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Research Article

Flipped Classroom: A Pedagogical Approach for Undergraduate Medical Education in India

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ABSTRACT

Background: The flipped classroom educational model reverses the role of the traditional format of a classroom lecture from group learning to individual learning, and the educator guides students in the application of knowledge and building concepts. The objective is to evaluate the perception of students in a flipped teaching model versus didactic /traditional classroom model. The purpose was to assess the ability of the educator to enhance the academic achievement of students.

Subjects and Methods: The current study was conducted for a period of six months, in which second-phase medical undergraduates participated. Informed / ethical consent was taken before the study was initiated. A total of 133 students out of 150 participated in the study. Two groups were formed, one had a traditional class, and the other had a flipped class. Pre-test and post-test in the form of a questionnaire were conducted before starting and after completion of the class, and the perceptions of students were assessed.

Result: Out of 150 students, only 133 participated in the study, 65 were in the flipped classroom space, and 68 were in the traditional model. The baseline performance of both groups was the same (mean difference 0.37, 95% CI: -0.35 to 1.10, p = 0.31). Post-intervention, both groups showed improvement, but the flipped classroom group demonstrated significantly greater gain.

Conclusion: The implementation of a new teaching model depends upon its acceptance, dynamism, logistics, understanding, and better outcomes. The innovative method (flipped) was found to be a more effective teaching-learning, thought-provoking model with enhanced students' engagement in learning and perception.

Introduction

The Flipped classroom is a model with a new educational concept in which students are provided with study materials to develop a clear understanding of the subject; hence, time is spent on different learning activities, clearing doubts, and group discussion. The teacher, like a mentor, monitors and supports the learner or mentee. In the current era, medical education has been experiencing a strong call for transformation[1,2]. Presently, the medical education system in India is centred on didactic teaching, which means giving lectures in the classroom and conducting practical classes. Traditional lectures have some benefits, like knowledge transfer and information at a time to a large group within a limited time. But in self-directed learning, flipped classroom model, students improve their self-effort by gathering information from the internet, e-books, videos, and self-involvement which is more rewarding. Hence, the instructors should provide more information to students so that they can participate actively. There is a need to implement new and innovative methods that develop attributes of metacognitive skills, and the flipped classroom fulfils the demand.

The current medical education system requires competent medical graduates to deliver safer, higher-quality care and cost-effective treatment modules through effective communication with the inter-professional team. [3] As per the current education policies future doctors ought to be professionals with more skills from perceptions gained by self-guided, continuous learning, teamwork, and the ability to communicate better. [4-7] Medical curriculum is tailored as per the syllabus required for Indian medical students. This entails a change in thinking from the established traditional teaching with one instructor delivering knowledge in a limited time to more active learning techniques under the guidance of a teacher [8] and giving instructions for making a careful selection of learning materials. [9] The "flipped classroom" educational model reverses the role of the traditional format of a classroom lecture and homework, in which direct instruction moves from group learning to individual learning, and the educator guides the students in the application of knowledge and building the concepts. [10] Flipping the classroom means that students gain first exposure to new material outside of class, usually by reading or watching lecture videos, and then use class time to do the harder work, like assimilation of that knowledge through group discussions or problem-based learning in the presence of a facilitator. [11] In our medical education system, it is imperative to seek ideas that utilize videos, PowerPoint presentations, and knowledge gained from the internet as potent supporters for deeper learning. [12]

The Flipped classroom model emphasizes that students need to be trained in applying theoretical knowledge into practice so that they can give appropriate treatment to align medical education in India to global standards. Commonly traditional teaching-learning strategies are lecture, demonstration, tutorial, practical, clinical, and field postings; these are occasionally augmented with seminar, student symposia, debate, role play, and panel discussion. There is a need to enable a fresh graduate to develop the key competencies.

The flipped classroom is a teaching approach where students engage with new material outside of class (e.g., watching videos, reading articles) and use class time for active learning activities like problem-solving, discussions, and collaboration, which reverses the traditional model. The strategic shift of teaching learning method plays a major role both in the perceived satisfaction and in perception domain gained by medical graduates.[13,14] Among the instructional tools identified for effective information transfer to learners, lectures and the flipped classroom model are two diverse educational approaches, each supporting different learning needs. [15] Lecture is the oldest and most ubiquitous method in medical institutions. [16-18] There is a significant association between the methods used in imparting knowledge by the lecturers and the assimilation by the students. Specifically, a lecture is easy to arrange, can effectively convey information to a large audience, has the potential to simplify complex concepts, and produces the desired results in terms of academic achievements.

