

A Comparative Study of Flipped Classroom (FC) Teaching versus Traditional Didactic Classroom (TDC) Teaching among Undergraduate Medical Students: A Two-period Crossover Quasi-experimental Study

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Abstract

Background: Flipped classroom (FC) teaching promotes pre-class learning and uses classroom time for interaction and application, whereas traditional didactic classroom (TDC) teaching relies primarily on lectures.

Aim: To compare the effectiveness of FC and TDC teaching in improving knowledge among second-year MBBS students and assess student and faculty perceptions of FC.

Methods: This interventional medical education study used a two-period crossover design involving 100 second-year MBBS students at ESIC Medical College and Hospital, Bihta, Patna, Bihar, India, from March to June 2025. Students received FC and TDC teaching on antepartum haemorrhage and postpartum haemorrhage. Knowledge was assessed using 20-item multiple-choice question pre-tests and post-tests. Student and faculty perceptions were assessed using 5-point Likert-scale questionnaires.

Results: Knowledge scores improved significantly after both teaching approaches ($p < 0.001$). In the first assessment, mean scores increased from 10.78 ± 1.70 to 13.48 ± 1.35 with FC and from 10.10 ± 1.60 to 11.76 ± 1.45 with TDC. In the second assessment, scores increased from 10.82 ± 1.56 to 14.52 ± 1.26 with FC and from 10.38 ± 1.44 to 12.16 ± 1.18 with TDC. Student feedback favoured interactive methods and learning resources, while faculty identified additional time, resource and training requirements.

Conclusion: Both approaches improved knowledge scores, with greater absolute improvements observed with FC.

Recommendation: Larger multicentre studies using rigorous allocation methods and assessing long-term outcomes are recommended to validate these findings.

Keywords: Flipped classroom; didactic teaching; medical education; undergraduate medical students; crossover study; active learning.

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1. Introduction

Medical education continues to evolve as institutions seek teaching approaches that promote active participation, meaningful learning and application of knowledge. Traditional didactic teaching is predominantly teacher-centred, with students receiving information during scheduled classroom sessions. Although lectures remain useful for structured content delivery, opportunities for discussion, questioning and active participation may be limited.

The flipped classroom (FC) is a blended-learning approach in which students review core learning material before the classroom session, allowing scheduled classroom time to be used for discussion, clarification, problem solving and application of concepts.[1] The model therefore changes the sequence of learning rather than simply replacing lectures with online material. Its educational rationale is to move initial information acquisition to the individual learning phase and use faculty contact time for higher-order learning activities.

Previous studies in medical and health-professions education have reported improved academic outcomes and favourable student perceptions with flipped learning.[2-4] More recent systematic reviews and meta-analyses also suggest that flipped approaches can improve knowledge and selected practical or problem-solving outcomes compared with conventional teaching, although heterogeneity between studies remains substantial.[5,6] The effectiveness of FC may depend on the quality of preparatory resources, faculty facilitation, student engagement and the context in which it is implemented.

In Obstetrics and Gynaecology, topics such as antepartum haemorrhage (APH) and postpartum haemorrhage (PPH) require not only factual knowledge but also interpretation, clinical reasoning and application of management principles. A teaching model that reserves classroom time for interaction and application may therefore be particularly relevant.

The present study was undertaken to compare FC and TDC teaching among second-year MBBS students using a crossover design and to assess student and faculty perceptions of the FC approach.

1.1 Aim and Objectives

Aim: To compare the effectiveness of flipped classroom teaching with traditional didactic classroom teaching in improving knowledge among second-year MBBS students.

- To compare pre-test and post-test knowledge scores after FC and TDC teaching.
- To compare the magnitude of improvement in knowledge scores between FC and TDC teaching conditions.

- To assess students' perceptions of the FC method using a 5-point Likert-scale questionnaire.
- To assess faculty/facilitator perceptions regarding the educational value, time requirements, resource requirements and training needs associated with FC.

2. Materials and Methods

2.1 Study design and setting

This was a quasi-experimental, two-period crossover study conducted from March 2025 to June 2025 in the Department of Obstetrics and Gynaecology, ESIC Medical College and Hospital, Bihta, Patna, Bihar, India. The institution is a medical college and hospital that provides undergraduate medical education and hospital-based clinical services. The study population comprised second-year MBBS students enrolled at the institution. The study was conducted after approval from the Institutional Ethics Committee. Because students received both teaching methods across two modules, the design is a crossover design; it should not be described as a one-group pre-test-post-test design unless the actual study procedures differed from those reported here.

