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# Effectiveness of flipped classroom as a teaching–learning method among undergraduate medical students – An interventional study

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## Abstract:

**BACKGROUND:** Attempts to put the available teaching–learning time to better use and address the needs of students by increasing active involvement led to the evolution of the flipped classroom (FC). It involves providing study resources for students to use outside the class so that class time is freed up for instructional activities. This study was done to assess the effectiveness of flipped classroom activity as a teaching–learning method.

**MATERIALS AND METHODS:** In this interventional study, 98 students were divided into two batches of flipped class and conventional small group teaching (SGT). An online Google group was created for the batch of FC. Brief introduction and prerecorded videos related to the assigned topic were posted in the Google group. Discussion was carried out in the form of solving cases and problem-solving exercises. Pretest and posttest were conducted at each session, and an end of module test was conducted for both the groups.

**RESULTS:** There was a significant difference between the pre- and posttest scores and also the mean scores of summative test between two groups ( $P < 0.001$ ). The perception of the students regarding FC was also evaluated. Eighty-two percent strongly agreed that FC was more engaging and interesting in comparison to traditional class. Seventy-six percent strongly agreed that more such classes should be conducted in the future.

**CONCLUSION:** Flipped classroom improved the student performance and learning experience effectively as compared to conventional SGT, and students' response was also largely positive.

## Keywords:

Effectiveness, flipped class, medical students, students' perception

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## Introduction

In medical course, a large proportion of teaching–learning time is occupied by didactic teaching sessions. Traditional teaching methods are definitely basic ways of imparting knowledge. Research in medical education technologies has supported that active learning strategies result in higher student engagement and greater learning gains as compared to

traditional instructor-centered methods such as didactic lecture.<sup>[1]</sup>

Attempts to put the available teaching–learning time to better use and address the needs of students by increasing active involvement in the teaching–learning process led to the evolution of the “flipped classroom (FC)” or “inverted classroom” approach.<sup>[2]</sup> The term “flipped classroom” was coined by Jonathan Bergmann and Aaron Sams, two high school chemistry teachers from Colorado, USA, in 2012. They

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had begun flipping the teaching and learning scenarios in 2007. In the words of the pioneers of the flipping classroom concept, “In this model of instruction, students watch recorded lectures for homework and complete their assignments, labs, and tests in class.”<sup>[1]</sup> Flipping the classroom involves providing instructional resources for students to use outside the class so that class time is freed up for instructional activities.”<sup>[3]</sup> In FC model, what is normally done in class and what is usually done as homework are interchanged.

During class time, facilitators focus on identifying and resolving misconceptions, fostering the development of problem-solving skills, and facilitating collaboration among students. A facilitator takes on the role of tutor or coach to help students in areas where they have trouble in the application of concepts.<sup>[4]</sup> Flipped classes enable instructors to spend extended time with students and facilitate them toward creation of higher level application projects which culminate in increased learning.<sup>[5]</sup> In this modern era of medical and technological advances, it is imperative to develop cardinal skills such as critical thinking, creativity, communications, and collaboration which are encouraged by activities employed while using FC model.<sup>[6,7]</sup>

Young *et al.* demonstrated medical residents’ preference for the flipped classroom format over the traditional lecture format.<sup>[8]</sup> Several studies have evaluated the impact of flipped classroom designs and the use of prerecorded videos in the pharmacy curriculum and found promising results with students’ performance and satisfaction with the courses.<sup>[7-11]</sup> Although the perceptions of students toward the FC approach have been evaluated in several disciplines and at varying levels of learning, such data are not available for medical students. More specifically, data on the efficacy of FC model in the teaching of pharmacology topics are lacking in literature, and also, there is a paucity of evidence regarding the evaluation of the effectiveness of flipped classroom as teaching–learning model. In the present era of evidence-based teaching and advances in medical education, this research will yield valuable information which can be used for adapting to the newer methods of teaching–learning on a regular basis which will be more student and teacher friendly. Hence, this study was planned to assess the effectiveness of flipped classroom activity as a teaching–learning tool as compared to conventional small group teaching (SGT) for the 2<sup>nd</sup>-year medical undergraduate students and to assess the perception of students and faculty on flipped classroom activity.

## Materials and Methods

The current interventional study was conducted to evaluate the effectiveness of the flipped classroom (FC)

activity, which was conducted among the 2<sup>nd</sup>-year medical undergraduate students. Ethical clearance was obtained from the Institutional Ethical Committee for Human Subjects Research. The study was conducted over a period of 6 months from June to December 2018 in the pharmacology department of a medical college. A batch consisting of 98 medical students posted in the department of pharmacology was randomly selected and included in the study using a universal sampling method. The students were included in the study after obtaining informed consent from each student. They were randomly divided into two batches comprising 49 of them in each of the two groups by Lot method. One batch was for FC activity and another for conventional method of SGT randomly.

