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ASSESSMENT OF FLIPPED CLASSROOM AS A NOVEL TEACHING-LEARNING METHOD IN PHARMACOLOGY AMONG SECOND PHASE MBBS STUDENTS

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Abstract

Background: Flipped classroom (FC) is learner-centric, self-paced knowledge acquisition followed by classroom-based discussion. It has three basic components- pre-class assignment, in class activities and post-class activities. This study was undertaken to assess flipped classroom as a novel method of teaching and learning pharmacology among second phase MBBS (Bachelor of Medicine and Bachelor of Surgery) students and to assess students' perspectives towards FC.

Methods: Eligible second phase MBBS students were divided into two groups (1 & 2). Two modules– A and B from core topics of pharmacology were developed by subject experts. Module A consisted of mechanism of drug action (MODA) whereas module B consisted of renin angiotensin aldosterone system (RAAS). In the module A, flipped classroom (FC) was administered to Group 1 and traditional didactic lecture (TDL) to Group 2 and in the module B, interventions were crossed over. Pre-class assignment consisted of a preparatory video of 20 minutes in FC group and reading study materials of their choice in TDL. In-class activity in FC consisted of facilitator-led group discussion whereas in TDL, it consisted of a power point-based lecture. A pre-test prior to in-class activities was conducted in both groups during both the modules. Post-class activities included MCQs-based post-test and retention test and a questionnaire-based survey.

Results: The mean pre-test score of students in FC (6.64±3.13 in module A and 6.90±2.92 in module B) was higher than that in TDL (4.98±2.07 in module A and 5.30±2.20 in module B) and difference was statistically significant in both modules A (mean difference=1.66, p=0.001) and B (mean difference=1.60, p=0.001). The mean post-test scores of FC (13.21±2.92 in module A and 13.90±2.55

in module B) was higher than that of TDL (10.54±2.54 in module A and 10.90±2.97 in module B) and differences were statistically significant in both modules A (mean difference=2.67, p=0.001) & B (mean difference=3.00, p=0.001). The mean change in score was higher in FC (6.57±1.18 in module A and 7.00±1.41 in module B) than in TDL (5.56±0.982 in module A and 5.88±1.18 in module B) and the difference was statistically significant in both modules A (difference in mean change=1.01; p<0.001 and B (difference in mean change=1.12; p<0.001). In the retention test, the mean score of students was higher in FC (9.46±2.75 in module A and 9.55±3.25 in module B) than in TDL (7.63±2.58 in module A and 7.78±2.77 in module B) and the difference was statistically significant in both the modules A (mean difference=1.83; p<0.001) and B (mean difference=1.77; p=0.003). In the questionnaire-based survey, most of students (77 to 85%) either strongly or simply agreed to questions favouring FC over TDL.

Conclusion: FC can be a better tool than traditional power point slide-based lecture for second phase medical students for teaching and learning pharmacology. Most of students had positive attitude towards FC and agreed to favour FC over TDL.

Keywords: flipped classroom, medical education, medical undergraduate, pharmacology

Introduction

Medical students frequently encounter physical and mental stresses attributable to vast curriculum, rigorous training, and high professional standards[1,2]. There has been continuous search of an innovative tool which could help students for better knowledge acquisition and development of critical thinking and communication skills[3,4]. The ultimate goal of competency based medical education (CBME) is to develop competent medical graduate who can deliver safer, quality-rich, and cost-effective health services. Basic tenets of CBME are cultivating the habit of self-directed and life-long learning[5,6]. The traditional didactic lecture (TDL) may be considered as teacher-centric approach with passive involvement and least engagement of students in learning process[7,8]. On the other hand, flipped classroom (FC) also termed as "inverted classroom" is learner-centric, self-paced knowledge acquisition followed by classroom-based assignments, discussion, and/or problem-based learning[9]. Flipping the classroom simply means that students gain first exposure to new material outside of class, usually via reading study material or watching lecture videos, and then use class time for assimilating that knowledge, through problem-solving, group discussion or debates in the presence of instructor or facilitator[10-12]. Flipped classroom essentially consists of three basic components- pre-class assignment, in class activities and post-class activities. In pre-class assignment, recorded video and printed study material are shared to students to be watched and read by them in order to prepare themselves for in class-activities. In class-activities involve facilitator-led enrichment of knowledge and skills by individual or small groups discussion, doubt-clearing and problem-solving sessions. The post-class activities are basically meant to assess the learning at the end of in-class activities using various methods[13].