2.2 Participants and sample size

A total of 100 second-year MBBS students who volunteered to participate were recruited. Students from earlier second-year MBBS batches were not included. Written informed consent was obtained before participation. Two groups of 50 students each were formed using an odd-even number-based pseudo-randomization procedure.

The final sample comprised 100 eligible second-year MBBS students recruited during the study period (50 in each group). The source manuscript does not document an a priori sample-size calculation or the assumptions needed to reproduce one (e.g., expected effect size, significance level, statistical power and allowance for attrition). Therefore, a sample-size formula cannot be reported reliably from the available study records. The authors should provide the original calculation, if one was performed; otherwise, state transparently that the sample was based on the number of eligible volunteers recruited during the study period and acknowledge the absence of an a priori calculation as a limitation.

2.3 Eligibility criteria

Inclusion criteria were: (1) second-year MBBS students who provided written informed consent and (2) access to the internet for viewing the videos and teaching materials before the classroom session. Students who were absent for any part of the teaching modules were excluded from the study analysis.

2.4 Measures to minimise bias and potential sources of bias

Both groups were assessed using structured 20-item MCQ tests, and the same broad teaching sequence was followed for each module. The odd-even allocation procedure was used to form the groups, but it was pseudo-random rather than concealed random allocation. The intervention could not be blinded to students or faculty. Volunteer recruitment, self-reported feedback, the use of two faculty members and differences between the two modules may have introduced selection, response, performance and instructor-related bias. Any additional steps actually used to standardise teaching sessions or score tests should be specified by the authors.

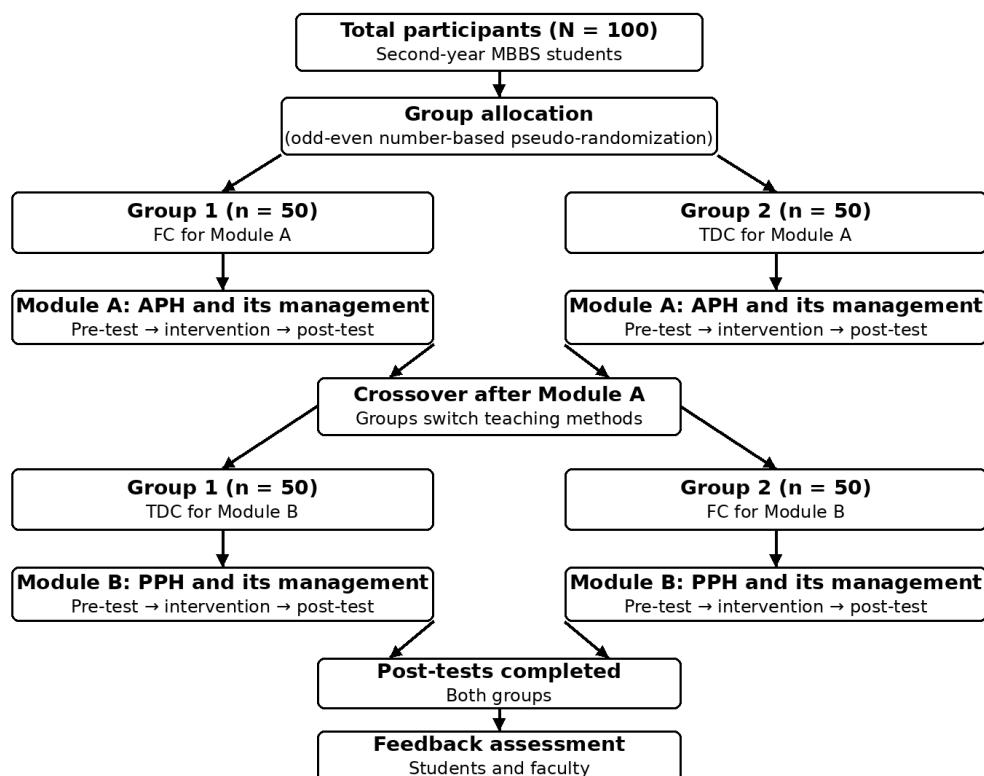
2.5 Intervention and module development

Two flipped-classroom modules covering core topics from the Obstetrics syllabus were prepared by the faculty and reviewed by subject experts. Module A covered antepartum haemorrhage and its management, corresponding to competency OG10.1. Module B covered postpartum haemorrhage and its management, corresponding to competency OG16.1.