Learning takes place when teaching is effective one whereas teaching without learning is of no importance. A major problem for any medical institution is that teachers need to deliver extensive knowledge in a very tight schedule, while students need to 'retain, remember, and effectively interpret' the same. This is the primary reason why most medical education systems need to brainstorm or re-think to make a curriculum that would focus on subject-based teaching involving interactive, problem-based, student-centred learning, or application of the flipped classroom teaching model. Teachers then employ the class time more effectively to encourage the students to learn lessons using the internet, videos and PowerPoint presentations, and other study materials so that their learning process becomes more interactive and genuine, and knowledge gain is for the long term. [19] Metacognitive skills can be developed with active learning habits [20].

In flipped classroom model passive learning is converted to active learning levels such as perception, analysis, and synthesis. [21] Flipped classroom for postgraduates reverses traditional learning, delivering content (videos, readings) online for self-paced pre-class study, while class time is used for active, collaborative application like discussions, problem-solving, and deep analysis with instructor guidance, fostering higher-order thinking, engagement, and personalized support crucial for complex postgraduate subjects. Researchers have used flipped classes for postgraduate teaching learning method and has a positive effect on active learning, provides more opportunities for students to engage in critical thinking. [22-24]

Thus, the current study was planned to train the students to apply theory to practice by using the flipped classroom methodology and to assess the ability of the educator to enhance the academic performance of students.

Subjects and Methods

The present study was conducted for six months in a tertiary care teaching hospital of Eastern India. The study was started after ethical committee approval and consent from each participant. The medical seats of the second year were 150, hence, the study population was oriented to the "flipped classroom model." The topic from endocrinology was chosen. "Drugs for the treatment of diabetes mellitus" was divided into two subtopics, namely insulin types and oral antidiabetic drugs. Two subtopics were taught on two separate days by two different ways, didactic versus flipped. Similarly, orientation on two other topics, namely corticosteroid and thyroid, was carried out. Two groups were formed, of 75 each, and two teachers took classes for each group. One group had a traditional class and the other had a flipped class (4 classes in 4 weeks for each group). After every 2 classes, the teachers were interchanged. A Pre-test was done on the first day before starting classes to assess their basic knowledge regarding the subject to be taught (questionnaire). Study materials related to the topic were given according to the learning objectives in the form of a PowerPoint presentation, video lectures, and reading materials for the flipped classroom learners. During the class, time was spent on briefing the topic and activities for higher levels of learning, like analytical work in the form of group activity, case-based learning, and a short debate. Gmail addresses provided by the college authorities to all students were utilized for sharing the Google Form links. A WhatsApp group was created to share the links. Learning materials were used to demonstrate the concept , and a Post-test (questionnaire based)was conducted after completion of the classes. Second-year medical students who gave consent and were present in the class during the research work were included in the study, and those who refused to participate or were absent during the study were excluded.

The Flipped classroom is a model with a new educational concept in which students are provided with study materials to develop a clear understanding of the subject; hence, time is spent on different learning activities, clearing doubts, and group discussion. The teacher, like a mentor, monitors and supports the learner or the mentee.

Google Forms were used before starting the comparative research activity, which consisted of three sections. Slide content was based on the topic. Students had to read the presentation. The slides were shared so that students were knowledgeable regarding the topic before

coming to class. After going through it, the students took a quiz, which was the second section of the Google Form. Questions were open-ended (answer as yes /no) The quiz was a method of self-assessment. The third section was an open-ended questionnaire to allow students to ask any queries The Google Form gave immediate feedback scores to the students which ensured student's grasp on the topic.

Two classes were conducted on two separate days to teach one topic split into two subtopics. Each classroom was held for 150 minutes with a short introduction. The topic was discussed for 40 minutes and during this briefing, all queries were addressed. The wrong concepts were also identified and cleared. Then, a group discussion was conducted between the two groups. Communication skills, such as role plays, were done on a particular topic. The classroom session was started with briefing to build concepts on the subject matter, the next one was activities to build their analytical skills, and the last one was focussed on building their communication skills. A questionnaire-based test was conducted to assess the knowledge gain on the chosen topic and on students' perception.

The new model was started to see the learning gains, which approximately tripled with the flipped classroom teaching that emphasizes students' interactive learning. This imparted lifelong learning skills even for slow-paced learners, and learning is self-paced.

