

RESEARCH ARTICLE

Effectiveness of the flipped classroom versus the traditional teaching method in enhancing learning among undergraduate medical students



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Abstract

Background: The flipped classroom is a form of interactive teaching strategy in which traditional learning is reversed by delivering core content outside the classroom and moving activities into the classroom. This study aimed to determine the effectiveness and medical students' perception of flipped classroom.

Methods: This quasi-experimental study included 100 first-year medical students who were divided into four groups (A, B, C, D), with 25 students in each group. Groups A and C received didactic lectures, while groups B and D participated in flipped classroom. Thereafter, there was a crossover for ethical purposes. All students took multiple-choice pre-tests and post-tests, and there was also a retention test two weeks after the flipped classroom sessions. Students were further divided based on their pre-test scores into two categories: the <50% and the ≥50% category. Wilcoxon and Mann-Whitney tests were used to analyse the data for statistical significance. Student perceptions were collected by Google questionnaire.

Results: The result showed a significant improvement in the post-test marks for both the teaching learning methods. However, the flipped classroom groups outperformed the didactic groups, with mean post-test scores of 82.2 (10.8) and 84.2 (10.3) for the <50% and ≥50% groups, respectively, compared to 63.2 (9.4) and 72.4 (14.9) for the traditional groups, with a $P < 0.001$. Knowledge retention was also notably better in the flipped classroom groups. The students' feedback supported flipped classroom method.

Conclusion: The flipped classroom boosts students' performance and encourages active participation and higher order thinking in them. It can be adopted to make the MBBS students self-directed and life-long learners.

Key messages

The competency-based medical education for undergraduate medical students emphasises on interactive teaching learning methods like the flipped classroom. In our study, the flipped classroom strategy improved learning outcomes in undergraduate medical students, especially among those with poor baseline academic performance. This interactive, student-centred method excelled at stimulating knowledge retention, active participation, and engagement over traditional lectures.

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Introduction

The introduction of the competency-based medical education (CBME) curriculum by the National Medical Council of India (NMC) has marked a paradigm shift to more interactive classes from the traditional didactic lecture class. The students participate actively in interactive classes, and higher-order thinking is encouraged [1]. Now, medical colleges all over our country are trying to bring modifications to the ongoing educational programs and various teaching-learning methods to inculcate the essence of self-directed learning to make them become lifelong learners. It will also help them to develop confidence to take “responsibility for their learning” [2]. One of the recent techniques adopted for interactive classes is the flipped classroom model (FCR) of teaching. The FCR potentially support student learning, so it is gaining momentum in medical education [3].

The FCR method is significantly adopted in the healthcare educational system to motivate and facilitate student participation in teaching and learning. In this method, students read the learning materials outside the class, giving more time for interactive activities in the class. This current medical education system aims to enable students to turn theory into practice [4]. In the previous traditional method of didactic lectures, the subject expert delivers the lecture to a large group of students. It consumed a lot of time, and the role of students in a lecture class was usually passive in the form of listening, understanding the concepts or taking notes, and having little opportunity to interact during the lecture hour [5]. The traditional didactic lectures helped to impart information to large groups of students. Still, they failed to develop the knowledge and problem-solving skills required in clinical practice in the students. “Flipped learning or the ‘flipped classroom’ is a strategy that reverses traditional learning by delivering core content outside of the classroom (often online), and moves activities more traditionally thought of as ‘homework’ into the classroom” [6].

The FCR is a type of “blended learning” where the students learn the “core” content of a topic before the lecture class either from the available resources, such as online resources or already circulated handout materials, books, class notes, etc. The main advantage of the FCR is that the students can learn in their environment and at their own pace, and it can be customised as per the difficulty level of the topic. It results in better and more effective time management of a class. This new teaching-learning method, the FCR method, was introduced to utilise the time available for teaching-learning fruitfully and help in the active participation of medical students to meet their learning needs [7]. Because the flipped classroom is a new education model in Indian medical education, so strong comparative studies are still required to determine its effectiveness compared with conventional teaching methods. With the CBME model, in particular, little data are available quantifying how this pedagogic change affects students' learning outcomes, satisfaction, and the acquisition of skills. In addition, an understanding of students' attitudes to this pedagogy is also necessary

in order to quantify its acceptability and identify potential limitations to its broader implementation. So, this study aimed to determine the effectiveness of the FCR method compared to the traditional classroom method and to study students' perceptions of the newly introduced teaching-learning method.

