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COMPARING THE IMPACT OF FLIPPED CLASSROOM AS AN INNOVATIVE TEACHING LEARNING TOOL WITH TRADITIONAL TEACHING LEARNING METHODS IN MEDICAL STUDENTS

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Abstract

Introduction: The Flipped Classroom is an innovative teaching learning method. It is based on the idea that traditional teaching is flipped in the sense that what is normally done in class is switched with what is normally done by the students out of class. Thus, instead of students being engaged and listening to a lecture in class and then going home to work on a set of assignments or problems, they read course literature and watch lecture material through video at home and then engage in teacher-guided problem-solving, analysis and discussions in class. ***Methods:*** This study focused on second professional-year MBBS students from the CBME Batch 2019 and employed a quasi-experimental crossover design, receiving approval from the Institutional Ethics Committee (IEC). The study duration spanned six months, from December 2021 to May 2022, involving a sample size of 131 students. Inclusion criteria comprised students present on the day of the flipped classroom session who provided consent, while exclusion criteria encompassed students absent during the flipped classroom session, as well as during formative and internal assessments. ***Results:*** The flipped classroom (FC) group was associated with significantly higher results than the didactic lecture (DL) group in different test p-values <0.05. Regarding the formative assessment, formative test 1, focusing on Parkinsonism and anti-epileptics, Batch B (FC) exhibited a slightly higher mean score compared to Batch A (DL), although the difference was not statistically significant (p-value = 0.15). However, in Formative Test 2, covering anti-depressants and sedatives/hypnotics, Batch A (FC) significantly outperformed Batch B (DL), as evidenced by a lower p-value of 0.01. The comparison between FC and DL shows that FC consistently outperforms DL in internal assessments. A survey reflecting student perceptions of FC reveals widespread agreement on its benefits: FC helps cover topics comprehensively (84.3% agreement), promotes active participation and communication (91.1% agreement), and enhances academic performance (82% agreement). Additionally, students find FC more enjoyable (88.1% agreement) and effective for understanding topics and interacting with peers and teachers (93% agreement). FC also aids visualization of clinical diseases (93.2% agreement) and encourages students to present and rectify their understanding (85% agreement). Overall, students view FC as a more engaging, interactive, and effective learning method compared to traditional lectures. ***Discussion:*** Students found the Flipped classroom to be a more effective teaching-learning method when compared with the traditional method. We found that students who received instruction via a flipped classroom approach achieved superior scores compared to their counterparts who were taught the same subjects through traditional didactic lectures which was consistent with the previous published evidence.

Keywords: Flipped classroom, Didactic lecture, Medical student, MBBS

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INTRODUCTION

Information technology in the last couple of decades has brought tremendous changes to the way education works among people in society. With the advent of low-cost and easy data storage networks, more powerful and advanced computing systems, and the widespread adoption of devices like smartphones, there is a new digital environment and experience for students now [1,2]. This digital transformation has not only affected the lives of individuals but also has influenced even how they learn. In academics, especially in the medical

field, it has been a big challenge to catch up with these technological improvements and adjust previous teaching methods. Medical education, in particular, demands a dynamic and adaptive approach that fosters critical thinking, problem-solving skills, and active engagement with complex clinical concepts [3,4]. In response to these demands, the concept of the flipped classroom has gained traction as a promising pedagogical strategy to enhance medical education. Medical education, in particular, demands a dynamic and adaptive approach that fosters critical thinking, problem-solving skills, and active engagement with complex clinical concepts. In response to these demands, the concept of the flipped classroom has gained traction as a promising pedagogical strategy to enhance medical education [5,6].