Data were entered in Microsoft Excel and analysed using SPSS version 26. Descriptive statistics were presented as mean and standard deviation for continuous variables, and as frequency and percentage for categorical variables. Paired t-tests were used to assess differences between pre- and post-test scores. Independent t-tests were applied to compare scores between flipped and traditional groups. Effect sizes were reported using Cohen's *d* to quantify the magnitude of differences. Multiple linear regression was performed to evaluate the independent association between flipped classroom teaching and post-test performance, adjusting for baseline (pre-test) scores. A *p*-value < 0.05 was considered statistically significant.

The current study was approved by the Ethics Committee of IMS and SUM Hospital, Siksha 'O' Anusandhan (deemed to be) University, K-8, Bhubaneswar, Odisha, India. Letter No: Ref No/DRI/IMS.SH/SOA/2021/102

Results

A total of 133 out of 150 students participated in the study, with 65 in the flipped teaching group and 68 in the traditional one. The groups were similar in terms of baseline performance. At baseline, the mean pre-test scores between the flipped (6.05 ± 2.04) and small group (5.68 ± 1.68) teaching groups were not significantly different (mean difference 0.37, 95% CI: -0.35 to 1.10, p= 0.31).

Post-intervention, both groups showed improvement, but the flipped classroom group demonstrated significantly greater gain. The mean improvement in the flipped group was 2.12 (95% CI: 1.41 to 2.82, p < 0.001), compared to 0.86 (95% CI: 0.23 to 1.5, p < 0.001) in the small group. The between-group difference in gain scores was statistically significant (p < 0.001) with a large effect size (Cohen's *d* = 0.78) (Table 1).

After adjusting for baseline performance, students in the flipped classroom group scored an average of 1.45 points higher than those in the traditional small-group teaching group (β = 1.45, 95% CI: 0.91 to 1.99, p < 0.001). The model was statistically significant (R^2 = 0.48, p < 0.001), explaining 48% of the variance in post-test scores (Table 2). The pre-test score was also a significant predictor (β = 0.49, 95% CI: 0.34 to 0.64, p < 0.001), indicating that higher baseline knowledge was associated with better post-test score.

Table 1: Overall academic performance at the baseline and after the class

Time Point	Group	Mean ± SD	Within-Group Difference (Post-Pre) (95% CI)	p-value	Between-Group Difference (95% CI)	p-value
Pre-Test	Traditional (n=68)	5.68 ± 1.68	-	-	0.37 (-0.27, 1.0)	0.51
	Flipped (n=65)	6.05 ± 2.04				
Post-Test	Traditional (n=68)	6.54 ± 2.03	0.86 (0.23, 1.5)	<0.001	1.63 (0.91, 2.35)	—
	Flipped (n=65)	8.17 ± 2.14	2.12 (1.41, 2.82)	<0.001		<0.001

Table 2: Multiple linear regression for post-test academic Score

Predictor	Coefficient (β)	95% CI	*p*-value
Intercept	3.22	(2.40, 4.04)	<0.001
Group (Flipped)	1.45	(0.91, 1.99)	<0.001
Pre-test Score	0.49	(0.34, 0.64)	<0.001

Students in the flipped classroom group reported significantly more favourable perceptions across multiple constructs. The mean perception scores for engagement and motivation (4.3 ± 0.5 vs. 3.4 ± 0.7), peer communication (4.0 ± 0.6 vs. 3.2 ± 0.8), teacher interaction (4.3 ± 0.4 vs. 3.9 ± 0.6), and autonomy/self-direction (4.2 ± 0.5 vs. 3.3 ± 0.7) were all significantly higher in the flipped group (p < 0.001 for all) (Table 3). However, teacher interaction was similar in both groups. Figure 2 presents the mean perception scores (out of 5) for each item across the flipped and traditional classroom groups. In most of the domains, the flipped classroom group reported higher mean scores. The largest differences were observed in understanding of the topic (4.35 vs. 3.48), group activity learning (4.35 vs. 3.67), and retention of knowledge (4.19 vs. 3.50). Both groups rated teacher respect and encouragement for discussion highly, with scores above 4. However, there is still room for understanding the requirement of class slides even before the class. The observed effect sizes for engagement, peer communication, and autonomy were all large (Table 3).