Flipped classroom has been found successful in many models of various disciplines including medical discipline. It has been recently evaluated for teaching and learning of many pre, para and clinical subjects[14-16], but its potential has not been thoroughly evaluated in MBBS students for teaching and learning of pharmacology. So, we aimed to assess flipped classroom as a novel method of teaching and learning pharmacology among second phase MBBS students and to assess students' perspectives towards FC. The primary objective was to compare flipped classroom (FC) with traditional didactic lecture (TDL) in teaching and learning pharmacology among second phase MBBS students. The secondary objective was to assess students' perspectives towards FC as novel method of teaching and learning pharmacology using 10-items questionnaire on 5-points Likert scale.

Materials and Methods

Study design and duration

This was a quasi-experimental, cross-over study conducted among second phase MBBS students at Department of Pharmacology, Indira Gandhi Institute of Medical Sciences, Patna for a period of 2 months from 16/10/2024 to 15/12/2024.

Ethical approval

Prior ethical approval from Institutional Ethics Committee, Indira Gandhi Institute of Medical Sciences, Patna (Ref. no: 61/IEC/IGIMS/2024) was taken and study was conducted in accordance with the ethical principles of Declaration of Helsinki.

Inclusion criteria

Second phase MBBS students of 2022 batch who were voluntarily willing to participate and give written informed consent were included in this study.

Exclusion criteria

Students who did not attend traditional didactic lecture or did not complete shared assignment and watch the shared video for flipped classroom as well as students who did not participate in both the modules were excluded from study.

Study participants and allocation

All second phase MBBS students (N=125) of the 2022 batch were requested to voluntarily participate in the study. Those willing to participate and to give written informed consent were enrolled in the study. A list of eligible students with their marks obtained in 1st professional MBBS examination in descending order was created, then two groups (1 & 2) were created by pseudo-randomization by odd and even serial number (Group 1‑odd numbered and Group 2‑even numbered) in the marks-list.

Study tool

For subjective assessment of flipped classroom as a novel tool for teaching and learning pharmacology, we checked students' perspective on a 5-point Likert scale (strongly agree, agree, neutral, disagree, and strongly disagree) through a pre-validated 10-items questionnaire. The questionnaire was modified as per our need and content validity was assessed by a subject expert panel. Internal consistency of the questionnaire was assessed by Cronbach's alpha (0.81). The questionnaire was pilot-tested in 20 second phase MBBS student of previous batch to assess appropriateness, relevance, clarity, and comprehensibility. To compare effectiveness of flipped classroom and traditional didactic lecture, we checked students' understanding of study materials through multiple choice questions (MCQs).

Outcome

The primary outcome was effectiveness of FC and TDL in teaching and learning pharmacology among second phase MBBS students, measured in terms of average marks scored by students subjected to FC and TDL in pre-test, post-test, and retention test.

The secondary outcome was students' perspectives towards FC as a novel teaching-learning method for pharmacology, assessed on 5-point Likert scale using a 10-items questionnaire.

Module development and implementation

Two modules (A and B) from core areas of pharmacology were developed by subject experts based on mutual consensus. The module A consisted of mechanism of drug action (MODA) and the module B consisted of drugs acting on renin angiotensin-aldosterone system (RAAS). In the module A, the FC was administered to Group 1 and the TDL to Group 2. In the module B, interventions were crossed-over, i.e., the TDL was given to Group 1 and the FC to Group 2. There was a two-week gap between these two modules.

Pre-class assignment

In both the modules, for students in FC, a link of a preparatory video of 20 min hosted on YouTube and a study material (assignment) in pdf format pertaining to the specified module were shared one week prior to the scheduled date of in-class activity in a WhatsApp group, made for the given group. The video was a pre-recorded power point presentation with audio voice-over. Students were asked to read the study material and view the video thoroughly and prepare for the topic without any fail so

that the topic could be discussed during the in-class activity. Students in TDL were asked to study the topic of the same module from any resource study materials of their choice.