The topics chosen for this study were “Drugs acting on Cardiovascular System” (CVS) from pharmacology curriculum. The conventional SGT group followed the traditional tutorial format of SGT conducted by the facilitator. Pretest and posttest were conducted at each session, and a summative test was conducted after 15 days of completion of all designated topics.

The second group was followed up with flipped class for the selected topic. Initially, an online “Google group” was created, and the general lesson plan and learning objectives were declared *a priori*. The FC module consisted of two parts: first, offloading content (online activity), and second, creating a learner-centered flipped classroom. The first part of FC activity included posting of study aids in the form of web source, brief introduction of the lecture topic, and prerecorded videos related to the assigned topic in the Google group, 1 week prior to the scheduled class. Instructions were posted in the Google group, for the students to access the materials for that week. The second part of the FC activity consisted of discussion in the form of solving cases, completing the blank flowcharts, and problem-solving exercises, which was planned for 2 h for each topic.

The second part of FC activity commenced with the administration of an objective type written pretest containing multiple-choice questions (MCQs) pertaining to the topics of discussion. Students were subdivided into groups of 5–6 students each, to facilitate group interaction, and were given handouts containing a set of problem-solving questions and case scenarios. The subgroups were given a time period of 20 min for the discussion among the group members. Subsequently, discussion was carried out with the help of clinical cases. Each case scenario was projected, and a member of the group randomly chosen by the facilitator to provide the answer to each question. The answer was discussed with the rest of the class. Additional questions in the form of MCQs, completing the

incomplete handouts, and extended R-type questions were incorporated during the discussion to review and emphasize the fundamental concepts. All the case scenarios and problem-solving questions allocated to all subgroups were addressed in a similar manner. At the end of discussion, supplemental information was provided by the facilitator for better understanding of its clinical relevance. At the end of each session, a posttest was administered. Similar sessions were conducted for all the selected topics of “Drugs Acting on Cardiovascular System.”

Apart from the pre- and posttest at each session, students’ performance was evaluated by an end of module test on drugs acting on CVS comprising short essay-type questions, which was conducted after 15 days of completion of all sessions. In addition, at the end of all sessions, a written feedback was obtained from the students who underwent FC activity and from the teaching faculty of the department regarding their perception on FC activity using a 5-point Likert scale in the form of questionnaire, with responders maintaining their anonymity. The feedback questionnaire on the FC activity was adapted from a validated questionnaire developed by Pierce and Fox.<sup>[12]</sup> This questionnaire was modified and revalidated appropriately to suit the needs. The number and percentage of students responding to each item were noted. The mean rating for each item was calculated. The questionnaire also contained open-ended questions at the end, so as to elicit freewheeling comments from the students as a qualitative dimension assessment. Student’s suggestions and remarks were also elicited.

### Data analysis

Data were coded and entered into the Microsoft Excel spreadsheet. The analysis was carried out with the Statistical Package for the Social Sciences (SPSS) version 20.0 [IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.]. The mean scores of pre- and posttest for each session were compared and analyzed using paired *t*-test. Besides this, scores obtained by the flipped class batch and conventional small group batch, in the end of module test, were compared using independent *t*-test.  $P \leq 0.05$  was considered statistically significant for all statistical tests. The scores of 5-point Likert scale were calculated and expressed as percentages to indicate agreement or disagreement of students with regard to the statements in the questionnaire.

## Results

This study was conducted to evaluate the effectiveness of flipped class as a teaching–learning method and to elicit the perception of the 2<sup>nd</sup>-year medical undergraduate students on FC.

The mean scores of pre- and posttest of FC group for all topics were compared, and the mean difference in the scores of all the three topics was found to be statistically significant ( $P < 0.001$ ) [Table 1]. The mean scores of the end of module test of FC batch and conventional SGT batch were  $15.53 \pm 3.76$  and  $9.61 \pm 3.90$ , respectively. Both the groups were compared, and the difference was statistically significant ( $P < 0.0001$ ) [Table 2]. The mean posttest scores of FC and conventional SGT groups were compared, and the difference was statistically significant ( $P < 0.0001$ ) [Table 3].