The distribution of students' responses to key perception items related to the flipped classroom is illustrated in Figure 2. All students unanimously agreed that flipped classroom teaching encouraged active participation of students. A majority of students either agreed or strongly agreed that the method encouraged communication between students and teachers (100%), and it improved their ability to apply knowledge in practice (85%). All students felt the teacher treated them with respect and effectively facilitated discussions. Notably, 92% reported method enhanced their curiosity and preparedness for class, and 100% found group activities beneficial to learning. While 92% agreed that the approach was time-consuming, only a minority perceived it as burdensome or unnecessary. These findings suggest strong acceptance and engagement with the flipped classroom format across cognitive, behavioural, and motivational domains.

Table 3: Comparison of mean perception scores between flipped classroom and traditional small group teaching across key learning constructs

Construct	Traditional Mean ± SD	Flipped Mean ± SD	Mean Difference (95% CI)	p-value	Cohen's *d*
Engagement & Motivation	3.4 ± 0.7	4.3 ± 0.5	0.9 (0.69 to 1.11)	<0.001*	1.48
Peer Communication	3.2 ± 0.8	4.0 ± 0.6	0.8 (0.56 to 1.04)	<0.001*	1.13
Teacher Interaction	4.0 ± 0.6	3.9 ± 0.4	-0.1 (-0.28, 0.08)	0.26	0.2
Autonomy / Self-direction	3.3 ± 0.7	4.2 ± 0.5	0.9 (0.69 to 1.11)	<0.001*	1.48