Methods

This Study participants

This quasi-experimental study was conducted in the Department of Physiology, IMS and SUM Hospital, Bhubaneswar, India between January and June 2022. First-year medical students of the 2021-22 batch participated in the study. Students who were absent during the study period were excluded from the study. The study was undertaken after receiving the Institutional Ethical Committee clearance and obtaining informed consent from all the participants.

The calculated sample size from a batch of 150 medical students was about 109 at a 95% confidence level and 5% margin of error using the finite population correction formula ($n = N / (1 + N \cdot e^2)$ where $N = 150$ and $e = 0.05$). Even though the calculated sample size was 109, 100 students (66.7% of the population) were included in the study based on logistical considerations. This was felt to be sufficient to ensure statistical power for quantitative analysis.

Study design

The participants were divided into four smaller groups (A, B, C, D) with 25 students each based on their roll numbers by convenient sampling. The entire FCR session was meticulously planned before implementation. The teachers were trained in FCR teaching. The process involved sensitising the students and faculty members about this new teaching-learning method, selecting pre-reading study materials, and forming a WhatsApp group of the faculties and students to share the pre-reading materials and collect feedback. Two topics in Endocrine Physiology with clinical application, actions of insulin and glucocorticoid, were selected. First, groups A and C attended the didactic lecture on actions of insulin, and groups B and D were assigned a flipped class on the same topic. Then, the two groups were swapped, and a crossover was done for ethical purposes. Groups A and C attended flipped class on actions of glucocorticoid, and groups B and D attended didactic lectures on same topic (Figure 1). In the flipped class, students had come prepared with the topic from the resource materials, like pre-recorded lectures and videos provided to them a day before the class. The students were allowed to discuss their difficulties and doubts in the one-hour flipped class for about 15 minutes. Then, they were allotted four cases from the topic to discuss in groups. Each group presented the case allotted to them and discussed it with the other groups for about 10 minutes. The teacher's role was to facilitate and guide the students wherever required. The teacher summarised the topic at the end of the class.

Data was gathered through a mix of objective assessments and structured feedback. For each teaching session-Didactic and Flipped Classroom

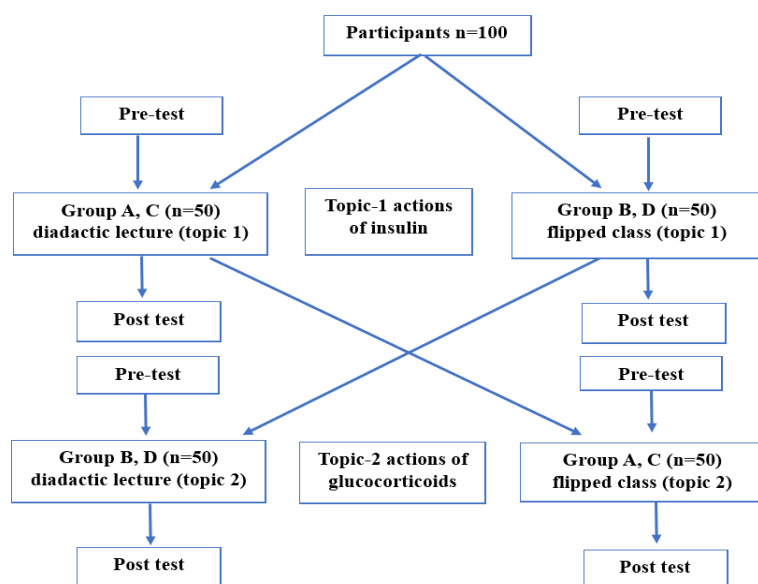


Figure 1 Distribution of students into traditional lecture class and flipped class groups

(FCR)-students took a multiple-choice question (MCQ) test of 10 marks. These test items were crafted to evaluate both their knowledge and problem-solving skills. Separate question papers were created for the pre-test and post-test, ensuring they were of similar difficulty. The MCQs were based on standard Physiology textbooks, and to ensure content validity, four subject experts and four faculty members from the Medical Education Unit (MEU) reviewed them. All students participated in both the pre-test and post-test evaluations that matched their instructional method. Moreover, a retention test (also 10 marks) using MCQs was conducted two weeks after the FCR sessions to evaluate the knowledge retention across both teaching methods. To gauge perceptions, student feedback on the FCR method was collected through a pre-validated structured questionnaire. This questionnaire included questions covering various aspects of the flipped classroom experience, as well as students' preferences for teaching and learning methods. The feedback form was developed based on a literature review, and its validity was confirmed by the same panel of subject experts and MEU members. The questionnaire was distributed digitally via google form.