In-class activities

In-class activity in FC consisted of problem-based learning, facilitator-led small group (6-10 students) discussion, doubt-clearing and motivating students to inculcate a lifelong habit of self-directed learning. In-class activity in TDL consisted of a power point slide-based lecture by the same teacher on same day. Prior to start of in-class activities, an MCQ-based (20 in number, each carrying one mark) pre-test was conducted. The MCQs were designed by subject experts and finalized after mutual discussion and consensus.

Post-class activities

Post-class activities for students with both FC and TDL consisted an MCQ-based (the same MCQ which was used for pre-test) post-test immediately after completion of in-class activity in each module. Marks obtained by students in this test was used to compare effectiveness FC and TDL. In addition, a questionnaire-based online survey (on Google form) was used to know students' perspective (on a 5-point Likert scale) towards FC. The survey was done immediately after completion of both the modules.

Retention test

An MCQ-based retention test (having 20 MCQs from respective topics but different from those asked in pre-/post-test) was done 30 days after the completion of each module.

Statistical analysis

The data for analysis were entered in Microsoft excel sheet. We captured marks obtained by eligible students in pre-test, post-test, and retention test of FC and TDL during module A and B and students' perspective towards FC on 5-point Likert scale. Data were checked for normality using Q-Q plot and found to be approximately normally distributed. Independent t-test were used to compare scores between two groups of students. Paired t-test were used for pre-post analysis (change in score). Students' perspectives have been presented as number with percentage of students who agreed or disagreed or had neutral response with different questionnaire items. Data were analysed using software Jamovi 2.3.28. A p-value < 0.05 was considered to be statistically significant.

Results

The batch capacity 2nd MBBS students during the study was 125. These students were divided into two groups- Group 1 (odd numbered in marks-list) and Group 2 (even numbered in marks-list) which initially consisted of 63 and 62 students respectively. Students who completed watching the shared video and reading study material and vowed for the same, were included in study. During module A (MODA), 2 students from Group 1 (FC) and 5 students from Group 2 (TDL) were not eligible to participate in the study. Reasons behind ineligibility were that in Group 1 (FC) those 2 students did not complete watching of video sent to them, so they were not allowed to participate the in-class discussion while in Group 2 (TDL) group those 5 students did not attend the lecture. During module B (RAAS), 6 students from Group 1 (TDL) and 4 students from Group 2 (FC) were not eligible to participate in the study, reasons remaining the same as in previous module. Fifty-nine (59) students from FC (Group 1) and 54 students from TDL (Group 2) participated in retention test of module A and whereas 56 from FC (Group 2) and 55 from TDL (Group 1) participated in retention test of module B. Only students who participated in both the modules were eligible for online questionnaire-based survey and 112 students participated in the survey. The number of study participants (students) involved in inclusion, exclusion, allocation, intervention (FC/TDL) and analysis in groups 1 and 2 of the modules A & B are shown in Figure 1.