The flipped classroom method can be moved from the teaching-oriented approach to a more personalized one, so students actively participate in the learning process and find the process significantly more engaging and challenging. Rather than relying solely on lectures as the primary mode of content delivery, educators leverage technology to provide students with access to pre-recorded video lectures, digital resources, and interactive materials outside of the classroom. This pre-class preparation allows students to familiarize themselves with foundational concepts and theories at their own pace, thereby enabling more meaningful engagement with the material during face-to-face class sessions. In the medical field, where the acquisition and application of knowledge are paramount, the flipped classroom approach empowers students to take an active role in their learning journey [7]. Another valuable impact of the flipped classroom model lies in its impact on essential lockdowns such as the pandemic of COVID-19. the flipped format of classroom education comes out as the unbroken way to continue medical education while the social distancing rules do exist. This alternative relies on web tools and online resources, allowing teachers to deliver courses effectively and without sacrificing educational quality even in settings changed by remote learning. Through pre-recorded video lectures and digital materials, students gain the flexibility to engage with course content at their own pace, transcending geographical and temporal barriers [8,9]. While student perceptions of the flipped classroom approach have been extensively studied across various disciplines and educational levels, there is a notable absence of data about medical students [10]. Specifically, research on the effectiveness of the flipped classroom model in teaching pharmacology topics is scarce in the literature, and there is a lack of evidence regarding its overall efficacy as a teaching-learning approach Consequently, this study aims to assess the effectiveness of the flipped classroom model compared to traditional teaching methods among second-year medical undergraduate students and to gauge their perceptions of this approach.

MATERIALS AND METHODS

Source of Data: Second-year MBBS students of CBME Batch 2019

Study Design: Quasi-experimental cross-over study

Study Duration: Total duration of 6 months (December 2021 – May 2022)

Sample size: 136 students

Inclusion criteria: Students who are present on the day of the Flipped classroom and who have given their consent for the same.

Exclusion criteria: Students absent on the day of Flipped classroom, Formative, Internal assessment.

Method: The second-year MBBS undergraduate students (n=136) will be divided into two batches A and B. B Batch will belong to the flipped classroom group (FC group) and the A Batch will belong to the traditional teaching-learning didactic lecture group (DL). All the students would be sensitized about the project on flipped classrooms before implementation and consent would be taken to participate in the research. For the FC group (B Batch), a WhatsApp group would be created to transfer the videos and teaching learning material of the classes, a week prior. Pretest and post-test questionnaires would be given, both before and after the sessions of the flipped classroom and traditional class. At the end of the module, a formative assessment of 30 marks will be taken as an assessment for both the flipped classroom batch and the traditional batch. Then a crossover of the batches will be done, and the same protocol will be followed. Following the formative assessment, topics chosen during the flipped classroom would be incorporated into the internal assessment examination for a better evaluation of the effectiveness of the flipped classroom. Analysis and interpretation of the data will be obtained from the questionnaire and written assessments. Feedback on the student's perception of flipped classrooms will be taken at the end of the project.

Timeline of our study

The progression of tasks and data collection activities over several months. In December 2021, the application for institutional ethical committee approval was performed. January 2022 saw the finalization of topics for flipped classroom teaching, followed by the preparation of questionnaires for pre-test and post-test assessments in February 2022.

The implementation of flipped classroom teaching commenced in February and continued into March and April. Data analysis from questionnaires and assessments was performed in May and June. The finalization of the project occurred in August. Overall, this timeline demonstrates the sequential completion of

tasks, from project inception to data analysis and presentation, highlighting the progression of the intervention and associated administrative processes Feedback Student perceptions of the FC teaching method were assessed using a pre-validated questionnaire administered after each session. The questionnaire utilized a 5-point Likert scale, ranging from "strongly agree" to "strongly disagree," to gauge student opinions and attitudes towards the FC approach.

Statistical analysis

Data analysis was conducted using SPSS (IBM, Chicago, IL, USA) software. Descriptive statistics including mean and standard deviation (SD) were employed to summarize the data. The Shapiro-Wilk test was utilized to assess the normality of continuous variables. Unpaired Student's t-test was employed for the analysis of continuous variables. A significance level of $p<0.05$ was applied to determine statistical significance.