**Statistically significant*

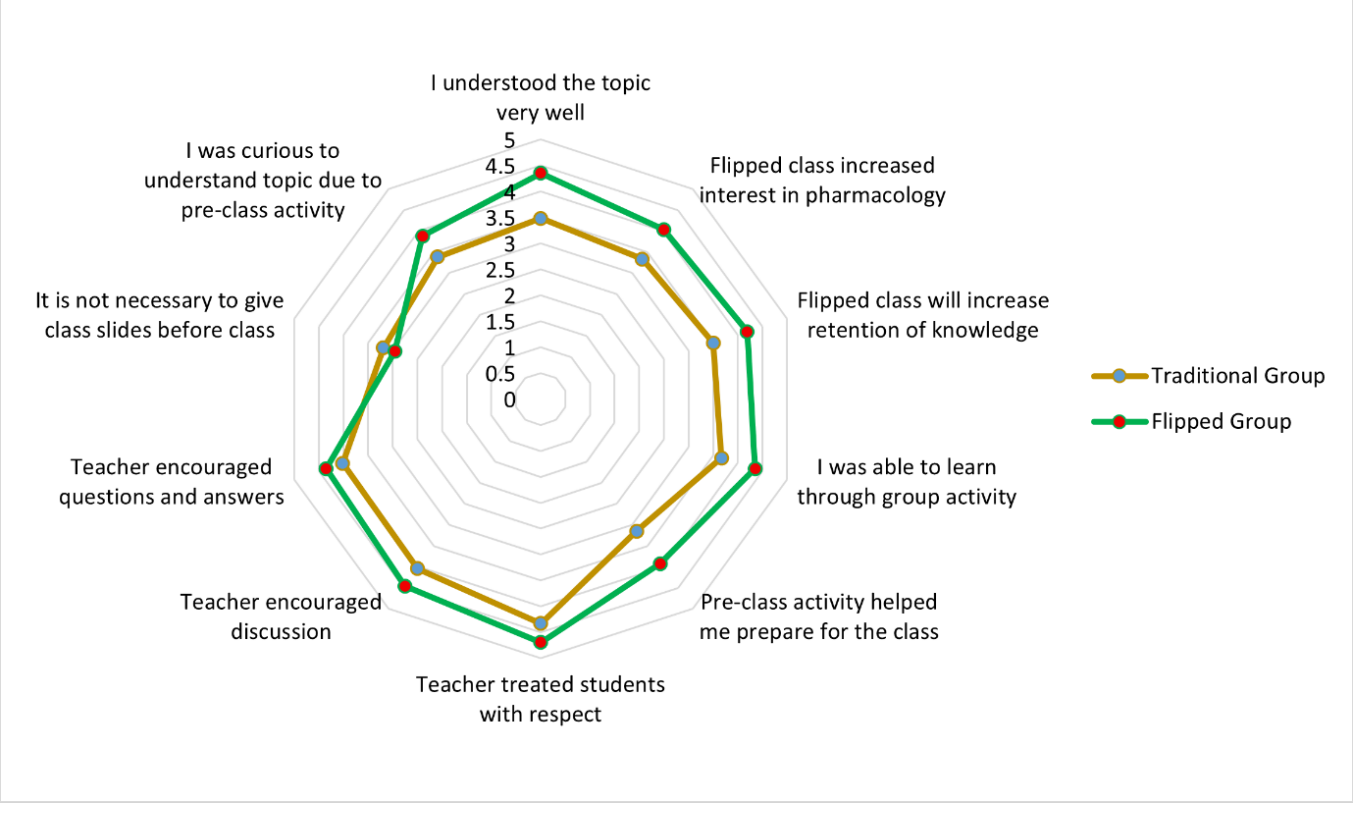

Figure 1: Radar chart comparing mean perception scores between flipped and traditional small groups

Students provided a range of suggestions for improving flipped classroom implementation (Table 4). Students mostly appreciated the method for encouraging self-study and improving understanding.

Table 4: Thematic summary of student suggestions for improving flipped classroom implementation

Theme	**Student Feedback (Illustrative Quotes)**
Preference for small topics	"Flipped class is better for short topics, not for long lectures. This method might not be useful for all topics, like where we require a long lecture or some demonstration." "I am not sure, as I experienced it for the first time."
Encouraged to self-study	"Slides made me read before class and ask questions."
Flipped helped understanding	"I understood better as I had time to read before class." "Sometimes happens that we are engaged with other subjects, and then it is difficult for the students." "To be honest, I didn't feel much difference between this and a regular class."
Request more videos/resources.	"The Teacher should give more videos before class."
Concern over time burden	"Sometimes it felt time-consuming with other assignments too."

