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Flipped pedagogical approach in teaching skeletal muscle physiology for undergraduate medical students

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ABSTRACT

Objectives: Medical teachers need to use different pedagogical approaches to enhance student learning. Students are exposed to the flipped classroom (FC) in addition to the other teaching approaches which may enhance the comprehension, interpretation, and analytic skills of the students. The objective of this study was to compare the test scores obtained after the FC teaching session with the test scores obtained after a traditional classroom teaching session on a topic in skeletal muscle physiology delivered to 1st-year undergraduate medical students.

Materials and Methods: Twenty-one 1st-year undergraduate medical students, undergoing a musculoskeletal system module at a private medical college were involved in this study. Students in the flipped pedagogical method were required to read the notes and power-point slides provided in addition to watching the prerecorded lecture videos before class. During the class, there was a topic review session followed by a small case discussion in groups. In the traditional classroom, students were advised to attend the lectures but there were no recorded videos to watch before the session. The effectiveness of the two types of pedagogical approaches was tested through pre-test and post-test using multiple-choice questions. The students' perception of FC was collected through a semi-structured validated questionnaire.

Results: The pre-test mean score was higher for FC (5.48 ± 1.44) when compared to the traditional classroom (3.19 ± 1.4). In our study, the scores from pre-test to post-test in a traditional classroom showed statistically significant improvement (P = 0.0014) but were not statistically significant in the FC. In the flipped pedagogical approach, the difference between mean correct responses for question number 5 (P = 0.031) in pre-test and post-test was statistically significant. There was an improvement in the mean scores in all the eight questions between pre-test and post-tests in the traditional pedagogical method of teaching. About 79.6% of students agreed that they watched all the assigned videos and 78.6% of students completed reading the assigned power-point presentation slides before coming to the FC. About 78.5% agreed to learn more topics in FC format and 78.6% of students agreed that FC was more engaging and interesting in comparison to a traditional class.

Conclusion: Our study showed that flipped and traditional pedagogical approaches both enhance student learning.

Keywords: Flipped pedagogy, Traditional classroom, Skeletal muscle physiology, Student perception

INTRODUCTION

The 1st year of medical education for undergraduate medical students involves teaching-learning sessions that help to establish a strong understanding of physiological principles. Physiology is the foundation of medicine in an undergraduate medical curriculum and has been recognised as

a challenging discipline for medical students to comprehend, integrate and apply in clinical sciences.[1] In the present times, emphasis has been placed on the development of critical thinking skills in contrast to the emphasis on the systems-based didactic lectures. Hence, physiologists are looking for different pedagogic approaches to teaching physiology to undergraduate medical students.

The traditional classroom is a teacher cantered teaching method wherein during the teaching session the content expert presents information about a topic to students and tries to pack as much content as possible in the given time limit. In a traditional classroom, foundational knowledge is passively transferred to students during class through the means of a lecture delivered by content experts.[2] The students spend most of the time listening to what the content expert tells during the teaching session. Hence, the student's engagement with the content expert during the session is constrained as there is insufficient time for them to discuss the topic with the faculty member. Hence, the content experts try to imbibe newer teaching-learning approaches in attempting to make the learning process more engaging.

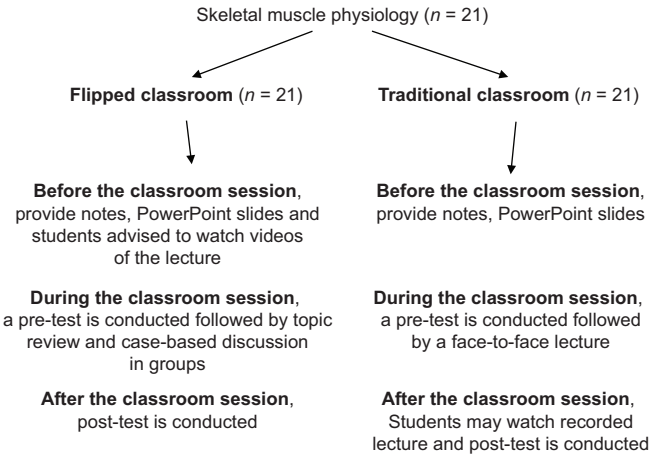
The flipped classroom (FC) is a type of instructional approach that encourages higher-order thinking and active participation from students.[3] The FC is changing the face of teaching across the world in higher education. The utilisation of the FC teaching method in teaching medical students was first demonstrated and published lately.[4] In the current years, educators encircle FC as it is a student-centered teaching method. In this method, students are subjected to teaching materials in the structure of short videos, PowerPoint slides, and assignments earlier to the class, and during the class the session is structured to encompass short lecture review sessions where students are provided a favourable circumstance to raise a question and get occupied with the content expert. After the review session, the content expert can conduct learning activities like short medical cases related to the topic, quizzes, and small group discussions which will help students to acquire a better understanding of the content in comparison with learning through traditional teaching methods.