Students were divided into two categories based on their pre-test marks: the <50% category and the ≥50% category. All marks were expressed in percentage. Analysis of their pre-test and post-test marks was done by applying appropriate statistics.

Table 1 Comparison of pre-test and post-test marks of didactic and flipped class groups (n=100)

Groups based on pre-test marks	Pretest marks (%)	Posttest Marks (%)	Difference in pre and post-test marks (mean improvement)	P
Didactic lecture classes				
<50%	36.6 (4.8)	63.2 (9.4)	26.6	<0.001
≥50%	52.8 (4.5)	72.4 (14.9)	19.6	<0.001
Flipped classes				
<50%	36.9 (4.7)	82.2 (10.8)	45.4	<0.001
≥50%	52.8 (4.6)	84.2 (10.3)	31.4	<0.001

Data presented as mean (standard deviation)

Statistical analysis

Statistical analysis was done using the SPSS software, version 18.0. Results were expressed in frequencies and percentages. The Wilcoxon signed-rank test was used to find the statistical significance between the pre-test and post-test marks in both categories. The post-test marks of both the T-L methods were compared by the Mann-Whitney U test between the categories. A p-value less than 0.05 was considered to be statistically significant.

Results

Out of 100 selected students, 62 were females and 38 were males. The mean post-test marks of both the T-L methods was significantly higher than the pre-test marks in the <50% marks and ≥50% category with a $P < 0.001$ (Table 1). However, the post-test marks of flipped class [82.2 (10.8) and 84.2 (0.3)] were significantly higher than the didactic class marks [63.2 (9.4) and 72.4 (14.9)] in the <50% and ≥50% category, respectively, with a $P < 0.001$ (Table 2).

Analysis of students' perceptions indicated that they experienced improved recall, understanding, analytical skills, and knowledge application with the flipped method compared to the traditional didactic approach (Figure 2). 78% of students preferred a flipped class over a didactic lecture class. The students of FCR achieved higher marks than didactic class in the knowledge retention test in both the categories (Figure 3).

Discussion

This generation's medical students are losing interest in the didactic form of lectures [8], which is evident from their poor attendance and poor performance [9-12]. Students are lacking proper training in problem-solving and critical-thinking skills [13]. They are also not very much aware of self-directed learning. However, the students show interest in interactive learning [14]. The FCR fosters a student-centric approach, which helps students to develop lifelong learning skills [15]. Interactive learning like FCR gives a chance for individualised education. The students read the study materials conveniently and use face time more efficiently. The increasing role of FCR in enhancing the students' involvement and encouraging them to take responsibility for their learning has been broadly accepted by medical teachers [3]. As per Bloom's Revised Taxonomy, the classroom is for lecture classes, which helps in the acquisition of knowledge and comprehension of facts, whereas FCR helps in long-term learning of the topics as it focuses on the identification of the learning needs of the students and involves 'application, analysis, and evaluation' of the knowledge. It consists of the principle of 'learning by doing' [16, 17].

Our study reveals that the post-test marks of both the traditional class and flipped class were more than the pre-test marks and the post-test result in the Flip classroom method was significantly higher than that of the traditional classroom method, indicating an improvement in the teaching-learning outcome with the Flip classroom method compared to the traditional method. The improvement was more marked in the low achiever group (<50% group), indicating the