For Module A, Group 1 received FC teaching and Group 2 received TDC teaching. After completion of Module A, the groups crossed over so that Group 1 received TDC and Group 2 received FC for Module B. One faculty member conducted the FC session for Group 1 and another conducted the corresponding TDC session for Group 2; faculty members crossed over with the groups for Module B. The study design and crossover sequence are illustrated in Figure 1.

Figure 1

Study outline showing odd-even pseudo-randomization and crossover between teaching conditions. FC, flipped classroom; TDC, traditional didactic classroom; APH, antepartum haemorrhage; PPH, postpartum haemorrhage.



2.6 Teaching procedure

Pre-session: During the six-day pre-session period, a 20-item MCQ pre-test was administered to both groups. For the FC condition, the topic and learning objectives were introduced and learning resources, including case scenarios,

relevant textbook extracts, handouts, animated material and online videos, were shared before the classroom session. Students were instructed to study the material in advance. For the TDC condition, the topic and learning objectives were introduced during the pre-session, but no teaching

resources related to the module were shared before the classroom session.

Classroom session: On the seventh day, the 60-minute FC session began with review of the learning objectives, followed by guided discussion and questions. The faculty member facilitated interaction, clarified concepts and summarized key points. In the TDC condition, the topic and learning objectives were followed by a conventional didactic lecture.

Post-session and crossover: A 20-minute post-test consisting of 20 MCQs was administered after the session. The groups then crossed over. On the eighth day, a 20-minute pre-test was conducted for Module B, followed by the corresponding intervention and post-test. Student and faculty feedback was collected after completion of the teaching sessions.

2.7 Outcome measures

The primary outcome was student performance on the 20-item MCQ post-test for each module. Pre-test and post-test scores were recorded for both teaching conditions. Secondary outcomes were student perceptions obtained using a 5-point Likert-scale questionnaire and faculty/facilitator feedback regarding the FC approach.

2.8 Feedback assessment

Students' perceptions of the FC method were assessed after the sessions using a structured questionnaire described in the source manuscript. Responses were recorded on a 5-point Likert scale, with additional open-ended items addressing the learning experience, perceived outcomes, resource materials and teaching methodology.

2.9 Statistical analysis

Data were analysed using SPSS (IBM, Chicago, IL, USA). Continuous variables were summarized using mean and

standard deviation (SD), and categorical responses were summarized as frequencies and percentages. The Wilcoxon signed-rank test was used for within-condition pre-test and post-test comparisons, and the Mann-Whitney U test was used for the reported between-condition comparisons. The chi-square test was used for categorical comparisons where applicable. A two-sided p value <0.05 was considered statistically significant. The crossover structure was reported with consideration of published guidance for crossover-trial reporting, while recognizing that the present allocation used odd-even pseudo-randomization rather than concealed true randomization.[8,9]

3. Results

A total of 100 second-year MBBS students participated in the study. Pre-test and post-test scores demonstrated statistically significant improvement in knowledge with both teaching approaches (within-condition $p < 0.001$). Across both modules, the absolute increase in mean score was greater under the FC condition than under the TDC condition.

3.1 Participant recruitment and characteristics

A total of 100 second-year MBBS students participated. The available manuscript does not report the number of students assessed for eligibility, the number excluded before enrolment, or reasons for non-participation; these details should be added from recruitment records if available. The manuscript also does not provide participants' age, sex or other sociodemographic characteristics. These data should not be inferred and must be inserted from the original dataset if collected.

Table 1

Pre-test and post-test knowledge scores in the first assessment (N=100). The reported between-condition comparison was statistically significant ($p < 0.001$).

Characteristic	Category	n (%)
Year of study	Second-year MBBS	100 (100%)
Study group	Group 1	50 (50%)
Study group	Group 2	50 (50%)

Note. Age, sex and other sociodemographic/clinical variables were not reported in the source manuscript. Add these variables and their observed values if collected; this table contains only characteristics supported by the available data.

Table 1

Pre-test and post-test knowledge scores in the first assessment (N=100). The reported between-condition comparison was statistically significant ($p < 0.001$).

