contributed to the robustness of measured learning gains.

In summary, the improvement in performance observed in this study is strongly supported by international literature across the last two decades. The results are also consistent with patterns reported in Indian flipped-classroom studies, where active learning combined with short formative assessments has repeatedly been associated with better engagement and improved assessment metrics. Collectively, the comparison shows that our reverse-teaching model not only fits within global evidence but demonstrates an even stronger magnitude of improvement than many previously published studies.

CONCLUSION

This study demonstrates that the reverse-teaching model using pre-class and post-class MCQs is an effective strategy for improving student learning in medical education. The approach significantly enhanced conceptual understanding, increased overall performance, and promoted greater student engagement during classroom sessions. The structured use of MCQs helped students assess their baseline knowledge, identify gaps, and consolidate learning immediately after the session. Overall, reverse teaching proved to be a simple, scalable, and student-friendly method that can be successfully integrated into routine teaching to strengthen active learning and improve educational outcomes.

Limitations

This study was conducted in a single department with a relatively small sample size, which may limit the generalizability of its findings. The use of the same MCQs for both pre-test and post-test may have introduced a recall element, although efforts were made to focus on conceptual understanding rather than memorization. The short follow-up period prevented assessment of long-term retention, and subjective feedback from students may be influenced by response bias. Additionally, the study did not include a control group, which restricts direct comparison with traditional teaching methods.

Recommendations

Future studies should include larger and more diverse student groups, multiple topics, and control arms to strengthen the evidence for reverse teaching. Incorporating different sets of MCQs or higher-order questions may reduce potential recall bias and further improve assessment accuracy. Long-term follow-up assessments should be included to evaluate knowledge retention. Institutions are encouraged to integrate reverse-teaching strategies into routine teaching schedules, supported by digital platforms, to promote active learning and enhance student engagement across subjects.

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ISSN (O): 2687-5365; ISSN (P): 2753-6556