RESULTS

In our analysis, we included 131 students in the Second-year MBBS students of CBME Batch 2019. Evaluating the efficacy of the FC group compared with the DL group in different medical topics. At first, we compared both groups to two topics; Parkinson and anti-epileptic topics where Batch A (DL) and Batch B (FC). For the pre-test 1 on Parkinsonism, Batch B had a significantly higher mean score (6.48) compared to Batch A (4.54), with a statistically significant p-value of 0.001, indicating a significant difference between the two groups. Similarly, in the post-test 1 on Parkinsonism, Batch B (8.83) outperformed Batch A (7.38) significantly, with a p-value of 0.001.

Moving to pre-test 2 on anti-epileptics, Batch A (4.18) had a higher mean score compared to Batch B (6.2), with a significant p-value of 0.001. However, in post-test 2 on anti-epileptics, Batch B (8.5) showed a higher mean score compared to Batch A (7.4), with a statistically significant p-value of 0.004. Indicating that the FC group showed significantly higher test scores compared with traditional learning methods**. Table 3**

After a crossover where Batch A becomes the FC group and Batch B becomes the DL group. In the pre-test 3 on anti-depressants, Batch A (7.37) exhibited a significantly higher mean score compared to Batch B (5.35), with a p-value of 0.001. However, in the post-test 3, although Batch A (10.26) still had a higher mean score than Batch B (9.58), the difference was not statistically significant (p-value = 0.079). For pre-test 4 on sedatives & hypnotics, Batch A (7.29) demonstrated a higher mean score than Batch B (5.95) with a significant difference between both groups a p-value of 0.007. In post-test 4, Batch A still reported a higher score of (9.46) than Batch B (8.64), however, the difference was not statistically significant p-value of 0.093. **Table 4**

Table 3 shows pre and post-test results between the flipped group and the traditional learning group.

Group Statistics (BATCH B FC & BATCH A DL)						
	SECTION	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**	P-value
PRE-TEST 1	**BATCH-A**	65	4.54	1.611	0.2	0.001*
(PARKINSONISM)	**BATCH-B**	66	6.48	2.322	0.286	
POST TEST 1	**BATCH-A**	65	7.38	1.809	0.224	0.001*
(PARKINSONISM)	**BATCH-B**	66	8.83	2.324	0.286	
PRE-TEST 2	**BATCH-A**	65	4.18	2.404	0.298	0.001*
(ANTI EPILEPTICS)	**BATCH-B**	66	6.2	2.171	0.267	
POST TEST 2	**BATCH-A**	65	7.4	1.919	0.238	0.004*
(ANTI EPILEPTICS)	**BATCH-B**	66	8.5	2.375	0.292	

Data were represented as mean and std. * significant value according to independent samples T-test. FC; flipped classroom, DL; didactic lecture group, std; Standard deviation.

Table 4 shows pre and post-test results between the flipped group and the traditional learning group.

Group Statistics (BATCH A FC & BATCH B DL)						
	SECTION	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**	**P-value**
PRE-TEST 3	**BATCH-A**	65	7.37	2.004	0.249	0.001*
(ANTIDEPRESSANTS)	**BATCH-B**	66	5.35	2.605	0.321	
POST TEST 3	**BATCH-A**	65	10.26	1.939	0.24	0.079
(ANTIDEPRESSANTS)	**BATCH-B**	66	9.58	2.462	0.303	
PRE-TEST 4	**BATCH-A**	65	7.29	2.448	0.304	0.007*
(SEDATIVES & HYPNOTICS)	**BATCH-B**	66	5.95	3.101	0.382	
POST TEST 4	**BATCH-A**	65	9.46	2.312	0.287	0.093

(SEDATIVES & HYPNOTICS)	BATCH-B	66	8.64	3.199	0.394	

Data were represented as mean and std. * significant value according to independent samples T-test. FC; flipped classroom, DL; didactic lecture group, std; Standard deviation.

