

ORIGINAL ARTICLE

Comparison Between Flipped Classroom and Traditional Classroom Strategies in Teaching Human Anatomy

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ABSTRACT

Objective: To compare the effect of flipped classroom versus traditional classroom on students' academic performance in teaching human anatomy. To assess the perceptions of medical students about flipped classroom and traditional classroom strategies.

Study Design: The present study followed quasi-experimental design, including pretest, posttest, and a questionnaire.

Place and Duration of Study: The study was carried out in the Department of Anatomy, at Wah Medical College, Pakistan from April 10th, 2023, to June 9th, 2023.

Materials and Methods: A total of 143 second year MBBS students were randomly divided into two groups; Group I (n=72) and Group II (n=71). Group I (Experimental group) was exposed to the flipped classroom while Group II (Control group) was taught through the traditional classroom. A Pretest and a posttest were taken at the start and end of the experiment. Perceptions of students regarding flipped classroom and traditional classroom strategies were recorded through a 5-point Likert scale questionnaire. The data was analyzed by SPSS version 23. The *p* value 0.05 was significant.

Results: The mean pretest score was not statistically significant between groups I and II ($p > 0.05$). By the end of the study, the mean posttest score of each group significantly raised as compared to its pretest score ($p < 0.001$). However, Group I achieved a significantly higher posttest score than Group II ($p < 0.05$). Students perceived flipped classroom as more beneficial than traditional classroom ($p = 0.001$) as it enhanced their understanding, memorization, integration, and application of subject knowledge. Moreover, flipped classrooms proved to be more valuable in engaging students and improving their ability to participate in problem-solving activities.

Conclusion: Flipped Classroom has proven to be a more effective strategy in teaching human anatomy to medical students compared to traditional classroom method.

Key Words: *Anatomy, Flipped Classroom, Student Performance, Teaching, Traditional Classroom.*

Introduction

Despite the advances in medical education, a large proportion of basic medical sciences curriculum is delivered to the students through teacher-centered lectures which are certainly considered to be the basic method of imparting knowledge. However, it has become increasingly difficult for the educators of

generation X (born between 1965 and 1979) to maintain interest of learners of generation Z (born after 1995) on account of short attention spans of these 'digital natives' and their interests towards creativity, stimulating and entertaining activities. They prefer to listen lesson recordings in their own comfortable time instead of taking notes during the lectures.¹

Anatomy, being the fundamental subject in medical sciences, has always been considered difficult to learn.^{2,3} Medical students frequently report problems related to memorization of the facts of human anatomy and its application in preclinical and clinical subjects.^{4,5} Although teachers practice a variety of pedagogical strategies, most of the classroom time is still utilized in listening to lectures in traditional classroom, and usually, students complete assignments at home.⁶ In the context of global curricular reforms, existing anatomy training

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has become more challenging and needs to be shifted from passive to active learning mode.⁷

Flipped classroom has emerged as an innovative active learning strategy and has gained much attention for its strong contribution to improving self-directed learning, motivation, and retention of knowledge.^{8,9} In flipped or inverted classroom approach, what is generally done during class time and what is typically completed as homework are reversed. Followed by pre-class preparatory work designed by the instructor, in-class time is effectively utilized in engaging the students in various learning activities which focus on peer discussions and develop problem-solving skills. Students take responsibility for their own learning while the teacher serves as a guide and resolves the queries of students. Learning retention is ensured by post-class activity in the form of reflections and practice.^{10,11}

Despite the reports of many researchers in favor of flipped classroom,^{11,12} some studies have found insignificant differences between the beneficial effects of flipped versus traditional classroom.^{13,14}

Flipped classroom model is still in its early phase and traditional lecturing is yet preferred by a large group.¹⁵ Moreover, available data in the discipline of Anatomy is very scarce. Keeping in view the current demand of evidence-based teaching and characteristics of generation Z students, the present study was designed to accomplish the following objectives:

- To compare the effect of flipped classroom versus traditional classroom on students' performance in teaching human anatomy.
- To assess the perceptions of medical students related to flipped classroom and traditional classroom strategies.

Materials and Methods

The present study followed quasi-experimental design, including pretest, posttest and a questionnaire.^{12,16,17} The study was carried out in the department of Anatomy, at Wah Medical College, Pakistan from April 10th, 2023, to June 9th, 2023. The approval of study was taken from the Institutional Review Board (Letter No. WMC/ERC/IRB/035, Dated: April 5th, 2023).

