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Efficacy of flipped classroom method in teaching-learning physiology

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ABSTRACT

Objectives: The overall goal of the study was to foster self-directed learning, critical thinking and problem-solving skills in 1st-year medical students. Another goal was to create interest in learning by making it more interactive. As per the requirement of a competency-based medical education curriculum, we tried to use a novel teaching method called Flipped classroom method to meet our goals. Hence, the objectives of this study were: (1) To compare the effect of flipped classroom method and didactic lecture on students' performance in the topics from renal physiology by MCQ test. (2) To obtain students' perception about flipped classroom method in learning physiology. (3) To obtain teachers' perception about flipped classroom method in teaching physiology.

Materials and Methods: Flipped classroom method was introduced for teaching two topics in renal physiology for first MBBS students. This cross-over experimental study included 112 first M.B.B.S. students, after taking their informed consent and Ethics Committee permission. They were divided into two groups according to odd and even roll numbers. In the first part of the study, Group A (odd roll numbers) attended the didactic lecture on Renal Clearance (RC) and Group B (even roll numbers) attended the didactic lecture on Glomerular Filtration Rate (GFR). These topics were taught by two different teachers in two different classrooms. They were administered pre-test and post-test in the form of case-based MCQs which tests knowledge, critical thinking, and problem-solving skills on the topic. In the second part, two groups were swapped. Group A attended flipped class for G.F.R. and Group B attended flipped class for RC. They were again administered pre-test and post-test in the form of the same MCQ test. The teacher remained the same for the particular topic. For the flipped class, students came prepared with the topic. They were provided with resource materials of the allotted topic 1 week prior, in the form of pre-recorded lectures and videos. Students' feedback in the form of a questionnaire and teachers' feedback in the form of the interview was obtained. Marks obtained by students after didactic teaching and flipped classroom method teaching were compared by "Student's *t*-test."

Results: The post-test score of students in the flipped class was significantly higher ($P < 0.05$) than the post-test score of students in didactic class. More than 85% of students agreed and strongly agreed that the flipped classroom method improved their learning in renal physiology and it increased their confidence in answering the topic in the final exam. Near about 50% of students liked the flipped class method because of its interactive nature and discussion which was based on the application of knowledge. The teachers were more satisfied by flipped classroom method of teaching.

Conclusion: Flipped classroom method is an effective teaching-learning method in physiology when compared with a didactic lecture.

Keywords: The flipped classroom, Competency-based medical education, Critical thinking ability, Problem-solving ability, Self-directed learning

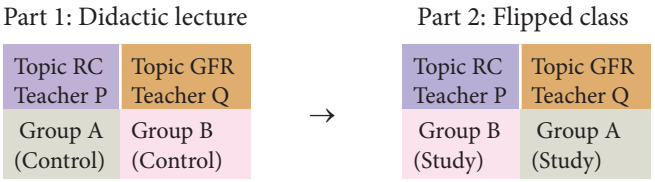
INTRODUCTION

New generation students are losing interest in didactic lectures.[1] It reflects in their poor attendance, attention and performance.[2-5] Students lack training in problem-solving and critical thinking.[6] They are also not aware of self-directed learning.[7] However, these students are interested in interactive learning.[2,3] They are also interested in online learning which is evident by their constant online availability. New Competency Based Medical Education demands the development of all these competencies such as problem solving ability, critical thinking abilities, and self -directed learning in students. It also encourages the use of novel interactive teaching-learning methods and technology in teaching. To serve all these purposes, a teaching method like "small group teaching" is not always feasible. Hence, we decided to test the efficacy of an alternative method with the same impact of interactive learning which is known as the "flipped classroom method."[8] Flipped classroom method is also known as the inverted classroom method. This is a type of blended learning where students are provided with the study material in the form of recorded lectures, videos, games, etc., for learning at home and they come prepared in the classroom for an interactive session. In the discussion, they apply their learned knowledge in critical thinking for case studies and problem solving. Many studies have been conducted in Western and Asian countries for the perception of students and teachers about flipped classroom method. However, a very few studies have actually tested the efficacy of flipped classroom method.[9] Hence, we conducted this study with objectives, to compare the effect of flipped classroom method and didactic lecture on students' performance in the topics from renal physiology by MCQ test and to obtain students' and teachers' perception about flipped classroom method in teaching-learning physiology.