Formative test

Focusing on the formative Test 1, covering topics of Parkinsonism and anti-epileptics. The mean score for Batch A (DL) was 17.14, with a standard deviation of 3.661 and a standard error mean of 0.454. Batch B (FC) achieved a mean score of 18.23, with a higher standard deviation of 4.861 and a standard error mean of 0.598. The p-value provided is 0.15, indicating that there is no statistically significant difference in the mean scores between the two batches for Formative Test 1. However, it's important to note that while the p-value suggests no significant difference, the mean scores still indicate a slight advantage for Batch B (FC) over Batch A (DL) in this test.

Concerning formative Test 2 covers topics of anti-depressants and sedatives/hypnotics. Batch A (FC) achieved a mean score of 24.4, with a standard deviation of 3.23 and a standard error mean of 0.401. On the other hand, Batch B (DL) obtained a mean score of 17.44, with a slightly higher standard deviation of 3.759 and a standard error mean of 0.463. The p-value provided is 0.01, indicating a statistically significant difference in the mean scores between the two batches for Formative Test 2. **Table 5**

Table 5 shows the formative test results

Group Statistics (BATCH B (FC) & BATCH A (DL))						
	SECTION	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**	**P-value**
FORMATIVE TEST 1	**BATCH-A**	65	17.14	3.661	0.454	0.15
(PARKINSONISM & ANTI EPILEPTICS)	**BATCH-B**	66	18.23	4.861	0.598	
Group Statistics (BATCH A (FC) & BATCH B (DL))						
	SECTION	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**	P-value
FORMATIVE TEST 2	**BATCH-A**	65	24.4	3.23	0.401	0.01*
(ANTI DEPRESSANTS & SEDATIVES HYPNOTICS)	**BATCH-B**	66	17.44	3.759	0.463	

Data were represented as mean and std. * significant value according to independent samples T-test. FC; flipped classroom, DL; didactic lecture group, std; Standard deviation.

Internal assessment and students' perception towards the flipped classroom.

Through the comparison of internal assessments, we examined the topics covered in both flipped classroom (FC) and didactic lecture (DL) approaches. The internal assessment consisted of a 100-mark paper, with 10 marks allocated to questions related to Parkinson's and anti-epileptic topics, and another 10 marks related to sedative, hypnotic, and anti-depressant topics. Our findings revealed that students who studied Parkinson's and anti-epileptic topics through the FC method achieved higher results, with a mean score of 6.094 and a standard deviation of 1.4242, compared to Batch A (DL) students who attained a mean score of 4.554 and a standard deviation of 1.5616 with a p-value 0.01. Additionally, those taught sedative, hypnotic, and anti-depressant topics through the FC approach also reported higher results, with a mean score of 6.129 and a standard deviation of 1.9411, in contrast to students taught the same topics through DL, who achieved a mean score of 4.212 with a standard deviation of 1.504 the p-value was also 0.01. (**Table 6).** The comparison between students' perceptions of the flipped classroom approach versus traditional didactic lectures was demonstrated in supplementary file one.

Table 6 shows the internal assessment results

Group Statistics (BATCH B FC & BATCH A DL)						
	SECTION	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**	**P-value**
	BATCH-A	65	4.554	1.5616	0.1937	
Internal assessment out of 10	**BATCH-B**	66	6.094	1.4242	0.1753	0.01
Group Statistics (BATCH A FC & BATCH B DL)						
	SECTION	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**	**P-value**
	BATCH-A	65	6.129	1.9411	0.2408	0.01
Internal assessment out of	**BATCH-B**	66	4.212	1.504	0.1851	

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Data were represented as mean and std. *Significant value according to independent samples T-test. FC; flipped classroom, DL; didactic lecture group, std; Standard deviation.

Perception of Students Towards Flipped Classroom in Comparison with Didactic Lecture

The survey presents the perceptions of students towards the flipped classroom approach compared to traditional didactic lectures across various aspects. Overall, a majority of students agree or strongly agree with the benefits of the flipped classroom model.