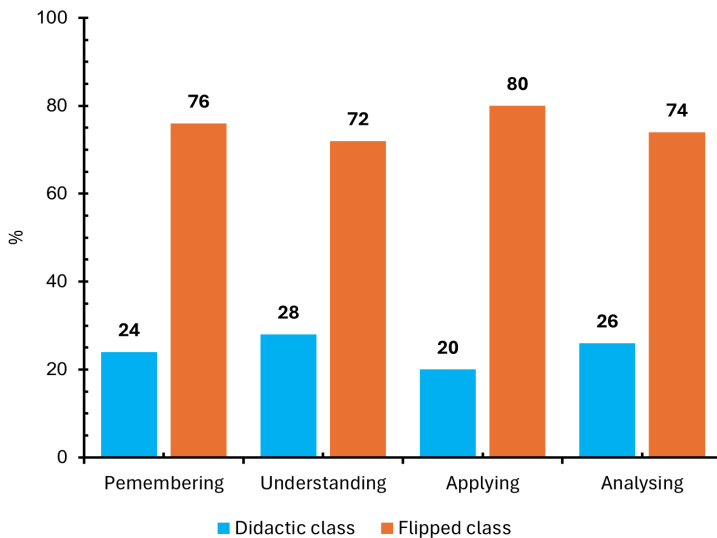


Figure 2 Cognitive domain of students based on various aspects of Bloom's Taxonomy according to didactic and flipped classes (n=100)

effectiveness of implementing FCR in the medical curriculum. In our study, the students whose score was less than 50% on the pre-test showed a significant increase in their post-test marks, indicating the effectiveness of the flipped class. Students could remember better, and there was better understanding, application, and analysis power in the flipped class than in traditional lecture methods. Our study also reveals that students preferred a flipped class over a traditional didactic lecture because students liked to learn at their own pace and an interactive lecture in the classroom, which was possible in a flipped classroom. Other studies that compared the flipped and traditional classroom methods showed that the flip class helps improve student learning process outcomes [18,19, 20]. A study by Viveka *et al.* [18] revealed that the passing percentage of students after intervention in the flipped classrooms was significantly more than that of students taught by the traditional method; they also found that students' perception was more in favour of the flipped classroom. Tune *et al.* [19] the study showed by adopting the flipped classroom model, there was an improvement in the performance of students in physiology. In their study, Christopher and Pound [20] said that students expressed massive satisfaction with introducing the Flipped class early in undergraduate medical education, which was preferred over lecture-based instruction. Whillier and Lystad's [21] study concluded that there was no significant difference in grades and satisfaction levels in a Flipped classroom of Neuroanatomy.

Table 2 Comparison of post-test marks of didactic lecture class and flipped class (n=100)

Group	Didactic posttest marks (%)	Flipped posttest marks (%)	Difference in marks (mean improvement)	P
<50%	63.2 (9.4)	82.2 (10.8)	19.0	<0.001
≥50%	72.4 (14.9)	84.2 (10.3)	11.8	<0.001

Data presented as mean (standard deviation)

The analysis of 82 papers by systemic review indicated that flipped class learning was a more favourable approach to motivating and engaging the students. However, there is little evidence about its effectiveness in retaining knowledge. In our study, we found FCR to be an interactive pedagogical tool that needs to be introduced early in medical education as it (i) helps the students to learn the subject assigned at their own pace, (ii) meaningfully use technology in learning the subject, (iii) helps in motivating students for self-directed learning, and (iv) enrich students with in-depth knowledge on the topic and facilitates conceptual learning. Memory retention was better for students of the flip class group than those who attended a didactic lecture in both groups. A meta-analysis of 46 papers with more than 9,000 participants revealed higher academic performance with flipped learning compared to a lecture-based approach [22]. Applying innovative methods like FCR in the teaching method can be rewarding. This type of student-centred approach enhances the lifelong learning ability of students. FCR promotes active learning by doing things and thinking about what they are doing. Based on Kolb's four learning styles, it was found that flipped sessions were more effective than the traditional method. In our study, students found FCR beneficial because it was student-friendly [23]. They reported that they could understand the basic concepts and that it was more active and provided an opportunity for one-on-one interaction within the group. Previous researchers have reported receiving a positive response to the FCR method from students and teachers' feedback. Zhao and Ho's analysis of students' feedback favoured FCR, although they did not find any improvement in students' academic performance following FCR in their studies. Studies have also concluded that students found FCR more beneficial because it engages them and facilitates interaction between students [24]. In our study, students showed that FCR improved their learning of the topic and their confidence to answer in the final exam. They also recommended teaching more topics using this method. In the studies of Veeramani *et al.* and Memon *et al.*, students' response to the FCR was hugely positive because the FCR approach met the learning objectives compared to didactic teaching [25, 26]. Buchner, in his article, pointed out that students were satisfied with this method as they got immediate feedback on their performance [27]. Szparagowski, in his project on flipped classrooms, mentioned some notes by students [28]. In this, students mentioned the benefits of FCR: it is less time-consuming than normal homework, and they can study from the videos at their convenience.