MATERIALS AND METHODS

This cross-over experimental study was conducted in 115 first M.B.B.S. students after taking their informed consent and Ethics Committee permission. However, only 112 students were considered eligible because three of them attended the wrong class (which was not assigned to them as a topic for flipped class) on the day of study. Out of these 112 students, four students were absent for a didactic lecture on the topic – "Renal Clearance (RC)." For the pre-test of flipped class on topics – 'Glomerular Filtration Rate (GFR)' and "RC," two and four students were absent, respectively. All participant students were divided into two groups according to odd and even roll numbers.

Two topics in renal physiology with clinical application, GFR and RC were selected. Two MCQ question papers comprising of knowledge-based, problem solving, and case-based MCQs on each topic were prepared. These MCQs were selected from different textbooks of physiology and validated by subject experts in the department of physiology. The teachers involved were trained in flipped classroom teaching. Feedback questionnaire was developed after a thorough literature review, focus group discussion of faculty of the Department of Physiology, and validated by MEU members. It was finalised after conducting cognitive interviews and conducting pilot testing.[10] The questionnaire includes the questions regarding whether or how flipped class improved students' learning, engagement, and satisfaction. Their difficulties and suggestions were also asked in the feedback. In the first part of the study, Group A (odd roll numbers) attended the didactic lecture on RC and Group B (even roll numbers) attended the didactic lecture on GFR. Topics were taught by two different teachers in two different classrooms. The students were administered the same pre-test and post-test before and after the class. In the second part, two groups were swapped. Group A attended flipped class for GFR. and Group B attended flipped class for RC.



For the flipped class, students came prepared with the topic. They were provided with resource materials of the allotted topic, 1 week prior in the form of pre-recorded lectures and videos. During the flipped class of 1 hour duration, the students were allowed to discuss their difficulties and doubts for about 15 min. The peer students were encouraged to clear their doubts. Then they were given four different cases to discuss in four groups. Every group presented and discussed a case with the whole class for about 10 min each. The teacher played the role of a facilitator and guided the students whenever required. At the end of the class, the teacher summarised the topic. They were administered the same pre-test and post-test before and after the class. The teacher remained the same for the particular topic. Feedback from students was taken and analysed on a 5-point Likert scale. Teachers' feedback was taken in the form of an interview. Qualitative analysis of teachers' feedback and open-ended questions in the students' feedback was done to identify the key themes.

Statistical analysis

Statistical analysis was done using SPSS version 21.

1. The post-test score in the study group (flipped classroom method) was compared with the post-test score of the control group (didactic lecture) by unpaired "*t*" test.
2. The pre-test score of each group (RC didactic, RC flipped, GFR didactic, GFR flipped) was compared with

its own post-test score by paired "*t*" test
3. Since the pre-test score of the flipped class showed trend of being higher than that of didactic lecture for both topics, we compared delta score between the flipped classroom and the didactic lecture.

RESULTS

1. According to [Table 1], the post-test score of students in the flipped class was significantly high ($P < 0.05$) compared to the post-test score of students in didactic class in both the groups RC and GFR.
2. According to [Table 2], the post-test score was significantly high ($P < 0.001$) compared to the pre-test score in both the methods flipped as well as didactic in all groups.
3. According to [Table 3], delta score of the flipped class was not significant ($P > 0.05$) compared to delta score of the didactic class.

According to [Table 4], More than 90% of students agree that flipped class is engaging, motivating, improves their problem solving skills, critical thinking skills and learning in renal physiology.

1. One open-ended question was asked about the cause of their liking or disliking for flipped classroom method. Near about 50% of students liked the flipped classroom method because of its interactive nature (student-teacher, peer) and discussion which was based on the application of knowledge. Other reasons for the liking of the flipped class were like pre-reading helps to prepare topic better, a better understanding of a topic by this method, better engagement, immediate feedback of learning, learning possible at one's own pace, and increases confidence.
2. One more open-ended question was asked inviting suggestions for improvement in the flipped classroom method. The majority of students suggested that more time should be given for discussion during the class and before the flipped class for preparation of the topic. The topic of the flipped class should be small. They also suggested of making smaller groups of students for case discussion. They wanted improvement in the audio quality of the recorded lecture.
3. In teachers' view, the preparation for flipped class takes more time and effort by teachers. Furthermore, more efforts are required to make all the students actively participate during the discussion. However, it gives more satisfaction to conduct flipped class.

DISCUSSION

A very few studies have investigated the effect of flipped classroom method on students' performance. In our study, according to [Table 2], the post-test score is significantly more compared to the pre-test score in both the methods

Table 1: Comparison of post-test score in Didactic and Flipped Class group.