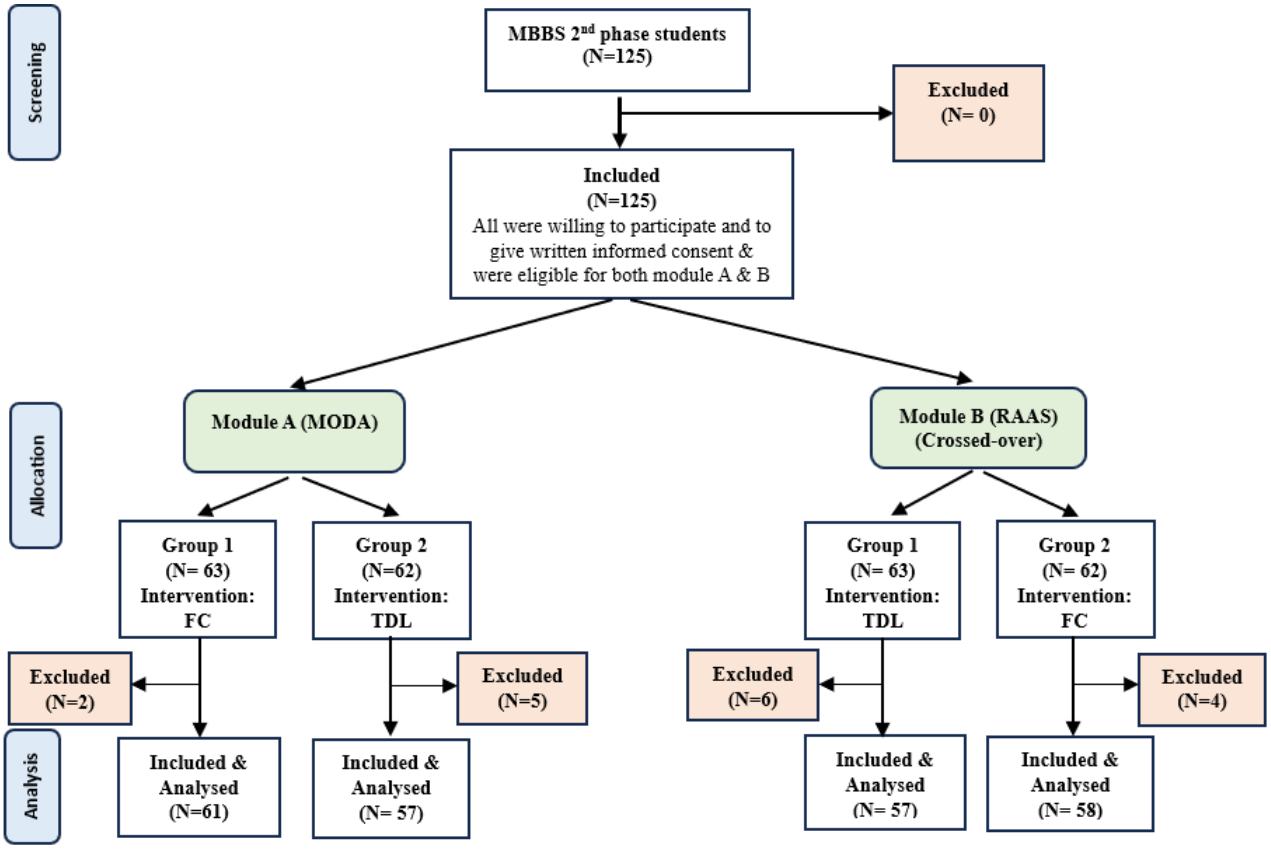

Figure 1: Flow diagram showing enrolment of study participants

The average marks (Mean±SD) scored by students in pre-test (Figure 2A), post-test (Figure 2B) and retention-test (Figure 2C); and mean change in scores (Figure 2D) are presented in Table 1.

Table 1: Average marks (Mean±SD) scored by students from Groups 1 & 2 in pre-test and post-test and retention-test during modules A & B

	Module A–MODA (N=118)				Module B–RAAS (N=115)			
	FC (Group 1, N=61)	TDL (Group 2, N=57)	Mean difference	p-value	FC (Group 2, N=58)	TDL (Group 1, N=57)	Mean difference	p-value
Mean pre-test score	6.64±3.13	4.98±2.07	1.66	0.001	6.90±2.92	5.30±2.20	1.60	0.001
Mean post-test score	13.21±2.92	10.54±2.54	2.67	0.001	13.90±2.55	10.90±2.97	3.00	0.001
Mean change in score	6.57±1.18	5.56±0.982	1.01	<0.001	7.00±1.41	5.88±1.18	1.12	<0.001
Mean retention -test score	9.46±2.75	7.63±2.58	1.83	<0.001	9.55±3.25	7.78±2.77	1.77	0.003

FC: Flipped classroom, TDL: Traditional didactic lecture, MODA: Mechanism of drug action, RAAS: Renin angiotensin aldosterone system