In terms of coverage of topics, 84.3% of students agree or strongly agree that the flipped classroom helps them cover all areas of the topic fairly. Similarly, 91.1% agree or strongly agree that it promotes active participation and effective communication in class.

Regarding academic performance, 82% of students agree or strongly agree that the flipped classroom improves their academic performance considerably. Additionally, 88.1% find it more fun and interesting compared to traditional lectures.

The flipped classroom also fosters better understanding and interaction with peers and teachers, with 93% agreeing or strongly agreeing. Furthermore, 93.2% of students find it beneficial for better visualization of clinical diseases through audio-visual aids and short films.

Sup table 1 - Perception of students towards Flipped Classroom in Comparison with Didactic Lecture

Perception of students towards Flipped Classroom inComparison with Didactic Lecture			
Questions		**Count**	**Column N %**
Flipped Classroom helped me to cover all areas of the topic fairly when compared to didactic lecture	Strongly Disagree	1	0.7%
	Disagree	5	3.7%
	Uncertain	15	11.2%
	Agree	78	58.2%
	Strongly Agree	35	26.1%
Flipped Classroom helped me to actively participate and communi-cate effectively in the class when compared to didactic lecture	Strongly Disagree	0	0.0%
	Disagree	2	1.5%
	Uncertain	10	7.5%
	Agree	73	54.5%
	Strongly Agree	49	36.6%
Flipped Classroom helped me to improve my academic perfor-mance considerably when com-pared to didactic lecture	Strongly Disagree	0	0.0%
	Disagree	1	0.7%
	Uncertain	23	17.2%
	Agree	77	57.5%
	Strongly Agree	33	24.6%
Flipped Classroom is more fun and interesting when compared toDidactic lectures when comparedto didactic lecture	Strongly Disagree	0	0.0%
	Disagree	4	3.0%
	Uncertain	12	9.0%
	Agree	67	50.0%
	Strongly Agree	51	38.1%
Flipped Classroom helped me to have a better understanding and interaction with peers and teacherwhen compared to didactic lecture	Strongly Disagree	0	0.0%
	Disagree	1	0.7%
	Uncertain	8	6.0%
	Agree	73	54.5%
	Strongly Agree	52	38.8%
Flipped Classroom allows meto have a better visualization of the clinical disease in question through AV Aids and Short Films when compared to didactic lecture	Strongly Disagree	0	0.0%
	Disagree	1	0.7%
	Uncertain	8	6.0%
	Agree	57	42.5%
	Strongly Agree	68	50.7%
Flipped Classroom encouraged me to present my understanding of the topic and rectify my short-comings when compared to didac-tic lecture	Strongly Disagree	0	0.0%
	Disagree	2	1.5%
	Uncertain	18	13.4%
	Agree	72	53.7%
	Strongly Agree	42	31.3%
	Strongly Disagree	0	0.0%
	Disagree	3	2.2%

Flipped Classroom was enjoyableand fun and motivating to do better when compared to didactic lecture	Uncertain	7	5.2%
	Agree	71	53.0%
	Strongly Agree	53	39.6%

Lastly, the flipped classroom encourages students to present their understanding of the topic and rectify shortcomings, with 85% agreeing or strongly agreeing. Overall, the findings suggest that students perceive the flipped classroom as a more engaging, interactive, and effective learning approach compared to traditional didactic lectures. **Sup table 1**

Perception of Students towards Flipped Classroom

The survey presents the perceptions of students towards the flipped classroom approach. The majority of students express positive views regarding various aspects of the flipped classroom.

Firstly, a large proportion of students (98.5%) agree or strongly agree that the flipped classroom helps them understand the given topic better. Similarly, an overwhelming majority (97%) find the material provided before the flipped classroom to be appropriate for preparing for the topic.

Regarding the activities conducted during the flipped classroom, the majority of students (93.2%) agree or strongly agree that the quizzes were beneficial and relevant, and 95.6% find them appropriate and challenging.