The effectiveness of flipped classroom was investigated in a course of human anatomy (Development of gastrointestinal tract) in Year-II

MBBS (NUMS Curriculum) Developmental Anatomy forms the compulsory part of curriculum. Generally, it is taught through the traditional lecture method.

A sample of 143 second year MBBS students was selected by non-probability convenience sampling technique. Students who have passed the first professional exam (in first attempt) were included in the study after their informed consent. Seven students were excluded from the study as they were irregular in classes, and they had to prepare for the supplementary exam. Similarly, students having attendance <75%, and those who were absent in pretest were also excluded from the study.

The second-year students (n=143, mean age=20.46±0.91 years) were randomly divided into two groups; Group I (n=72, mean age=20.37±0.11 years) and Group II (n=71, mean age=20.55±0.11). Group-I (Experimental group) was exposed to flipped classroom (8 sessions, each of 1-hour duration) while Group II (serving as control group) was taught through traditional classroom (8 sessions, each of 1-hour duration). Both groups were taught by the same instructor/ facilitator on the same day of each week (Group I immediately after group II, in the subsequent hour). Moreover, topics and their learning outcomes were the same for both groups except for the teaching strategy. The details of study participants are given in Figure 1.

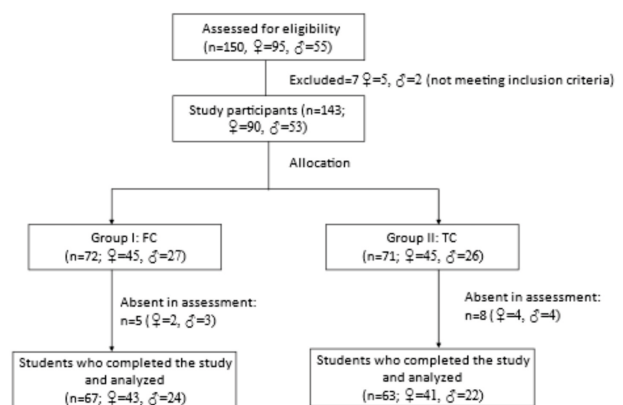


Figure 1: Showing Number of Study Participants in Group I: Flipped Classroom (FC) and Group II: Traditional Classroom (TC)

A Pretest (Comprising 10 MCQs and 2 SEQs based on clinical scenarios) was taken from both groups at the start of experiment. In each session of flipped classroom, three steps were followed: Step-I: pre-class; Step-II: in-class; Step-III: after-class. Step-I was

online. For this purpose, an on-line google classroom was created. The facilitator posted reading material in the form of lecture notes, ppt/pdf, and relevant videos at least 2 days prior to the scheduled face-to-face in-class session. In addition, the facilitator supervised the online discussions of students with their peers and encouraged them to come in class with questions. Step-II was face-to-face session (in-class session). The facilitator provided a quick review of already posted material. Class time was mainly utilized in student-centered activities designed by the facilitator. The in-class activities were selected in accordance with topic demand e.g. demonstration on models by the students, case-based discussions, presentations, and various problem-solving activities. Main theme was to engage students and to augment discussions with peers and teacher to resolve the queries of students. Throughout the session, the teacher served as a guide, however, she contributed to discussions where necessary, focusing on achievement of desired session learning outcomes. Step-III (after-class) was online in the form of writing reflection and reviewing the content. Similar content was taught to Group II by the same instructor but through traditional way (teacher-centered). There was no preparatory work assigned to the students. Although lectures were interactive but most of the class time was utilized by the students in listening didactic lecture. By the end of each lecture, a question-answer session was carried out and the students were given assignments. At the end of study, a posttest (Comprising 10 MCQs and 2 SEQs based on clinical scenarios) was taken from both groups.

Although most of students attended the sessions, some students were highly irregular and short of attendance (<75%) on account of various reasons and were absent on the day of posttest. Finally, 67 students of group-I and 63 students of group-II completed the study (Figure 1). Instruments used for data analysis were as follows:^{12,16.}

1. Instrument 1: At the start of experiment, a pretest was taken from both groups to confirm the homogeneity of both groups, in terms of academic achievement.
2. Instrument 2: By the end of study, academic performance of both groups was assessed through a posttest assessing the development of

digestive system.

3. Instrument 3: A 12-item questionnaire was adopted from Bansal et al¹⁶ to assess the perceptions of students regarding flipped classroom and traditional classroom strategies. The questionnaire was reviewed by the Institutional Research Advisory Committee/ Institutional Review Board. Responses were based on a 5-point Likert scale: 1= Strongly disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly agree.