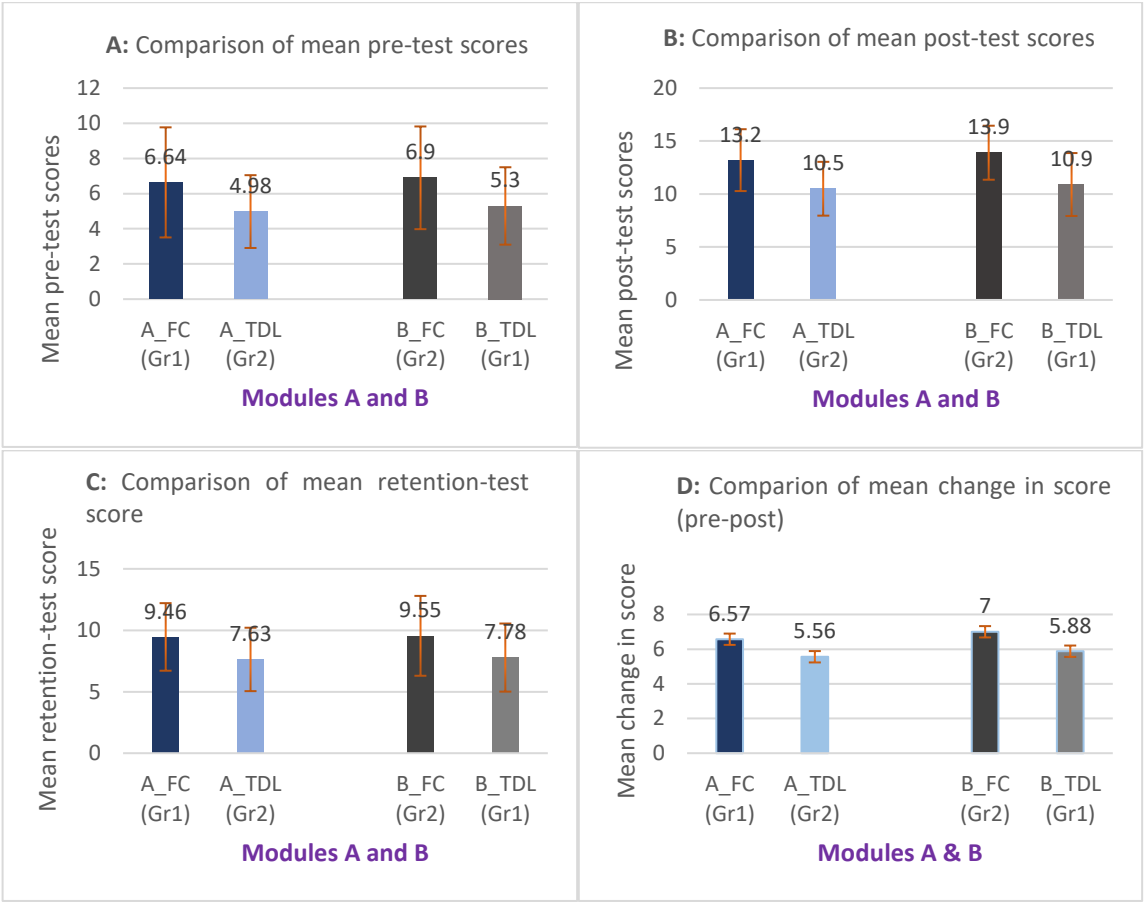

Figure 2: Comparison of marks obtained by students of Group 1 and Group 2 in pre-test, post-test and retention-test during module A and B. (A: mean pre-test score, B: mean post-test score, C: mean retention-test score, D: mean change in score).

A total of 112 students participated in online questionnaire-based survey and provided their responses on 5-point Liker scale as strongly agree, agree, neutral, disagree and strongly disagree (Table 2 and Figure 3).

Table 2. Questionnaire items and students' response on Likert scale for each item (N=112)

S. No.	Items	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	I felt motivated to participate in online pre-class assignment of FC.	80	15	12	3	2
2	Do you agree that facilitator-led in class discussion of FC was very useful to clear doubt and for concept building.	72	20	8	7	5
3	Flipped class was better than TDL to prepare for post-test.	70	19	7	10	6
4	Flipped classroom (FC) method was more engaging and interesting than traditional didactic lecture (TDL).	76	12	12	8	4
5	I found FC as an innovative and effective way of teaching and learning pharmacology.	72	14	12	8	6

6	Do you agree that an innovation in teaching and learning pharmacology in the form of FC is much needed.	74	15	10	6	7
7	I believe FC would help to improve my performance in summative assessment.	69	20	8	9	6
8	Flipped classroom will help me to retain knowledge for longer duration than TDL.	75	16	11	7	3
9	Do you agree that FC may be an effective tool to achieve the goals of competency based medical education.	66	25	12	5	4
10	Do you agree that learning through Flipped Classroom (FC) was time-consuming.	10	12	15	20	55

