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Original Research Article

Exploration of The Effectiveness And Perception of Flipped Classroom and Team-Based Learning in Pharmacology Among Medical Undergraduates - An Observational Parallel Group, Cross Over Study

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Abstract:

Purpose: Competency-based medical Education (CBME) focuses student-centred learning and development of critical thinking and lifelong learning skills. Traditional Pharmacology teaching methods fail to engage students effectively. Active learning strategies like Flipped Classroom (FC) and Team Based Learning (TBL) promote higher-order cognitive skills. Combining FC and TBL enhances the learner's autonomy, self- directed learning, motivation, advanced critical thinking and conceptual understanding. However, literature on their combined effect in pharmacology is very limited. This study aimed to evaluate the effectiveness of integrating FC and TBL in Pharmacology.

Aim: To explore the combined effectiveness of FCs and TBL in fostering higher-order cognitive skills among medical students.

Methodology: A parallel-group, comparative, crossover study was conducted among II nd year MBBS students, divided into two groups. In session I, Group A underwent FC and TBL learning methodology while Group B received traditional teaching. In the session 2 cross over of the teaching strategies was done. Pre-test, team test and post-test scores were collected along with student's feedback using validated questionnaire. Data was analysed using student's t-test.

Results: Pre-test, team test and post-test scores showed a significant improvement in group exposed to FC and TBL ($p < 0.001$). No significant improvement was observed in the group taught using traditional methods. Student feedback strongly inclined towards FC and TBL for promotion of critical thinking, teamwork, self-directed learning and leadership skills.

Conclusion: Combined use of FC and TBL is highly effective teaching strategy in Pharmacology for medical undergraduates enhancing knowledge acquisition and promoting essential cognitive and collaborative skills.

Keywords: Flipped class room, Team based learning, Traditional learning.

Introduction

Competency-Based Medical Education (CBME), which aims for lifelong and self-directed learning, is generally student learning centered emphasizing more for the development of critical appraisal and analytical thinking skills in MBBS students. Traditional teaching methods predominantly focus on lower-order cognitive skills and rely on lectures, a passive learning technique with limited retention which does not adequately address the diverse learning needs of the students. Lecture-based teaching alone does not equip students with the necessary knowledge, critical thinking abilities, and practical application skills required to address real-world clinical challenges. The various roles of Indian Medical graduates cannot be effectively fulfilled through didactic lectures and lecture dominated tutorials alone. Therefore, adapting teaching and learning methods to incorporate active learning strategies is crucial to enhance student's competency and preparing them for diverse medical practices. Implementing active learning approaches in place of traditional lectures have shown to

enhance learning efficiency, reduce lecture time and consequently minimize excessive content coverage [1].

The paradigm shifts from passive to active learning increase the significance of interactive teaching methods. The flipped classroom (FC) teaching strategy replaces traditional didactic teaching, allowing students to prepare at their own pace for a deeper understanding of key concepts [2]. This approach enables students to take responsibility for crucial aspects of their learning, particularly the acquisition of basic knowledge and comprehension, problem-solving abilities and communication skills which form the foundation of the learning process [3]. By engaging in self-directed learning (SDL) outside the classroom, students develop essential skills such as planning, time management, and self-assessment. Team based learning (TBL) is a small group instructional active learning method that guides students through a structured sequence of individual tasks, teamwork and immediate feedback to facilitate conceptual understanding [4]. Through TBL students enhance their higher-order thinking, reasoning and problem-solving skills making it an innovative approach to student-centered learning and complementing the FC model in healthcare education [5].

Integrating FC and TBL enhances the overall teaching–learning process more effectively than using either strategy alone. This hybrid approach promotes time efficiency, self-paced learning, content reinforcement and interactive engagement, minimal use of space and instructor resources, ultimately yielding a positive impact on students' academic success, attitudes and behaviors [6, 7]. There is enthusiasm and readiness to implement this new strategy in the classroom; however, there is limited evidence of its effectiveness in Pharmacology. Conventionally, the teaching of Pharmacology to undergraduate students is done commonly by traditional methods like didactic lectures for large groups and practical's and tutorials for small groups, which is more of a passive teaching. Hence, to keep pace with the changes in the curriculum, it is the need of the hour to reduce dependence on rote memorization and adopt new teaching strategies that promote critical thinking and application-based knowledge among students to enhance patient care and develop skills effectively [8]. There is existing literature on the individual use of the FC and TBL in the context of pharmacological education. Some studies have indicated that combining FC with TBL significantly enhances all aspects of effectiveness compared to traditional lecture-based learning. [9] However, the literature on the combined effect of flipped classroom and team-based learning in pharmacology is very limited. Hence, this study was planned to appreciate the effectiveness of FC combined with TBL to obtain evidence to support this teaching strategy in Pharmacology. These could be more useful in the teaching of complex content, which has an important role in therapeutics.