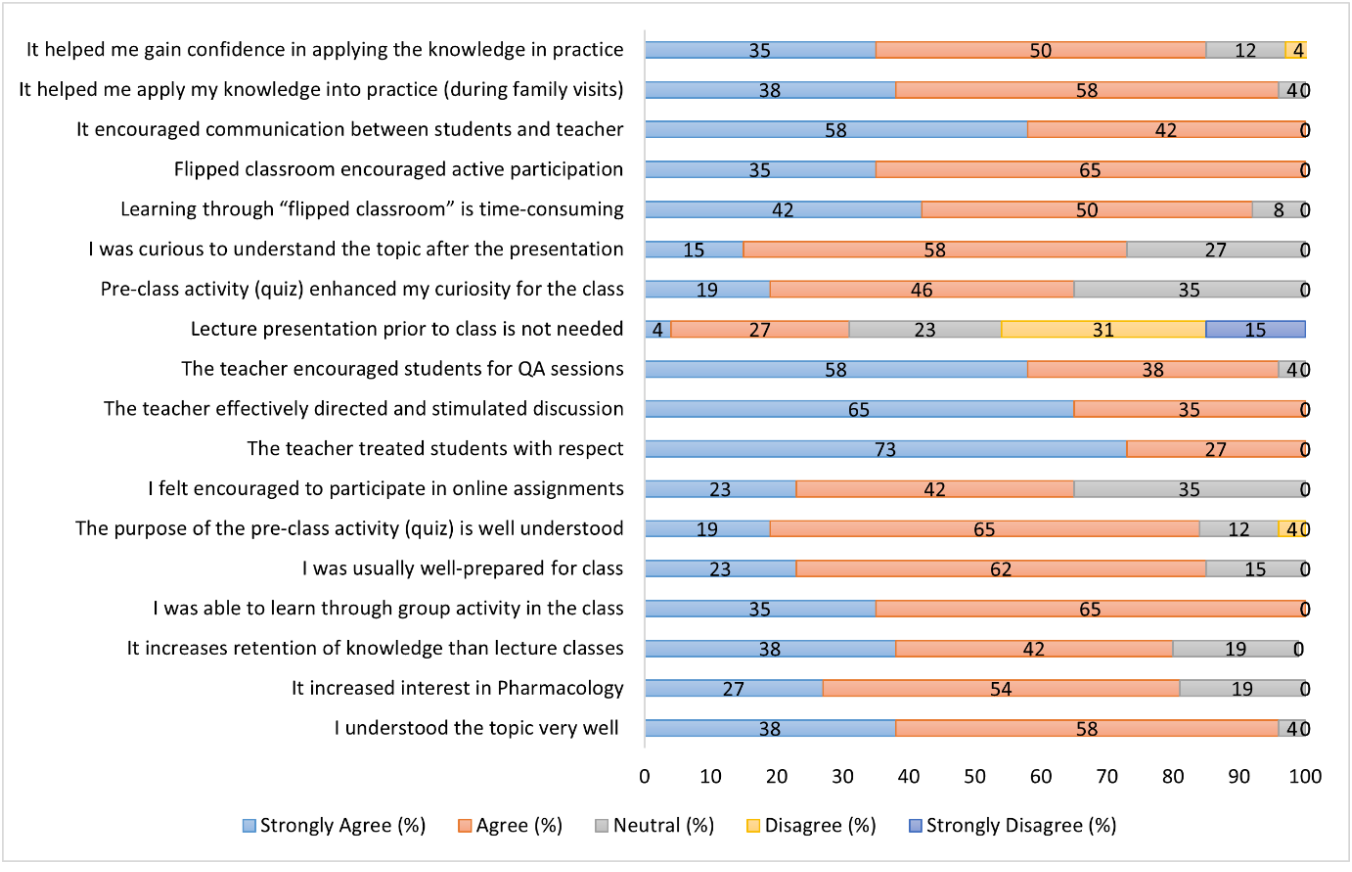

Figure 2: Distribution of student responses on selected perception items related to flipped classroom teaching

Discussion

The current research was done to assess the perception of second-year medical students obtained from two types of teaching models: flipped and traditional didactic teaching. The medical education system is ever evolving, both in content and innovation of teaching models. The aim of stakeholders of the medical education system is to have a high command of the medical curriculum. Learning should initiate thinking instead of being facilitated. In the current research, the assessment score achieved by the students of new model was significantly higher than that of the traditional teaching group. A similar study showed that the knowledge acquired though not affected, but students had scored high in perception from the innovative model (flipped). [25] Veronica Gillispie observed significant perception gain in various medical institutions. [26-29] It was inferred that the innovative classroom was more beneficial for medical students, as per Veronica Gillispie et al [26] and Veeramani R et al. [30,31.] In this study, it was shown that if learners were provided with good-quality study material, then there would be a greater possibility that the students would go through the material before attending the class. It was previously concluded that the innovative method has the potential to encourage learning and increase knowledge. From the above studies, it is worth noting that the students feel more confident in flipped classrooms while participating in classroom activities because, before going to the classroom, they have already read the content of the topic. Furthermore, the new method creates a flexible environment, improves the learners' choice to gain erudition at their own pace

Students provided a range of suggestions for improving the implementation of the flipped classroom. Students mostly appreciated the method for encouraging self-study and improving understanding. However, some students preferred this method only for shorter or simpler topics, expressing concerns about its applicability to content requiring extended explanations or demonstrations. A few respondents highlighted practical challenges, such as competing academic demands and limited time for preparation. Others recommended including more videos and supplementary materials to aid comprehension.

The current study showed a significant increase in perception score after attending the new teaching model. This is similar with the results of Unal and Unal [32]. At first, the educational materials for the flipped classroom should be carefully chosen to gain the maximum. It was observed from the current study that the interaction between student and teacher was relatively higher in the new model compared to the traditional one. Though students' unwillingness to adopt the new teaching method was there, it provided an incentive for the students' learning, active involvement, and self-driven effort to gather all information.

As a limitation, learning gains and communication skills were not evaluated in this study, and this is accounted as one of the first limitations. Secondly, the study was conducted for the second year students only in one college. Estimation may be more substantial when applied to various subjects, including clinical and non-clinical ones. Similar studies must be conducted for more academic years and in more colleges.

Conclusion

The current study emphasizes conducting training for teachers and medical undergraduates regarding the innovative teaching models and their impact on learning. This requires a willingness to actively participate, logistics, and support from stakeholders. So, before implementation, the institutional stakeholders should provide all the devices required for implementation of new teaching model. Due to the students' unfamiliarity with this new teaching method, teachers should have more control over their performance in the initial phase of implementation.

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Conflict of Interest

The author declares no conflicts of interest related to this work.

Data availability

Data are available upon reasonable request.

Author Contributions

SM contributed to conception and study design; MB contributed to drafting of the manuscript; DM and DK contributed to data acquisition; SSM contributed to data analysis and interpretation. All authors contributed to manuscript revision, read and approved the final version.

All authors meet the ICMJE criteria for authorship and agree to be accountable for all aspects of the work.

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