Teaching method	Pre-test mean $\pm$ SD	Range	Post-test mean $\pm$ SD	Range	Within-group p-value	Absolute mean score change
FC	10.78 $\pm$ 1.70	8–13	13.48 $\pm$ 1.35	10–16	<0.001	+2.70
TDC	10.10 $\pm$ 1.60	7–13	11.76 $\pm$ 1.45	9–15	<0.001	+1.66

In the first assessment, as shown in Table 1, the mean score increased by 2.70 points with FC, compared with 1.66 points with TDC. The reported between-condition comparison was statistically significant ($p < 0.001$).

Table 2

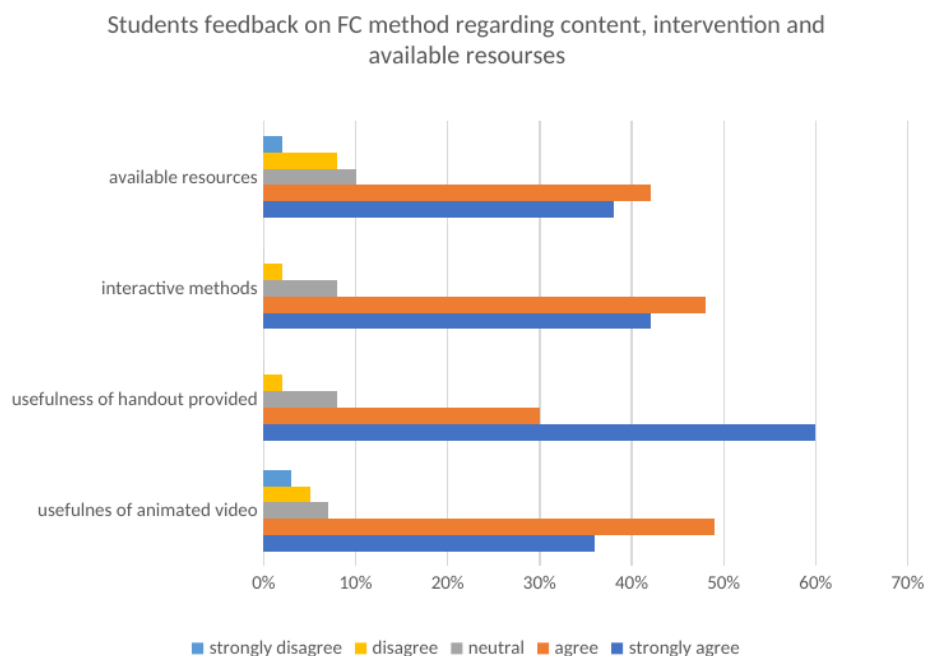
Pre-test and post-test knowledge scores in the second assessment (N=100). The reported between-condition comparison was statistically significant ($p < 0.001$).

Teaching method	Pre-test mean $\pm$ SD	Range	Post-test mean $\pm$ SD	Range	Within-group p-value	Absolute mean score change
FC	10.82 $\pm$ 1.56	8–14	14.52 $\pm$ 1.26	11–17	<0.001	+3.70
TDC	10.38 $\pm$ 1.44	8–13	12.16 $\pm$ 1.18	10–15	<0.001	+1.78

In the second assessment, as shown in Table 2, the mean score increased by 3.70 points with FC, compared with 1.78 points with TDC. The reported between-condition comparison was again statistically significant ($p < 0.001$).

Figure 2

Student feedback on the flipped classroom method. Responses were recorded on a 5-point Likert scale.