S. No.	Group	(N) Flipped Class	(N) Didactic	Post-test-didactic (Mean±SD)	Post-test-flipped class (Mean±SD)	*P*-value
1.	GFR	56	56	3.714±1.107	4.143±0.923	0.028*
2.	RC	56	52	3.904±1.417	4.446±1.043	0.025*

*$P<0.05$ Significant, N: Number of students, RC: Renal clearance, GFR: Glomerular filtration rate

Table 2: Comparison of pre-test and post-test score.

S. No.	Group	*N*	Pre-test (Mean±SD)	Post-test (Mean±SD)	*P*-value
1.	Didactic-RC	52	2.077±1.398	3.904±1.417	0.000*
2.	Flipped-RC	52	2.692±0.829	4.519±1.019	0.000*
3.	Didactic-GFR	56	2.161±1.124	3.714±1.107	0.000*
4.	Flipped-GFR	54	2.296±1.092	4.111±0.924	0.000*

*$P<0.001$ Significant, N: Number of students, RC: Renal clearance, GFR: Glomerular filtration rate

Table 3: Comparison of Delta score in Didactic and Flipped Class group.

S. No.	Group	(N) Flipped Class	(N) Didactic	Delta score-didactic (Mean±SD)	Delta score-Flipped class (Mean±SD)	*P*-value
1.	GFR	54	56	1.554±1.347	1.815±1.304	0.304
2.	RC	52	52	1.712±1.612	1.923±1.117	0.439

$P<0.05$ Significant, *N*: Number of students, RC: Renal clearance, GFR: Glomerular filtration rate

Table 4: Students feedback analysed on Likert scale.

S. No.	Question	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	% (Agree+ Strongly agree)
1.	The flipped classroom allows better communication with other students.	1	3	12	66	33	86
2.	The flipped classroom is more engaging than traditional didactic lecture.	1	1	4	55	54	94
3.	I am more motivated to learn renal physiology in the flipped classroom.	0	1	9	70	35	91
4.	The flipped classroom has improved my learning of renal physiology.	0	1	6	72	36	93
5.	The flipped classroom helps me in better application of renal physiology knowledge.	0	2	10	59	44	89
6.	Flipped classroom improves my problem solving and critical thinking in renal physiology.	1	1	4	60	49	94
7.	The video lecture is comfortable and convenient than didactic lecture.	1	6	24	43	41	73
8.	I would prefer a flipped class over a traditional didactic lecture.	1	3	18	48	45	80
9.	More topics should be covered in the flipped classroom mode.	0	3	11	50	51	87
10.	Flipped classroom will increase my confidence in answering the topic, in the final exam.	2	0	14	55	44	86

Column number 3–7 indicate number of students and column number 8 indicate % of students

flipped as well as didactic. The test was based on knowledge, case studies and problem-solving in renal physiology. This suggests that both the methods of teaching are working well in increasing the knowledge and critical thinking and problem-solving ability of the students. This may also suggest that teachers in the study are good at teaching and students are good at learning. However, according to [Table 1], the post-test score of students in flipped class is significantly higher ($P < 0.05$) than the post-test score of students in didactic class. This suggests that flipped classroom modality's potential to improve critical thinking and problem-solving ability in students is better than didactic lecture. According to [Table 3], delta score of Flipped class is not significantly higher than delta score of didactic lecture. We attribute the cause of this statistical result to high pre-test score of Flipped class. It was due to administration of pre-test to the flipped class students after giving them learning material. The students learned the material and came prepared for flipped class as compared to the students attending didactic lecture who did not learn material before pre-test.

A review article studying the importance of flipped classroom method in technology and engineering education stated that flipped classroom method is very helpful in linking theory and practice in engineering students. This method teaches students real world skills such as problem-solving, working in a team, interacting with experts, planning and programming.[11] Veeramani *et al*., Pierce and Fox, and Memon *et al*. in their respective studies have similar findings that students performed better in flipped class teaching.[12-14] Richard Pierce attributed this better performance to the availability of course material before classes, formative assessments administered during the module, and the interactive class activities. In the study of Memon *et al*., the students felt that understanding of subject and attentiveness in class was better because of active learning in this method. In contrast, Zhao and Ho in their study found no significant difference in students' performance after flipped classroom teaching.[15]