Students who participated in the FC activity responded to the questionnaire regarding their perception toward flipped class. The responses to each statement are summarized in Table 4. Ninety-four percent of students felt that the flipped classroom approach was better at fulfilling the stated learning objectives, 90% felt that the worksheet provided prior to the class enabled a better understanding of the subject, and 94% were of the opinion that learning key foundational content prior to coming to class greatly enhanced the learning of course material in class. Ninety-six percent of the students felt that the interactive, applied in-class activities during the flipped class greatly enhanced their learning. All the students opined that more such flipped classroom sessions should be organized in the future. The mean ratings for each category ranged between 3.85 and 4.76 proving the fact that the students appreciated flipped classroom approach. All the teaching faculty members opined that such classes were helpful in active learning and should be conducted on a regular basis.

Some of the opinions expressed by the students obtained in the form of open-ended questions from the flipped classroom approach are given below:

*“Teaching of difficult topics should be done in this way as it will make us understand the topics easier and it is an interactive method.”*

**Table 1: Comparison of pre- and posttest scores of flipped class for selected topics in pharmacology (n=49)**

Topics of flipped class	Mean±SD		
	Topic 1	Topic 2	Topic 3
Pretest scores	9.65±1.58	9.71±1.85	9.61±1.79
Posttest scores	12.63±1.48**	12.88±1.74**	13.29±1.41*

Independent *t*-test \* $P < 0.001$ , \*\* $P < 0.0001$ . SD=Standard deviation

**Table 2: Comparison of mean scores of the end of module test among flipped class and conventional small group teaching group (n=98)**

Groups	Flipped class group (n=49)	Conventional SGT group (n=49)
Mean scores of the end of module test	15.53±3.76*	9.61±3.90

Independent *t*-test \* $P < 0.0001$ . SGT=Small group teaching

**Table 3: Comparison of posttest scores of flipped class and conventional small group teaching group for selected topics in pharmacology (n=98)**

Method of teaching-learning activity	Mean±SD		
	Posttest scores of Topic 1	Posttest scores of Topic 2	Posttest scores of Topic 3
Conventional SGT group	10.20±1.77	10.04±1.76	10.22±1.75
Flipped class group	12.63±1.48**	12.88±1.74**	13.29±1.41**

Independent t-test. \*\*P<0.0001. SGT=Small group teaching, SD=Standard deviation

**Table 4: Perceptions of the students to flipped classroom as a teaching-learning activity (n=49)**

Content and structure	Response on Likert scale					Mean rating
	5	4	3	2	1	
At the beginning of the each session, all educational objectives were clearly defined	29 (59.1)	17 (34.8)	3 (6.1)	0	0	4.53
The worksheet given prior to the session was very useful to understand the topic	28 (57.1)	16 (33.7)	4 (8.2)	1 (2.0)	0	4.4
Learning key foundational content prior to coming to class greatly enhanced my learning of course material in class	29 (59.1)	17 (34.8)	2 (4.1)	1 (2.0)	0	4.35
I read assigned readings prior to coming to class	24 (48.8)	17 (34.8)	4 (8.2)	4 (8.2)	0	3.85
Interactive, applied in-class activities greatly enhanced my learning	29 (59.1)	18 (36.8)	2 (4.1)	0	0	4.43
I participated and engaged in discussions in class	22 (44.9)	22 (44.9)	2 (4.1)	3 (6.1)	0	4.05
In-class discussions of course concepts with my peers greatly enhanced my learning	27 (55.1)	19 (38.8)	2 (4.1)	1 (2.0)	0	4.30
The activities during FC session improved my understanding of the key concepts	31 (63.3)	15 (30.6)	2 (4.1)	1 (2.0)	0	4.39
Time allotted for the discussion was adequate	26 (53.0)	17 (34.7)	4 (8.2)	2 (4.1)	0	4.05
Enjoyable way of learning	31 (63.3)	15 (30.6)	3 (6.1)	0	0	4.39
This method was more engaging and interesting in comparison to traditional class	40 (81.7)	8 (16.3)	1 (2.0)	0	0	4.74
Instructor was able to engage me in the FC activity	35 (71.4)	12 (24.6)	1 (2.0)	1 (2.0)	0	4.55
More such modules should be organized in the future	37 (75.4)	12 (24.6)	0	0	0	4.76

Values are presented as number of responses to each statement (%) Response Likert scale. FC=Flipped classroom, 5=Strongly agree, 4=Agree, 3=Uncertain, 2=Disagree, 1=Strongly disagree

*“It helped us greatly in preparation for exams; more such classes should be conducted in future which could help us in many ways.”*

*“It was interesting, I was able to interact with the facilitator better as I had gone through the topic prior to class; it created an environment to share our understanding about the topic and allowed us to clarify the concepts.”*

*“I liked this type of class very much. The clinical case discussion was enjoyable. The scenarios made us like the topics of Pharmacology. Group activity was good as well.”*

Students also felt that this was an active learning process, and the discussion made them more attentive in the class and made them understand the concepts clearly. Some students were also of the opinion that FC should be carried out for difficult topics only, as it would help them understand the difficult concepts.