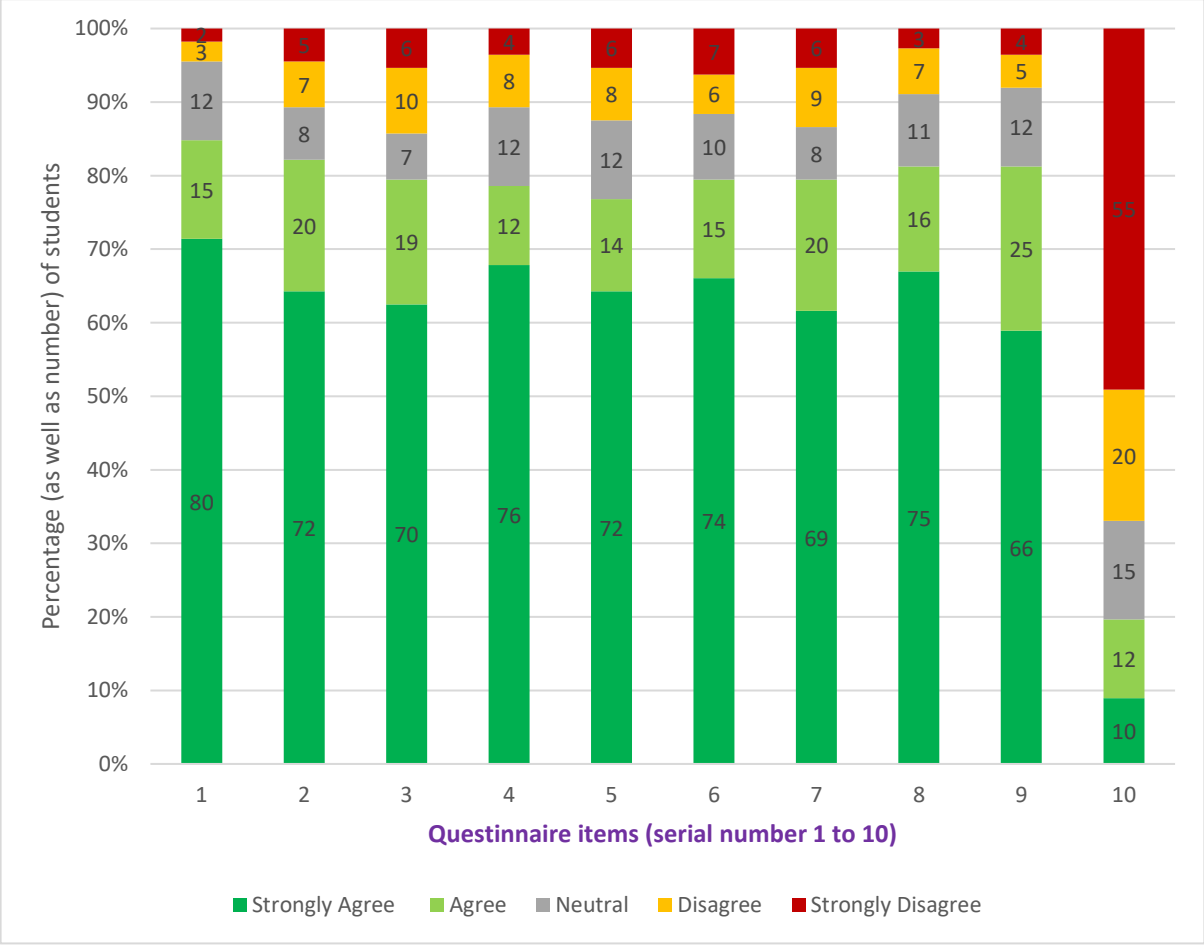

Figure 3: Student's perspectives towards FC on 5-point Likert Scales

Discussion

The average marks scored by students in pre-test in FC (6.64±3.13 in module A and 6.90±2.92 in module B) were higher than those in TDL (4.98±2.07 in module A and 5.30±2.20 in module B) in both modules A & B. The difference between mean pre-test score of FC and that of TDL was statistically significant in both the module A (mean difference=1.66, p=0.001) and B (mean difference=1.60, p=0.001). This means students were able to perform better in the pre-test of FC,

suggesting the shared video of study material in the form of pre-class activity of FC is better preparatory tool for in class activity than students reading study materials of their choices as in TDL. The mean post-test scores of FC (13.21±2.92 in module A and 13.90±2.55 in module B) were also higher than those of TDL (10.54±2.54 in module A and 10.90±2.97 in module B) and differences were statistically significant in both modules A (mean difference=2.67, p=0.001) & B (mean difference=3.00, p=0.001). This suggest FC is better teaching learning tool than power point slide-based teaching of TDL for in class-activity. This finding was in the alignment of studies conducted by Angadi et al. [17] who also found FC to be better teaching-learning tool for pharmacology.