The data was analyzed by SPSS version 23. For quantitative analysis, mean \pm SD scores of each group were calculated for pretest & posttest. Descriptive statistics were applied for measuring frequencies, percentages, means and standard deviations. Mean pretest score was compared by independent samples t-test between control and experimental groups. Similarly, mean posttest score was also compared between both groups by independent samples t-test. Then a paired samples t-test was applied to compare mean difference in pretest and posttest score of each group (at the start and end of experiment). The p value 0.05 was significant. Scores obtained from Questionnaire were analyzed using independent samples t-test. A score ≥ 4 was considered satisfactory.¹⁸

Results

Out of 143 second year MBBS study participants, 130 students completed the study. Of the 130 analyzed students, 67 were from group I who participated in flipped classroom and 63 students were from group II which were taught through traditional classroom. Pretest score (mean \pm SD) was not statistically significant between the groups I & II ($p > 0.05$), indicating that both groups were homogenous at the start of experiment (Table I).

After the experiment, posttest score of each group significantly raised as compared to its pretest score ($p < 0.001$) (Table II). However, Posttest score of group I was significantly higher than group II ($p = 0.05$) reflecting that flipped classroom outweighs the traditional classroom (Table I)

For each item in the questionnaire, the mean score for each teaching strategy is shown in Figure 2. Likert-scale analysis of questionnaire showed that students perceived flipped classroom as more beneficial than traditional classroom ($p < 0.001$) as it enhanced their

Table I: Showing Comparison of Pretest and Posttest Score Between Group I (n=67) and Group II (n=63)

	Group I (mean \pm SD)	Group II (mean \pm SD)	p value
Pretest Score	10.43 \pm 3.15	10.49 \pm 3.27	0.91
Posttest Score	13.73 \pm 4.03	12.20 \pm 4.10	0.03*
Independent samples t-test was applied. *Significant at p value \leq 0.05			

Table II: Showing Comparison of Pretest and Posttest Score within Each Group

Groups	Pretest Score (mean \pm SD)	Posttest Score (mean \pm SD)	p value
Group I (n=67)	10.43 \pm 3.15	13.73 \pm 4.03	<0.001***
Group II (n=63)	10.49 \pm 3.27	12.20 \pm 4.10	<0.001***
Paired samples t-test was applied. ***Significant at P value < 0.001			

understanding, memorization, integration, and application of subject knowledge. Moreover, flipped classroom proved to be more valuable in engaging students and improving their ability to solve clinical scenarios (Table III)

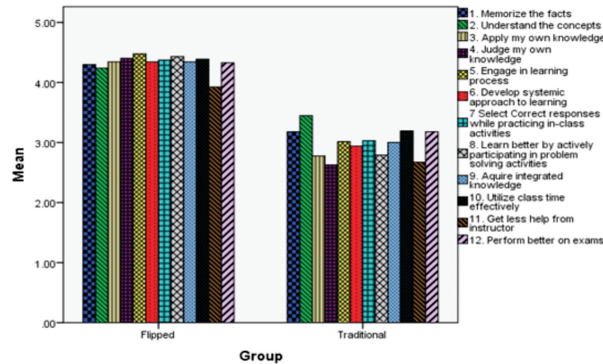


Figure2: Showing perceptions of students regarding beneficial effects of flipped classroom versus traditional classroom on a 5-point Likert scale: 1= Strongly disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly agree.

Discussion

With an awareness of the challenges in learning human anatomy, we conducted a comparison of academic performance of students in flipped classroom versus traditional classroom in a course of human anatomy taught to second year MBBS students. The perceptions of students regarding both teaching strategies were also evaluated. In our findings, we observed that academic performance of flipped classroom students was statistically significant ($p < 0.05$) than students taught

Table III: Showing Comparison of Mean Score of Perceptions of Students Regarding Flipped Classroom (FC) Versus Traditional Classroom (TC) Recorded on 5-Point Likert-Scale Questionnaire