In terms of the duration of the flipped classroom sessions, a majority of students (81.3%) agree or strongly agree that the duration was appropriate.

Sup table 2 - Perception of Students towards Flipped Classroom

Perception of Students towards Flipped Classroom			
Questions		**Count**	**Column N %**
Flipped Classroom helped me tounderstand the given topic better	Strongly Disagree	0	0.0%
	Disagree	0	0.0%
	Uncertain	2	1.5%
	Agree	68	50.7%
	Strongly Agree	64	47.8%
Material given before Flipped Classroom was appropriate to pre-pare for the particular topic	Strongly Disagree	0	0.0%
	Disagree	0	0.0%
	Uncertain	4	3.0%
	Agree	65	48.5%
	Strongly Agree	65	48.5%
Activity (Quiz) conducted for theFlipped Classroom was beneficial and relevant	Strongly Disagree	1	0.7%
	Disagree	1	0.7%
	Uncertain	7	5.2%
	Agree	70	52.2%
	Strongly Agree	55	41.0%
Activity (Quiz) conducted for the Flipped Classroom was appropri- ate and challenging	Strongly Disagree	1	0.7%
	Disagree	1	0.7%
	Uncertain	4	3.0%
	Agree	75	56.0%
	Strongly Agree	53	39.6%
Duration of Flipped Classroomsession was appropriate	Strongly Disagree	1	0.7%
	Disagree	9	6.7%
	Uncertain	15	11.2%
	Agree	74	55.2%
	Strongly Agree	35	26.1%
Flipped Classroom encourages toimprove the way of understandingof the topic	Strongly Disagree	0	0.0%
	Disagree	1	0.7%
	Uncertain	7	5.2%
	Agree	55	41.0%
	Strongly Agree	71	53.0%
Flipped Classroom allows to havea creative and independent mind- set for the topic	Strongly Disagree	0	0.0%
	Disagree	2	1.5%
	Uncertain	11	8.2%
	Agree	61	45.5%
	Strongly Agree	60	44.8%
	Strongly Disagree	0	0.0%

Flipped classroom is a better teaching learning method when compared to traditional didactic lectures	Disagree	3	2.2%
	Uncertain	25	18.7%
	Agree	58	43.3%
	Strongly Agree	48	35.8%

The flipped classroom is perceived to encourage improvement in understanding the topic and foster a creative and independent mindset by a significant majority of students (94%). Additionally, a substantial portion of students (79.1%) agree or strongly agree that the flipped classroom is a better teaching-learning method compared to traditional didactic lectures.

Overall, the findings indicate that students have a positive perception of the flipped classroom approach, considering it effective for understanding topics, providing appropriate materials and activities, fostering independent learning, and being superior to traditional lectures. Sup Table 2

DISCUSSION

In this cross-over study, we evaluated the effectiveness of the flipped classroom model compared to traditional teaching methods among second-year medical undergraduate students and assessed their perceptions of this approach. We examined the performance of two groups, Batch A (DL) and Batch B (FC), across various topics through pre- and post-tests. Initially, Batch B (FC) consistently demonstrated significantly higher mean scores compared to Batch A (DL) in pre-test 1 on Parkinsonism and post-test 1 on Parkinsonism, as well as pre-test 2 on anti-epileptics. This indicated the effectiveness of the flipped classroom (FC) method in enhancing test scores. Following a crossover where Batch A became the FC group and Batch B became the DL group, Batch A continued to show higher mean scores in pre-test 3 on anti-depressants and pre-test 4 on sedatives & hypnotics. However, in post-tests 3 and 4, although Batch A still exhibited higher mean scores than Batch B, the differences were not statistically significant. Focusing on the tests; formative test 1, focusing on Parkinsonism and anti-epileptics, Batch B (FC) exhibited a slightly higher mean score compared to Batch A (DL), although the difference was not statistically significant (p-value = 0.15). However, in Formative Test 2, covering anti-depressants and sedatives/hypnotics, Batch A (FC) significantly outperformed Batch B (DL), as evidenced by a lower p-value of 0.01. Furthermore, regarding the internal assessment FC group consistently outperformed the DL group in both assessments.