It is suggested that the FC actively encourages the incorporation of independent learning and use of technology outside the classroom and student-centered activities[5] and more organised student-teacher interactions inside the classroom.[6] Hence, the study was conducted with the objectives to assess the test scores of the participating 1st-year MBBS students after an FC session on a topic in skeletal muscle physiology (using a pre-test and post-test) and to compare these scores with the test scores after traditional classroom teaching session on a topic in skeletal muscle physiology (using a pre-test and post-test) and to assess the students' appreciation toward the FC teaching method using a semi-structured peer validated feedback questionnaire.

MATERIALS AND METHODS

After obtaining permission from the Institutional Ethics Committee, the objectives of the study were explained to 1st-year medical students, who were enrolled in the Bachelor of Medicine, Bachelor of Surgery (MBBS) course in a private medical school. Twenty-one 1st year medical students agreed to participate in this study by giving written consent. In the MBBS curriculum, skeletal muscle physiology is covered in three lectures. One of the lectures was flipped and the other two lectures were conducted in traditional format. All 28 students attended both flipped and traditional format lectures.

Flow chart showing the study design for traditional versus flipped classroom



Study design for FC

The study resources which were made available for the FC included the PowerPoint slides, the recorded lecture videos, and the discussion questions. The study resources were posted on Moodle 72 h before the scheduled teaching session. The students had to listen to four recorded lecture videos each of 15-min duration. A lecture review was conducted in the first 15 min of the FC session where the faculty member cleared the concepts and discussed the questions raised by the students. Following the review session, students were divided into six small groups randomly and were ready to start with the case-based discussion. For the case-based discussion, a clinical scenario with six short essay questions was given to the students for discussion. Students were advised to discuss the short essay questions with the group members. Students were given 45 min time duration to discuss the short essay questions. Once the class completed the group work, the faculty member discussed these questions and answers.

Study design for traditional classroom

The study resource included PowerPoint slides which were made available on Moodle 72 h before the scheduled teaching session. The in-class lecture of 1 h duration was captured and the video was made available to the students immediately after the lecture session on Moodle to view as needed.

Pre-test and post-test

The pre-test was conducted before the teaching sessions which comprised eight one correct response types of multiple-choice questions. One mark was awarded for the right answer and the maximum marks achievable by students was eight. The post-test was conducted 2 days after the teaching sessions, using the same questions which were used for the pre-test and the time duration was 10 min for each test. The scores of the pre-and post-tests were analysed.

Student feedback

A validated questionnaire about students' attitude regarding the FC teaching session was obtained after the FC session but before the traditional classroom session. The students' feedback on the traditional classroom was not obtained.

Statistical analysis

The data were analysed using SPSS version 22.0.

The independent variable used in the study was the type of classroom (flipped, traditional). Mean, standard deviation, and confidence interval was stated. Independent samples *t*-tests were used to compare mean scores across groups to detect statistically significant differences. The standard error of difference between two means was calculated and statistical significance was determined at $P < 0.05$.

RESULTS

In the present study, out of 28 1st year undergraduate MBBS students, seven students did not give post-test due to absenteeism for varied reasons. Hence, they were excluded from study and data analysis was done for 21 students. All the cohorts ($n = 21$) involved in the study were taught by the same faculty for both flipped and traditional classroom sessions and the pre-and post-tests questions were same for both the sessions. This is done to ensure and rule out the consequences, if any, of confounding variables.

Distribution of total scores in pre- and post-tests

The mean score for FC was 5.48 ± 1.44 in the pre-test and 5.67 ± 1.56 in the post-test and the mean score for traditional classroom was 3.19 ± 1.4 in the pre-test and 5.33 ± 1.85 in the post-test [Table 1]. The pre-test mean score was higher for FC (5.48 ± 1.44) when compared to traditional classroom (3.19 ± 1.4). In our study, the scores from pre-test to post-test in a traditional classroom showed statistically significant improvement ($P = 0.0014$) but was not statistically significant in the FC [Table 1].