S. No	The Course helped me to:	Teaching Strategy	Mean	SD	p Value
1.	Memorize the facts	FC	4.29	±0.79	<0.001***
		TC	3.17	±1.12	
2.	Understand the concepts	FC	4.23	±0.85	<0.001***
		TC	3.44	±1.01	
3.	Apply my own knowledge	FC	4.34	±0.76	<0.001***
		TC	2.77	±1.02	
4.	Judge my own knowledge	FC	4.40	±0.85	<0.001***
		TC	2.62	±1.05	
5.	Engage in the learning process	FC	4.47	±0.74	<0.001***
		TC	3.01	±1.02	
6.	Develop systemic approach to learning	FC	4.34	±0.74	<0.001***
		TC	2.94	±1.07	
7.	Select correct responses while practicing in-class activities	FC	4.37	±0.79	<0.001***
		TC	3.02	±1.08	
8.	Learn better by actively participating in problem-solving activities	FC	4.43	±0.83	<0.001***
		TC	2.79	±1.05	
9.	Acquire integrated knowledge	FC	4.34	±0.80	<0.001***
		TC	3.00	±1.10	
10.	Utilize class time effectively	FC	4.38	±0.79	<0.001***
		TC	3.19	±1.14	
11.	Get less help from instructor	FC	3.92	±1.09	<0.001***
		TC	2.67	±1.28	
12.	Perform better on exams	FC	4.32	±0.94	<0.001***
		TC	3.17	±1.16	
Independent samples t-test was applied.					
***Significant at p Value < 0.001					

through traditional classroom. The considerable improvement in scores observed among students in the flipped classroom can be attributed to the features in which this teaching method has benefited

them (Table III, Figure 2). Moreover, students reported that the flipped classroom proved to be more effective in memorizing the subject than traditional classroom. Our findings are consistent with a previous study which demonstrated significantly higher retention levels of students in flipped classroom compared to their counterparts in the classical blended learning group, in a scientific research methods course.¹² However, some researchers did not find statistically significant difference between assessment score of students taught through flipped classroom and traditional classroom.¹³

Certainly, medical graduates must employ an ample understanding of anatomy for the practice of medicine safely.⁵ To attain profound and extensive learning, students need to be able to apply and assess their own knowledge. Moreover, it is essential in this context to grasp concepts, acquire integrated knowledge, and cultivate a systemic approach to learning.¹⁶ In accordance with previous researchers¹⁸, students utilizing the flipped classroom in our study highly appreciated these specific benefits of the approach.

Students in the flipped classroom also expressed appreciation for the enhanced chance to engage in problem-solving activities, thereby making effective use of class time. They interacted with each other and got less help from the teacher. These findings of present study are concomitant with Angadi et al¹¹ who investigated the effectiveness of flipped classroom approach in a course of pharmacology. Flipped classroom improved the performance of students as compared to conventional classroom and 82% students favored it in terms of engaging and building their interests in the subject.

In a study conducted on 800 university students, flipped classroom mode was found to be very effective in improving self-regulated learning and social connectedness of students.¹⁷ An interventional study was carried out at Agha Khan university to conduct online flipped classroom in a module of endocrine reproduction. The learner curve demonstrated substantial increase in the knowledge learned. The students praised this strategy and requested its continuation in future.¹⁹ Amazingly, flipped classroom strategy proved to be exceptionally valuable for difficult topics,

particularly for medical students with lower performance levels.¹⁶

Contrary to our findings, in an ophthalmology clerkship, fourth year medical students complained of increase in burden and pressure during preparatory work of flipped classroom.²⁰ Similarly, a randomized controlled trial was carried out in a university-level statistics and epidemiology course and assessment scores of flipped classroom versus traditional classroom were not statistically significant despite the preference of students for flipped classroom than traditional classroom.²¹

The discrepancy between the results of various studies can be ascribed to various factors including dissimilar study designs, selection of course, planning and implementing of pre-class and in-class learning activities. Considering the characteristics of generation Z students, certain points need to be emphasized. Firstly, every topic is not suitable for flipped classroom outcomes. Secondly, similar in-class activities for each topic don't work. Thirdly, inverting the classroom does not make the teacher a mere observer. Instead, their guidance in assisting students to attain their learning objectives remains of utmost importance.^{22,23}

Conclusion

In conclusion, flipped classroom proves to be a more effective learning strategy for teaching human anatomy to medical students compared to traditional classroom approach. Students expressed high satisfaction with flipped classroom approach as it improved their understanding, memorization, integration, and application of the subject knowledge. The flipped classroom also demonstrated its value in engaging students, optimizing class time, and establishing itself as an active learning strategy.

Limitations of study

The study's limitations include its restriction to a single department and class, making it difficult to generalize the results to other institutions. Additionally, the focus on short term results points towards the need for long-term impacts of flipped classroom approach.

Future work should focus on exploring various models of flipped classroom and evaluating the correlation between different pre-class and in-class activities and students' performance.

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CONFLICT OF INTEREST

Authors declared no conflicts of Interest.

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DATA SHARING STATMENT

The data that support the findings of this study are available from the corresponding author upon request.

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