In the pre-post analysis, the mean change in score was higher in FC (6.57±1.18 in module A and 7.00±1.41 in module B) than TDL (5.56±0.982 in module A and 5.88±1.18 in module B) in both modules and difference was statistically significant in both modules A (difference in mean change=1.01; $p<0.001$ and B (difference in mean change=1.12; $p<0.001$) suggesting that FC is a better teaching leaning method than TDL for the improvement of score.

In the retention test, conducted 30 days after completion of each module the average marks scored by students was higher in FC (9.46±2.75 in module A and 9.55±3.25 in module B) than in TDL (7.63±2.58 in module A and 7.78±2.77 in module B) and the difference was statistically significant in both the modules A (mean difference=1.83; $p<0.001$) and B (mean difference=1.77; p=0.003). This suggests that the students were able to retain memory of knowledge and concept to a greater extent in FC than in TDL. Riddell et al. [18] who conducted similar study in emergency medicine residency programs, found that mean test score in 90-day retention test was significantly higher in FC than traditional lecture.

In the questionnaire-based survey to know perspective of students towards FC, most of students (77 to 85%) either strongly or simply agreed to questions (no. 1 to 9) favouring FC over TDL. About 85% (95 out of 112) of students felt motivated to participate in online pre-class assignment of FC, 82% agreed that facilitator-led in class discussion of FC was very useful to clear doubt and for concept building, 79% agreed that FC was better than TDL to prepare for post-test as well as agreed that FC method was more engaging and interesting than traditional didactic lecture (TDL). Similarly, 77% students found FC as an innovative and effective way of teaching and learning pharmacology, 79% agreed that an innovation in teaching and learning pharmacology in the form of FC is much needed as well as believed FC would help to improve our performance in summative assessment. About 81% of students agreed that FC will help us to retain knowledge for longer duration than TDL as well as agreed that FC may be an effective tool to achieve the goals of competency based medical education. Question number 10 was negatively framed (i.e., disfavoured FC). About 67% (75/112) of students either strongly or simply disagreed that learning through Flipped Classroom (FC) was time-consuming. Similar findings regarding students' perceptions towards FC were observed by Bhavsar et al. [8], Tang et al. [13], Angadi et al. [17], and Alabiad et al. [19].

Limitations

The sample size used in this study was limited to the classroom only which may not have sufficient power. The methods by which students were allocated to group 1 and 2 was not a true randomization. Also, assessment of performance of students in pre-test, post-test and retention test was based on MCQ which may not be the best way of assessment to check effectiveness of the tool.

Conclusions

Watching shared video and reading assigned study material as a part of pre-class assignment of FC is a better preparatory tool for MBBS 2nd phase students preparing pharmacology for in-class activity than reading study materials of their choices as in TDL. FC is a better teaching-learning tool for pharmacology among MBBS 2nd phase students than power point slide-based teaching for the improvement of score in the assessment and may help in the improvement of score in internal (formative) as well as summative assessment. FC helped MBBS 2nd phase students to retain memory

of knowledge and concept of pharmacology to a greater extent than TDL. Most of students had positive attitude towards FC and agreed to favour FC over TDL.