### Discussion

The flipped classroom model (also called an inverted classroom) has spread to many other branches and milieus of learning and education around the world. The use of FC has the potential to be an effective and beneficial method of education. Replacing direct instruction from the class time with video lectures observed outside of the classroom allows for more class time to be used for active learning and is gaining momentum across

a variety of educational institutions. This approach has been cited in health professional programs such as medicine, nursing, dentistry, and pharmacy. Flipped classes enable instructors to engage the participants, help the stakeholders toward self-directed learning, and facilitate them toward critical thinking which will result in better understanding of the subject by promoting active learning.<sup>[4,5]</sup>

In this study, we assessed the effectiveness of FC and perception of students regarding FC approach in teaching certain topics in pharmacology. Our FC design included active learning through solving clinical cases, interactions among students, and interactions with the facilitator. In our study, the mean posttest scores and the overall scores improved significantly in the flipped class model. Overall, the students viewed their learning experience positively, based on the results from the students’ feedback toward flipped class model.

The results from this study demonstrate that students who were exposed to online modules using the flipped course performed better than the conventional SGT batch of students, which are consistent with the results of the previous studies. The studies by Pierce and Fox, Litzinger *et al.*, and Olds and Johri also reported that the pharmacy students expressed a consistently high preference for the FC instructional model relative to the traditional instructor-led lecture model.<sup>[10,13,14]</sup>

A study conducted on nursing students to determine the effect of flipped classroom concluded that blending new teaching technologies with interactive classroom activities can result in improved learning but not necessarily improved student satisfaction.<sup>[15]</sup> In a study done by Gubbiyappa *et al.*, which evaluated the perception of undergraduate pharmacy students and effectiveness of FC activity using Poll Everywhere Audio Record System and another study which evaluated the effectiveness of FC activity as a teaching–learning tool for delivering complementary medicine module in the undergraduate pharmacy program, revealed that the FC activity is an effective teaching–learning method.<sup>[4,7]</sup>

The use of flipped classroom made students to learn the basic concepts effectively by viewing the posted study materials before the class, which gave more room for the facilitator to concentrate on the critical part of the lecture, application knowledge, and problem-solving skills during the class time as recommended by Milman who identified that the flipping allows increased class time for more engaging instruction, increased student engagement, and focused classroom discussion.<sup>[16]</sup>

In a study conducted by Nouri which examined students' perceptions of flipped classroom education among last-year university course in research methods, the results revealed that a large majority of the students had a positive attitude toward flipped classroom which strongly correlated to the perceptions of increased motivation, engagement, and effective learning. Low achievers significantly reported more positively as compared to high achievers with regard to attitudes toward the use of video as a learning tool, perceived increased learning, and perceived more effective learning.<sup>[17]</sup> Our study also substantiated this.

In a study conducted by Cabi, the results indicated that there were no statistically significant differences between the scores of conventional and FC group, i.e., the use of the FC model does not yield significant impacts on increasing the students' academic achievement.<sup>[18]</sup> Conversely though, the results of our study showed a significant difference in the performance among the FC group.

The key to the success of this approach is that students take responsibility for their own learning. Advantages of this approach include that there is an increase in opportunities for interaction between students and facilitators with a shift in the responsibility for learning onto the students, the opportunity to revise the material and as many times as required, the freedom to prepare for the class at a time that suits them, and the ability to readily archive learning resources. There was an increase in student engagement which led to shift from passive

to active learning. There are certain shortcomings of flipped class which include the need to invest time and resources to develop such courses and the possible need for technological investment and time for both teachers and students to acquire and adapt to the new skills required for this more active and self-directed approach to learning.

Flipping the traditional classroom is both a feasible and necessary move to educate students to reinvent their classrooms in a way that empowers students to develop higher order cognitive skills and to engage in meaningful learning that will ultimately improve the delivery of health care.<sup>[11]</sup>

There are certain limitations to this study. The entire pharmacology course cannot be taught using flipped classroom. Hence, it is important to plan and consider the academic time taken to deliver a course using a flipped classroom model. A hybrid of didactic teaching sessions interspersed with flipped sessions may be ideal.

## Conclusion

Medical teaching with flipped classroom approach improved the student performance and learning experience effectively as compared to conventional SGT. The flipped classroom approach improved the students' performance and perceptions of the learning experience. Student response to the flipped classroom structure was largely positive, indicating it to be an approach worth pursuing in future years for advancement in medical education technologies.

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## Conflicts of interest

There are no conflicts of interest.

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