Bhavsar et al [5] conducted a study that included 100 students. Using pseudo-randomization, the participants were divided into two groups, with one group undergoing the FC method and the other the Traditional Didactic Classroom (TDC) method in module A. In module B, a crossover of groups was implemented. Following the intervention in each module, both groups underwent a post-test assessment. Feedback regarding their perception of the FC method was collected from the students. Their results were consistent with our results. They reported that a significant statistical distinction ($p<0.05$) was observed in the post-test scores of both FC groups across both modules (FC Method: 14.77 ± 2.16 and 11.26 ± 1.76 vs TDC Method: 12.16 ± 2.05 and 10.03 ± 2.57). Overall, favourable feedback was received for the FC teaching approach compared to the TDC method. A comprehensive review by Nichat et al [11] included a total of 19 articles that compared FC and DL in medical education from 2018 to 2023. They reported that the advent of the FC represents a promising advancement in educational strategy, offering potential enhancements to medical students' learning outcomes and educational experiences. This approach has shown promise in improving learning outcomes, engagement levels, and critical thinking skills among medical students. However, successful implementation requires careful consideration of various factors including curriculum design, technological support, faculty training, and student readiness. Achieving optimal results necessitates finding a balance between self-directed study and meaningful in-person interaction, leveraging the strengths of both components. By incorporating technology, active learning methodologies, and student-centred approaches, medical educators can continue to innovate and provide a transformative educational experience that benefits both students and the future of healthcare. HEW et al [12] performed another meta-analysis including 28 comparative studies employing a between-subject design revealed a notable advantage of flipped classrooms over traditional classrooms in health professions education. The analysis indicated a significant overall effect favouring flipped classrooms (standardized mean difference, SMD = 0.33, 95% confidence interval, CI = 0.21–0.46, $p < 0.001$). Moreover, the effectiveness of the flipped classroom approach was further enhanced when instructors incorporated quizzes at the beginning of each in-class session. Additionally, a higher proportion of respondents expressed a preference for flipped classrooms over traditional ones. Chan et al [6] performed a randomized clinical trial to tackle the challenge of teaching non-core specialities, particularly those with restricted teaching time and low student involvement, a Flipped Classroom Case Learning (FCCL) module was created and integrated into a mandatory 5-day ophthalmology rotation for undergraduate medical students. They reported that utilizing the FCCL module in ophthalmology education

improved medical students' satisfaction, performance in examinations, and retention of knowledge. Such an approach could potentially be adapted for use in other medical specialities as well. Furthermore, a comparative study with both pre-test and post-test assessments, along with a control group.

Khayat et al [13] compared the FC and DL among the academic students at Farhangian University in Ahvaz City in 2019. A convenience sample of 36 students was selected, and then randomly assigned to either the experimental group (n=18) or the control group (n=18). The research utilized two instruments: The Basic Psychological Need Satisfaction questionnaire and the Class Perception Questionnaire. The experimental group underwent a flipped teaching program consisting of six 120-minute sessions conducted once a week, while the control group received traditional teaching methods. Their findings revealed a notable contrast between flipped classroom instruction and traditional teaching methods ($p<0.05$).

The study's scope may be constrained by its small sample size and focus exclusively on second-year MBBS students. To achieve a more comprehensive understanding, future research should consider conducting larger-scale randomized trials involving a broader range of participants.

CONCLUSION

FC, an innovative approach to interactive teaching, holds considerable promise in medical education. It significantly enhances learning outcomes among medical students and receives overwhelmingly positive feedback from student perceptions. The FC teaching method accelerates students' comprehension of the subjects to be studied, fostering more efficient and effective learning.

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