They mentioned that FCR is a beneficial method because they can access multiple links and get help, and it introduces the topic before learning in class. In our study, students liked FCR because of their interactive nature and application-based discussion. They also found reading from recorded lectures and videos more convenient at home. Our findings are similar to a study by Nouri, who stated low achievers significantly reported more positively than high achievers and their perceived increased learning [29].

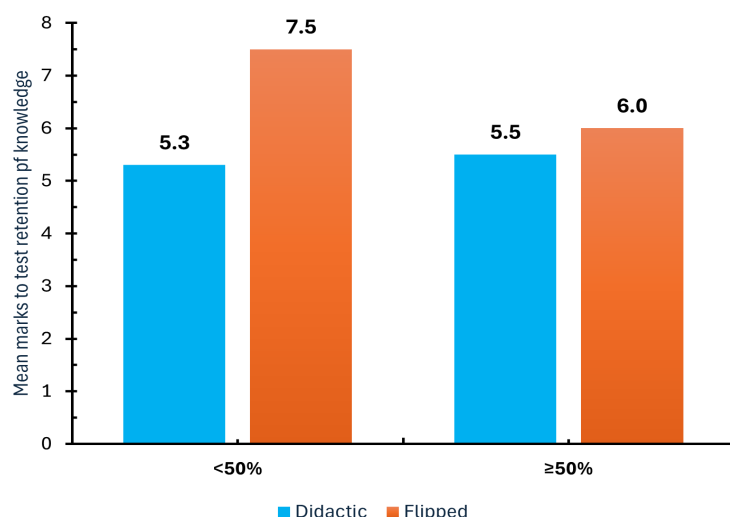


Figure 3 Retention of knowledge in didactic and flipped class group (n=100)

The significant challenges in implementing FCR are that, as almost all of us are acquainted with didactic lectures, a lot of preparation is needed both on the part of the students and teachers for its implementation. Increased workload and time constraints are other challenges. Students (i) have to be aware of self-directed learning; (ii) have to be ready for the class from the pre-reading material; (iii) have to know how to use smartphones and to access the internet; and (iv) need to be prepared with the assignments. Teachers (i) have to sort and list important pre-reading material, (ii) come prepared with lecture materials to the class in the form of MCQs, and (iii) provide the assignment materials like flowcharts, diagrams, etc. The strength of our study is that it employs a crossover design whereby each participant is exposed to both the conventional lectures and the flipped classroom approach. This not only amplifies the learning process but also ensures ethical integrity in providing equity of exposure to the learning strategies. We have divided the students into two groups, the <50% group and the ≥50% group, which helped us to identify the low achievers and to find out whether the new T-L method was useful for them or not. The major limitation of our study was the time constraint, under which we could do FCR only on a few topics with students of one batch and faculty members of the first phase only. A multicentric study involving multiple medical colleges and including a larger number of students and faculty members will help find out the actual effectiveness of the FCR.

Conclusion

Our study revealed that there is a marked improvement with FCR. The knowledge-retaining capacity was also better with students taught by the FCR method. It stands out as a promising strategy for cultivating self-directed, lifelong learners in the field of medical education. We recommend that FCR should be implemented in undergraduate medical teaching as it is an established teaching-learning tool that helps students gain a better understanding of the subjects compared to traditional Didactic lectures.

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Author contributions

Conception or design of the work; or the acquisition, analysis, or interpretation of data for the work: DM, AM, TM, AM, PKS. *Drafting the work or reviewing it critically for important intellectual content:* DM, AM, TM, AM, PKS. *Final approval of the version to be published:* DM, AM, TM, AM, PKS. *Accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved:* DM, AM, TM, AM, PKS.

Conflict of interest

We do not have any conflict of interest.

Data availability statement

We confirm that the data supporting the findings of the study will be shared upon reasonable request.

Supplementary file

None

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