Table 1: Mean and SD of total scores in pre- and post-tests in the flipped classroom and traditional classroom.

	Flipped classroom			Traditional classroom		
	Pre-test	Post-test	*P*-value	Pre-test	Post-test	*P*-value
Mean	5.48	5.67	0.5182	3.19	5.33	0.0014*
SD	1.44	1.56		1.40	1.85	

SD: Standard deviation, *Statistically significant

Question wise distribution of mean correct responses in FC

The mean scores in question number 2, 3 and 5 showed an improvement in score between pre and post-tests but only the difference between mean correct responses for question number 5 ($P = 0.031$) was statistically significant [Table 2]. For question number 5, the mean score increased from 0.19 ± 0.4 (95% CI: 0.007–0.37) in the pre-test to 0.52 ± 0.51 (95% CI: 0.29–0.75) in the post-test. The mean scores in question number one, four and six showed a decrease in post-test score when compared to pre-test score. The mean scores in question number seven and eight did not show any change between pre and post-tests scores.

Question wise distribution of mean correct responses in traditional classroom

There was improvement in the mean scores in all the eight questions between pre-test and post-tests but the mean scores of question numbers 5 ($P = 0.031$), 6 ($P = 0.031$) and 7 ($P = 0.008$) in pre-test and post-test were statistically significant [Table 3]. For question number 5, the mean score increased from 0.33 ± 0.48 (95% CI: 0.11–0.55) in the pre-test to 0.67 ± 0.48 (95% CI: 0.45–0.89) in the post-test. For question number 6, the mean score increased from 0.24 ± 0.44 (95% CI: 0.04–0.44) in the pre-test to 0.57 ± 0.51 (95% CI: 0.34–0.80) in the post-test. For question number 7, the mean score increased from 0.24±0.44 (95% CI: 0.24–0.70) in the pre-test to 0.62 ± 0.5 (95% CI: 0.39–0.85) in the post-test.

Comparison of post-test scores of FC and traditional classroom

The mean post-test scores of both flipped and traditional classroom were compared. In our study, the post-test scores

Table 2: Mean correct responses in pre- and post-tests in the flipped classroom.

Question number	Pre-test (*n*=21)		CI		Post-test (*n*=21)		CI		Z value	*P* value
	Mean	SD	Lower	Upper	Mean	SD	Lower	Upper		
1	0.67	0.48	0.4468	0.8865	0.52	0.51	0.2909	0.7568	0.10433	0.186
2	0.76	0.44	0.5632	0.9606	0.9	0.3	0.7678	1.0417	0.07825	0.083
3	0.57	0.51	0.3406	0.8023	0.71	0.46	0.5036	0.9250	0.12509	0.267
4	0.62	0.5	0.3925	0.8456	0.43	0.51	0.1977	0.6594	0.11168	0.104
5	0.19	0.4	0.0073	0.3736	0.52	0.51	0.2909	0.7568	0.14365	0.031*
6	1	0	-	-	0.9	0.3	0.7678	1.0417	0.06564	0.162
7	0.86	0.36	0.6939	1.0204	0.86	0.36	0.6939	1.0204	0.09759	1
8	0.81	0.4	0.6264	0.9927	0.81	0.4	0.6264	0.9927	0.09759	1

SD: Standard deviation, CI: Confidence interval at 95% confidence limits, Z value: Standard error of difference between means. *Statistically significant

Table 3: Mean correct responses in pre- and post-tests in the traditional classroom.

Question number	Pre-test (*n*=21)		CI		Post-test (*n*=21)		CI		Z value	*P* value
	Mean	SD	Lower	Upper	Mean	SD	Lower	Upper		
1	0.81	0.4	0.6264	0.9927	0.86	0.36	0.6939	1.0204	0.10859	0.666
2	0.29	0.46	0.0750	0.4964	0.57	0.51	0.3406	0.8023	0.14046	0.055
3	0.62	0.5	0.3925	0.8456	0.81	0.4	0.6264	0.9927	0.16358	0.258
4	0.19	0.4	0.0073	0.3736	0.48	0.51	0.2432	0.7091	0.14046	0.055
5	0.33	0.48	0.1135	0.5532	0.67	0.48	0.4468	0.8865	0.14365	0.031*
6	0.24	0.44	0.0394	0.4368	0.57	0.51	0.3406	0.8023	0.14365	0.031*
7	0.24	0.44	0.0394	0.4368	0.62	0.5	0.3925	0.8456	0.12866	0.008*
8	0.48	0.51	0.2432	0.7091	0.76	0.44	0.5632	0.9606	0.14046	0.055

SD: Standard deviation, CI: Confidence interval at 95% confidence limits, Z value: Standard error of difference between means. * Statistically significant

between a FC and traditional classroom were not statistically significant [Table 4].