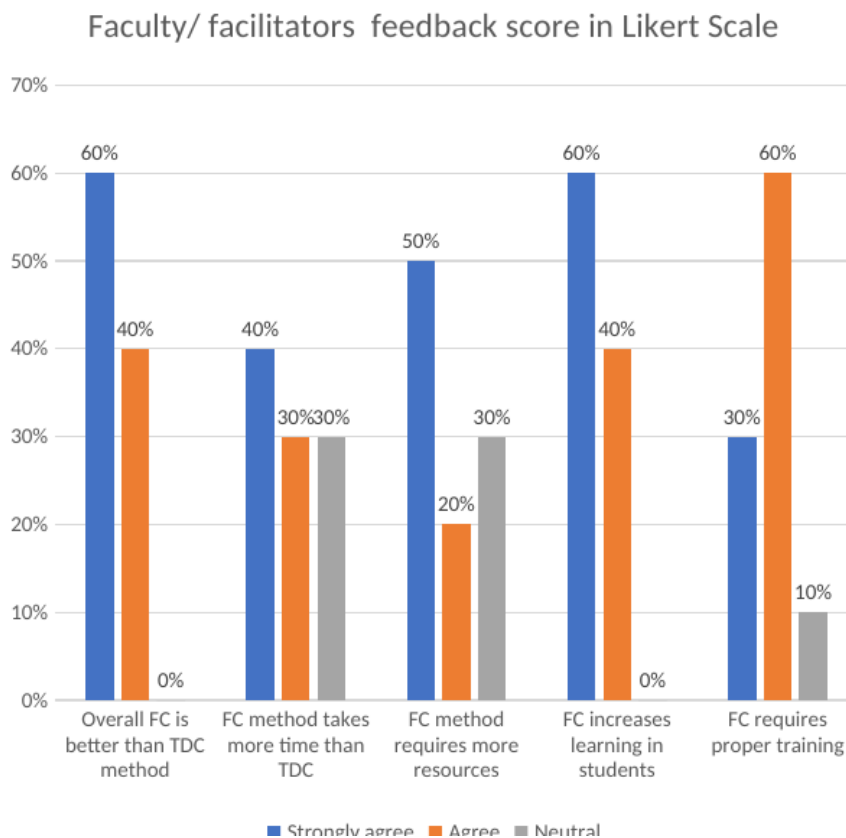


As shown in Figure 2, student feedback was predominantly positive for the interactive learning components. Agreement or strong agreement was reported by 85% of students for the usefulness of the animated video, 90% for interactive

methods, and 90% for the usefulness of the handout. For availability of resources, 52% selected agree or strongly agree.

Figure 3

Faculty/facilitator feedback on the flipped classroom method. Responses were recorded on a 5-point Likert scale.



As shown in Figure 3, faculty feedback was favourable regarding the educational value of FC. All faculty members agreed or strongly agreed that FC was better than TDC and that it increased student learning. At the same time, 70% agreed or strongly agreed that FC required more time than TDC, 70% reported that it required more resources, and 90% agreed or strongly agreed that proper training was required.

4. Discussion

The present crossover educational study found that both FC and TDC teaching were associated with significant improvements in knowledge scores among second-year MBBS students. The absolute increase in mean score was greater with FC in both modules: 2.70 versus 1.66 points in the first assessment and 3.70 versus 1.78 points in the second assessment. The findings suggest that both methods can support knowledge acquisition, while the FC format may provide additional benefit when classroom time is used for interaction and application.

The findings are consistent with earlier studies of flipped teaching in medical and health-professions education. Viveka et al. reported improved performance after flipped anatomy teaching together with favourable student perceptions.[2] Tune et al. reported improved examination

performance among graduate students exposed to a flipped physiology curriculum compared with traditional lecture-based teaching.[3] Ramnanan and Pound described generally favourable student perceptions of flipped classroom teaching in medical education.[4]

More recent evidence also supports the educational potential of FC. A 2025 systematic review and meta-analysis of 141 studies reported better knowledge outcomes and higher student satisfaction with flipped teaching than traditional approaches, although substantial heterogeneity was present.[5] A 2026 systematic review and meta-analysis of randomized trials in medical students similarly reported improvements in theoretical knowledge and practical skills, while noting heterogeneity and no clear pooled effect on satisfaction.[6] These findings provide contemporary support for the direction of the present study, while also emphasizing that implementation and context matter.

The structure of the present intervention is consistent with the underlying flipped-learning model, in which core content is made available before class and classroom time is used for interaction, discussion and application.[1,7] The positive student feedback, particularly regarding interactive methods, handouts and animated videos, supports the value of providing varied preparatory resources followed by facilitated classroom interaction.

Faculty feedback highlighted an important implementation issue. Although the educational value of FC was viewed favourably, many faculty members reported greater time and resource requirements, and most indicated a need for proper training. This is relevant because successful flipped learning depends not only on access to digital resources but also on faculty preparation, appropriate instructional design and active facilitation. Recent reviews similarly suggest that resource availability and faculty readiness can influence the effectiveness and feasibility of flipped learning.[5,6]

The crossover design was a strength because both student groups experienced both teaching conditions across the two modules. Nevertheless, the findings should be interpreted in the context of the study design. The two modules differed in content, the study was conducted at a single institution, and students were volunteers. In addition, different faculty members conducted the sessions, so faculty effects cannot be completely separated from teaching-method effects. The short interval between interventions also limits conclusions about long-term retention or sustained changes in learning behaviour.