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References

1. Zhang Z, Zhang Z, Yu Y, Jiang M, Deng L, Guo L. Impact of different teaching modes on medical students' performance under the scoring criteria for multiple-choice questions: A meta-analysis. Medicine (Baltimore). 2024 Dec 20;103(51):e41008. doi: 10.1097/MD.0000000000041008
2. Zhang SL, Ren SJ, Zhu DM, et al. Which novel teaching strategy is most recommended in medical education? A systematic review and network meta-analysis. *BMC Med Educ* 24, 1342 (2024). doi: 10.1186/s12909-024-06291-4
3. Hughes Y, Lyons N. Does the Flipped Classroom improve exam performance in medical education? A systematic review. MedEdPublish (2016). 2017 Jun 13;6:100. doi: 10.15694/mep.2017.000100
4. Challa KT, Sayed A, Acharya Y. Modern techniques of teaching and learning in medical education: a descriptive literature review. MedEdPublish (2016). 2021 Jan 21;10:18. doi: 10.15694/mep.2021.000018.1
5. Singh K, Mahajan R, Gupta P, Singh T. Flipped Classroom: A Concept for Engaging Medical Students in Learning. Indian Pediatr. 2018 Jun 15;55(6):507-512.
6. Hurtubise L, Hall E, Sheridan L, Han H. The Flipped Classroom in Medical Education: Engaging Students to Build Competency. J Med Educ Curric Dev. 2015 Apr 27;2:JMECD.S23895. doi: 10.4137/JMECD.S23895
7. Ramnanan CJ, Pound LD. Advances in medical education and practice: student perceptions of the flipped classroom. Adv Med Educ Pract. 2017 Jan 13;8:63-73. doi: 10.2147/AMEP.S109037
8. Bhavsar MH, Javia HN, Mehta SJ. Flipped Classroom versus Traditional Didactic Classroom in Medical Teaching: A Comparative Study. Cureus. 2022 Mar 30;14(3):e23657. doi: 10.7759/cureus.23657
9. Ge L, Chen Y, Yan C, Chen Z, Liu J. Effectiveness of flipped classroom vs traditional lectures in radiology education: A meta-analysis. Medicine (Baltimore). 2020 Oct 2;99(40):e22430. doi: 10.1097/MD.0000000000022430
10. Prabhavathi K, Kalyani PP, Rohini P, Selvi KT, Saravanan A. Flipped classroom as an effective educational tool in teaching physiology for first-year undergraduate medical students. J Educ Health Promot. 2024 Jul 29;13:283. doi: 10.4103/jehp.jehp_1854_23
11. Kaushik JS, Raghuraman K, Verma S, Arya V, Gehlawat VK. Online Interactive Flipped Classroom Teaching in Pediatrics for Medical Undergraduates. Cureus. 2023 Apr 15;15(4):e37603. doi: 10.7759/cureus.37603
12. Naing C, Whittaker MA, Aung HH, Chellappan DK, Riegelman A. The effects of flipped classrooms to improve learning outcomes in undergraduate health professional education: A systematic review. Campbell Syst Rev. 2023 Jul 7;19(3):e1339. doi: 10.1002/cl2.1339
13. Tang F, Chen C, Zhu Y, et al. Comparison between flipped classroom and lecture-based classroom in ophthalmology clerkship. Med Educ Online. 2017;22(1):1395679. doi: 10.1080/10872981.2017.1395679
14. Yadgari M, Kalantarion M, Sadoughi MM, Ahmady S, Shahriari MH. Enhancing ophthalmology education through a mobile flipped classroom: a new teaching method. BMC Res Notes. 2025 Jan 21;18(1):29. doi: 10.1186/s13104-025-07104-7
15. Thongsricome T, Longsomboon R, Srithawatpong N, Atchariyapakorn S, Kaikaew K, Wangsaturaka D. Sustained Improvement in Medical Students' Academic Performance in Renal

Physiology Through the Application of Flipped Classroom. Clin Teach. 2025 Feb;22(1):e70021. doi: 10.1111/tct.70021
16. Nunez D, Suarez RI, Molina M, et al. Pharmacology of Sedating and Anesthetic Agents: A Case-Based Flipped Classroom Exercise for Preclinical Medical Students. MedEdPORTAL. 2024 Nov 8;20:11462.
17. Angadi NB, Kavi A, Shetty K, Hashilkar NK. Effectiveness of flipped classroom as a teaching-learning method among undergraduate medical students - An interventional study. J Educ Health Promot. 2019 Oct 24;8:211. doi: 10.4103/jehp.jehp_163_19
18. Riddell J, Jhun P, Fung CC, et al. Does the Flipped Classroom Improve Learning in Graduate Medical Education? J Grad Med Educ. 2017 Aug;9(4):491-496. doi: 10.4300/JGME-D-16-00817.1
19. Alabiad CR, Moore KJ, Green DP, Kofoed M, Mechaber AJ, Karp CL. The Flipped Classroom: An Innovative Approach to Medical Education in Ophthalmology. J Acad Ophthalmol (2017). 2020 Jul;12(2):e96-e103. doi: 10.1055/s-0040-1713681