Student feedback on FC

In the present study, 79.6% agreed that they watched all the assigned videos before coming to the FC [Figure 1]. Majority of the students agreed that the interactive applied in class activities and in-class discussions of the course concepts with peers during FC enhanced their learning. About 78.5% of the students agreed that FC was an enjoyable way of learning [Figure 1].

DISCUSSION

This study was designed to evaluate the effectiveness of FC versus traditional classrooms in teaching skeletal muscle physiology to 1st-year MBBS students.

In our study, the pre-test mean score was higher for FC (5.48 ± 1.44) when compared to the traditional classroom (3.19 ± 1.4) [Table 1]. In a study conducted among 95 4th-year students enrolled in the ophthalmology clerkship, there were no differences between the FC group and traditional lecture-based classrooms with regard to their pre-test scores, but the post-test showed that students in the FC group had

Table 4: Comparison of post-test scores of flipped classroom and traditional classroom.

	Flipped classroom	Traditional classroom	*P*-value
	Post-test	Post-test	
Mean	5.67	5.33	0.43846
SD	1.56	1.85	

SD: Standard deviation

significantly higher scores than those from the traditional lecture-based classroom.[7]

The scores from pre-test to post-test in a traditional classroom showed statistically significant improvement but not in the FC [Table 1]. A traditional classroom is a passive learning method and students have minimal knowledge about the topic prior to the classroom session. The power-point slides were designed to help students to prepare for the pre-test and the lecture but power-point slides without a video did not stimulate any interest among our students which resulted in a decrease in the pre-test score. The results show that the traditional passive teaching approach has a positive impact on student cognitive outcomes. But in a study conducted at a medical