4.1 Generalizability

The findings may be most applicable to second-year MBBS students receiving Obstetrics and Gynaecology teaching in a medical-college setting similar to the study site. Generalizability is limited by the single-centre sample, volunteer recruitment, the two selected teaching topics, the short follow-up period, pseudo-random allocation and potential instructor effects. The findings should therefore not be assumed to apply to all medical colleges, disciplines or learner groups without further evaluation.

4.2 Limitations

- Individual-level paired data were not available in the supplied manuscript, limiting independent verification of the reported statistical comparisons and preventing a more comprehensive crossover analysis accounting for period and carryover effects.
- No formal a priori sample-size calculation was documented in the supplied source manuscript.
- Student perceptions were self-reported and may be influenced by response or social-desirability bias.

- The allocation procedure was odd-even number-based pseudo-randomization rather than concealed true randomization.
- The use of two different faculty members may have introduced faculty-related differences that cannot be separated completely from the teaching-method effect.
- The study period was short and included only two teaching modules; long-term knowledge retention and transfer to clinical performance were not assessed.
- Participants were volunteers, creating the possibility of selection and volunteer bias.
- The study was conducted at a single medical college and included only 100 second-year MBBS students, which may limit generalizability.

5. Conclusion

Both flipped classroom (FC) and traditional didactic classroom (TDC) teaching significantly improved knowledge scores among second-year MBBS students. However, FC teaching demonstrated greater absolute improvements in both teaching modules. Students responded favourably to interactive learning methods, handouts, and animated videos. Faculty members acknowledged the educational benefits of FC but highlighted the need for additional time, resources, and training. FC may be a useful student-centred approach in undergraduate Obstetrics and Gynaecology education. Larger multicentre studies with rigorous allocation methods and long-term outcome assessment are recommended to validate these findings.

6. Recommendations

Medical colleges may consider FC as a complementary teaching strategy for topics that benefit from discussion and application, provided students have access to preparatory materials and faculty receive appropriate training. Future studies should use adequately justified sample sizes, robust allocation procedures, standardised teaching materials, crossover-appropriate statistical analyses, and follow-up assessments of knowledge retention and clinical performance. Multicentre studies should also report student characteristics and implementation costs.

List of Abbreviations

APH – antepartum haemorrhage
 FC – flipped classroom
 HOD – head of department
 MBBS – Bachelor of Medicine, Bachelor of Surgery
 MCQ – multiple-choice question
 PPH – postpartum haemorrhage
 SD – standard deviation

SPSS – Statistical Package for the Social Sciences

TDC – traditional didactic classroom

Author Biographies

Dr. Rajib Roy is Professor and Head of the Department of Obstetrics and Gynaecology at ESIC Medical College, Bihta, Patna, Bihar, India. His qualifications and research interests should be added by the author.

Dr. Lata is Assistant Professor in the Department of Obstetrics and Gynaecology at ESIC Medical College, Bihta, Patna, Bihar, India. Her qualifications and research interests should be added by the author.

Ethics Approval and Consent to Participate

The study was conducted in accordance with the ethical principles applicable to research involving human participants and was approved by the Institutional Ethics Committee of ESIC Medical College and Hospital, Bihta, Patna, Bihar, India. Written informed consent was obtained from all participants before their participation in the study.

Consent for Publication

Not applicable. The manuscript does not contain individually identifiable personal data or images of individual participants.

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Conflict of Interest

The authors declare that they have no conflicts of interest related to this study, its conduct, or the publication of this manuscript.

Author Contributions

Dr. Rajib Roy: Conceptualization, study design, supervision, teaching intervention, interpretation of findings, critical revision of the manuscript, and final approval of the version to be published. **Dr. Lata:** Study coordination, data collection, teaching intervention, data analysis, interpretation of results, manuscript preparation, critical revision of the manuscript, and final approval of the version to be published. Both authors agree to be accountable for all aspects of the work and have approved the final manuscript.

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Data Availability

The datasets generated and/or analysed during the current study are not publicly available because they contain participant-level educational assessment data. Data may be made available from the corresponding author on reasonable request, subject to institutional policies, participant confidentiality, and applicable ethical requirements.

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