Many studies have obtained students' and teachers' feedback about flipped classroom method and not to surprise; all of them have received positive feedback about flipped classroom method. Even Zhao and Ho received positive feedback from students; though the performance of students did not improve in their study. Students found flipped class beneficial because of its engaging nature and more cross-talking among students.[15] According to [Table 4] and open ended questions in the questionnaire, in our study most of the students found flipped class more engaging, motivating, and interesting. This suggests that flipped classroom method fulfills our goal of making learning interesting by making it interactive. In our study, students agreed that flipped class improved their learning of the topic and improved their confidence for answering in the final exam. They also recommended covering more topics by this method. A descriptive cross-sectional

study conducted on medical students in Andhra Pradesh found that students liked the flipped class method because it is more engaging than the traditional class.[16] These students found videos in their study material very interesting. But still, when asked for preference between the traditional method and flipped class method, students were confused. The probable cause of this controversy is not discussed in this study by Sreegiri *et al*. In the studies of Veeramani *et al*. and Memon *et al*., students' response to the flipped classroom structure was largely positive because flipped classroom approach was able to fulfill the learning objectives compared to didactic teaching.[12,14] Buchner in a review article stated that students are satisfied with this method because of immediate feedback of their performance.[11]

Szparagowski in his project on flipped classroom mentioned some notes by students.[17] In this, students mentioned some benefits of the flipped classroom like, it is not as time consuming as normal homework. They can study the videos at their own pace. They mentioned that it is a useful method of teaching because they can click on other links and get help and it introduces the topic before learning about it in class. In our study also students liked flipped class because of its interactive nature and application-based discussion. They also found it convenient to learn recorded lectures and videos at their own pace at home. In a study by Nouri, low achievers significantly reported more positively as compared to high achievers about the use of video as a learning tool and their perceived increased learning.[18]

In our study, we asked for suggestions from students for further improvement in the delivery of flipped classroom method. These suggestions will surely help us to improve on the conduction of flipped class. The majority of students suggested that more time should be given for discussion during flipped class and for preparation before class. They suggested of keeping the topic of discussion small. They also suggested making smaller groups of students for case discussion. One technical aspect they wanted to improve the sound quality of recorded lecture video. Szparagowski in his study received comments from students on the weakness of flipped classroom method that sometimes videos do not load if the internet is bad.[17].Furthermore, some students felt that learning something that was not taught in class was not liked by them initially. Park *et al*. in their study based on teachers' experience in flipped class teaching found certain hurdles in flipped classroom method.[19] Some students do not prepare for lecture materials. Some students do not participate in questions and discussions. There are difficulties in classroom preparation for teachers such as case questions, quizzes, team-based learning, and creating the classroom environment. They suggested that teachers have to be properly trained for conducting the flipped class. The teachers also should be motivated and need support from the institution.

Buchner in his study mentioned one advantage of this method for teachers that the diversity of teaching methods keeps their interest in the topic high even if repeating it semester after semester.[11] In our study, teachers who worked on flipped class had a view that the preparation for flipped class takes more time and effort by teachers. Furthermore, more efforts are required by teachers to make all students actively participate during discussions. However, it gives more satisfaction to conduct a flipped class. Similarly, Dong in their study mentioned teachers' view that this teaching mode helps to make full use of the classroom time and resources and improves the classroom teaching efficiency.[20] Sattar *et al*. also got the teacher's positive feedback about their satisfaction.[21]

Mclaughlin *et al*. in their article about the experience of course redesign for pharmacy school emphasised that flipped classroom method of teaching is feasible and necessary because it empowers students to develop higher-order cognitive skills and to engage them in meaningful learning. Thus, it will ultimately improve the delivery of health care.[22]

CONCLUSION

Clinical application-based topics in physiology should be regularly taught in the form of flipped classroom method because the flipped classroom method is an effective teaching-learning method when compared with didactic lecture, most of the students want more topics to be taught by this method and the teachers are also more satisfied by this method.

Limitations of study

Whether all the students studied the material provided for flipped class before attending the class could not be tracked. Furthermore, students' attendance for both the classes' pre-tests and post-tests could not be controlled. Including a large number of students in the study would have helped to extend the validity of the study to a big class of a large number of students. More time should have been allotted for the discussion of cases in smaller groups of students. Flipped class intervention should be over a period of the semester to test validity and feasibility in our institutional setup. This will be the further scope of the study.

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Declaration of patient consent

Institutional Review Board (IRB) permission obtained for the study.