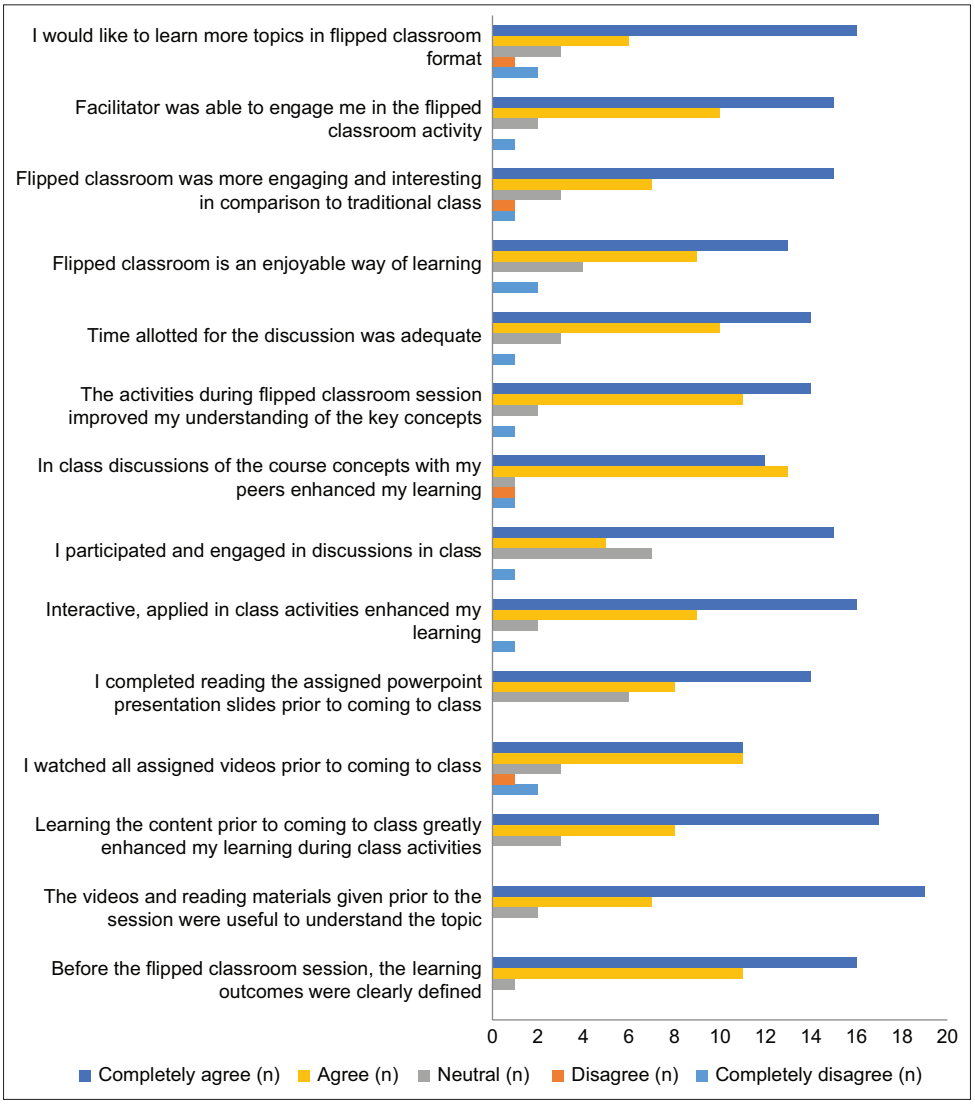


Figure 1: Students' perception about flipped classroom.

college in India among medical students about knowledge of participants about various components of the National Vector Borne Disease Control Program statistically significant improvement in knowledge from pre-and post-intervention because of the 'Flipped Teaching Model' was reported.[8] Tune *et al*. also reported statistically significant improvement in knowledge of medical students about cardiovascular, respiratory, and renal physiology with flipped teaching methodology when compared to traditional teaching methodology.[9] In a study conducted in India among 150 1st year medical students, there is statistically significant post-test score in FC method compared to traditional classroom method, concluding FC method improves teaching-learning outcome compared to traditional method[10] which contrasts with the findings observed in our study.

In the FC, the mean scores in question number 2, 3 and 5 showed an improvement in score between pre and post-tests but only the difference between mean correct responses for question number 5 (P = 0.031) was statistically significant [Table 2]. In the traditional classroom, there was improvement in the mean scores in all the eight questions between pre-test and post-tests but the mean scores of question numbers 5 (P = 0.031), 6 (P = 0.031) and 7 (P = 0.008) in pre-test and post-test were statistically significant [Table 3]. This shows lack of pre class preparedness among students in a traditional classroom format when compared to the FC format and the effectiveness of passive traditional teaching method. The post-test scores between a FC and traditional classroom were not statistically significant [Table 4]. This indicates that traditional and FC pedagogical approaches cause equal retention of knowledge.

In our study, 79.6% of students agreed that they watched all the assigned video and 78.6% of students completed reading the assigned power-point presentation slides before coming to the FC [Figure 1]. Short videos which present information to students makes learning easier for students and strengthen their concepts. About 78.5% agreed to learn more topics in FC format [Figure 1]. Christopher and Pound studies said medical students have generally expressed strong satisfaction with early applications of the FC to undergraduate medical education and generally prefer this method to lecture-based instruction.[11]

When queried if FC was more engaging and interesting in comparison to traditional class, 78.6% of students agreed [Figure 1]. This is consistent with the study which was conducted among 1st-year undergraduate medical students where students' enjoyment during class hours, interaction and learning process in FC method was more compared to the traditional method.[10] In our study, when students were enquired about various factors which enhanced their learning 89.2% students agreed that interactive, applied in class activities enhanced their learning, 89.3% agreed that in class discussions of the course concepts with my peers enhanced my learning and 89.3% agreed to that the activities during FC session improved their understanding of the key concepts. It is a fact already known that the strategy of FC is to provide students an opportunity to apply what they have learned prior to class and this is well documented from the student feedback when they were asked about various factors that enhance their learning. In the FC, the in-class activity involves discussions over the assigned topic and application-based learning activities which are based on the study materials provided earlier. In a study conducted among students undergoing a basic-science course in the 1st-year curriculum which covered basic neuroscience, neuroanatomy, histology, and systems physiology, the majority of students felt that the FC better helped them increase their analytical thinking (58.5%) and problem-solving skills (61.5%) compared to the traditional classroom.[12]

CONCLUSION

Our findings suggest that flipped pedagogical approach and traditional teaching approach are both effective means of teaching undergraduate medical students.

Limitations

Limitations of the present study were that it was conducted on only one batch of MBBS cohort and only to skeletal muscle physiology topics.

Acknowledgments

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Declaration of patient consent

Patient's consent not required as there are no patients in this study.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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