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Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Butler JA. Use of teaching methods within the lecture format. Med Teach 1992;14:11-25.
2. Alaagib NA, Musa OA, Saeed AM. Comparison of the effectiveness of lectures based on problems and traditional lectures in physiology teaching in Sudan. BMC Med Educ 2019;19:365.
3. Remington TL, Bleske BE, Bartholomew T, Dorsch MP, Guthrie SK, Klein KC, *et al*. Qualitative analysis of student perceptions comparing team-based learning and traditional lecture in a pharmacotherapeutics course. Am J Pharm Educ 2017;81:55.
4. Nevins E, Moori P, Alexander L, Richards B, Bleasdale V, Sharma AK. Could Attendance at Medical School be Improved? A Prospective Study of Medical Education at the University of Liverpool: Study of Attendance at a UK Medical School. Europe: MedEdPublish; 2016.
5. Rodgers JR. A panel-data study of the effect of student attendance on university performance. Aust J Educ 2001;45:284-95.
6. Majumder MA, Bidyadhar SA, Alateeq, FA, Rahman S. Handbook of Research on Critical Thinking and Teacher Education Pedagogy. United States: IGI-Global; 2019.
7. Premkumar K, Vinod E, Solomon S, Pulimood A, Umaefulam V. Self-directed learning readiness of Indian medical students: A mixed-method study. BMC Med Educ 2018;18:134.
8. Jonathan B, Aron S. Flip Your Classroom, Reach Every Student in Every Class Every Day. 1st ed. United States: International Society for Technology in Education; 2012. p. 19-35.
9. Nielsen P, Bean N, Larsen R. The impact of a flipped classroom model of learning on a large undergraduate statistics class. Stat Educ Res J 2019;17:121-40. Available from: http://www.stat.auckland.ac.nz/serj. [Last accessed on 2021 May 15].
10. Artino AR, Rochelle JS, Dezee KJ, Gehlbach H. Developing questionnaires for educational research: AMEE Guide No. 87. Med Teach 2014;36:463-74.
11. Buchner J. The inverted classroom model in technology and engineering education: Teaching "real-world" skills to solve "real-world" problems. Open Online J Res Educ 2015;4:24-7. Available from: http://www.journal.ph-noe.ac.at. [Last accessed on 2019 May 03].
12. Veeramani R, Madhugiri V, Chand P. Perception of MBBS students to "flipped classroom" approach in neuroanatomy module. Anat Cell Biol 2015;48:138-43.
13. Pierce R, Fox J. Vodcasts and active-learning exercises in a "flipped classroom" model of a renal pharmacotherapy module. Am J Pharm Educ 2012;76:196.
14. Memon S, Goswami P, Iqbal A, Baloch S. Second-year MBBS students' views about flipped classroom practice in neuroanatomy course. J Postgrad Med Inst 2016;30:244-9.
15. Zhao Y, Ho A. Evaluating the Flipped Classroom in an Undergraduate History Course: [Unpublished Ph.D. Thesis on the Internet]. Harvard Graduate School of Education: Harvard Graduate School of Education; 2014. Available from: http://www.harvardx.harvard.edu/files/harvardx/files/evaluating_the_flipped_classroom_-_zhao_and_ho.pdf. [Last accessed on 2019 Mar 03].
16. Sreegiri S, Madhavi B, Lakshmi K. Student's perception of flipped classroom teaching method in Andhra Medical College, Visakhapatnam. IOSR J Dent Med Sci 2018;17:6-9.
17. Szparagowski R. The Effectiveness of the Flipped Classroom: [Unpublished Ph.D. Thesis on the Internet]. Honors College, Bowling Green State University: Honors College at ScholarWorks@BGSU; 2014. Available from: https://www.scholarworks.bgsu.edu/honorsprojects/127. [Last accessed on 2019 May 02].
18. Nouri J The flipped classroom: For active, effective and increased learning-especially for low achievers. Int J Educ Technol High Educ 2016;13:1-10.
19. Park KH, Park KH, Chae SJ. Experiences of medical teachers in flipped learning for medical students: A phenomenological study. Korean J Med Educ 2018;30:91-100.
20. Dong X. Application of Flipped Classroom in College English Teaching. Vol. 7. Wuhan, China: Scientific Research Publishing; 2016. p. 13351339. Available from: https://www.scirp.org/journal/paperinformation.aspx?paperid=67723. [Last accessed on 2019 May 03].
21. Sattar K, Sethi A, Akram A, Ahmad T, John J, Yusoff MS. Flipped classroom teaching modality: Key concepts and practice endorsements. Educ Med J 2019;11:1-10.
22. Mclaughlin J, Roth M, Glatt D, Gharkholonarehe N, Davidson C, Griffin L, *et al*. The flipped classroom: A course redesign to foster learning and engagement in a health professions school. Acad Med 2014;89:236-43.

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