Aim and Objectives

Aim: To explore the effectiveness of flipped classroom and team based learning on a higher order of cognition**.**

Objectives:

1. To sensitize the students to flipped classroom and team based learning method
2. To determine the effectiveness of flipped classroom and team based learning methods in pharmacology.
3. To assess the student's perception about flipped classroom and team based learning**.**

Methodology

A parallel group, comparative, crossover study was conducted in II nd MBBS students in department of pharmacology in a tertiary care hospital and medical college in central India. The batch of 250 students was divided into two groups based on college roll number to remove the bias. Roll number 1-125 were in enrolled in group A and roll number 126-250 in group B.

After institutional ethic committee clearance (3565/EC/Pharmac/GMC/NGP/13/09/2024) the study was conducted in the II MBBS students. In the session 1, learning resources on the topic were shared one week in advance to promote self-directed learning (SDL) to students of group A only. During the contact session, Group A was exposed to a FC and TBL approach, while Group B was taught using traditional teaching methods on the same topic at the same time. Consent to participate in the study was obtained digitally from both groups through a consent form linked to multiple-choice questions (MCQ) in pre-test. Students who did not voluntarily provide their consent were unable to access pre-test. Both groups were given the same pre-test consisting of validated MCQs called as individual readiness assurance test (iRAT) administered via Google Forms to assess their baseline knowledge. Students in the group A exposed to FC and TBL methodology were further divided into 10 teams, each comprising approximately 10 students. A team leader was selected in every team for the smooth conduction of the work. Each team was allotted 10 minutes for a discussion of the topic, followed by a team based Readiness assurance Test (tRAT). [10] Immediate feedback was provided through a discussion of the MCQs, followed by addressing queries raised by the team leader after the team discussion. Additionally, a case-based scenario question was discussed in FC and TBL exposed group to enhance conceptual clarity and understanding. Post-test assessments

were conducted for both the FC & TBL group and the traditional teaching group and the scores were recorded. Feedback is the key to knowledge acquisition and retention so student's feedback on the FC and TBL approach was collected using a validated questionnaire reviewed by the Medical Education Unit (MEU) members. [11, 12] The internal consistency of the feedback questionnaire was calculated using Cronbach's alpha with a reliability coefficient exceeding 0.70, indicating high reliability and consistency.

As the study was cross-over in design, in the session 2 the learning resources on another topic was shared one week prior to students of group B and in contact session it was exposed to the FC and TBL methodology while group A received traditional teaching method. The same procedure as described above was followed.

Inclusion Criteria: All II nd year MBBS professional students who were present on the day of the session and provided voluntary informed consent through Google Forms to participate in the study.

Exclusion Criteria: Students who were unwilling to provide informed consent, or absent on the day of the FC and TBL activity.

Observations and Results

The Data collected was the scores of the pre-test and post-test of both the groups, team test of the exposed group, and feedback of the whole batch. Only the data from students who completed both the pre-test and post-test in the non-exposed group and all three assessments (pre-test, team test, and post-test) in the exposed group were included in the analysis. A total of 205 students participated in the session 1 where 102 students were exposed to the FC and TBL method (Group A), and 103 students attended the traditional method of learning (Group B). While in Session 2, a total of 204 students participated. 103 students (Group B) were exposed to FC and TBL methodology and Group A (101) students were exposed to the traditional method of teaching.

Table 1 shows the analysis of mean scores of the pre-test, team test and post-test score of the groups exposed to FC and TBL method in session 1 & 2. The scores of the groups were analysed using the student's t-test. The results were significant in the exposed group whereas the results were non-significant in the non-exposed group in both the sessions.

Table 1: Analysis of pre-test, team test and post-test of exposed and non-exposed group in session 1 &2

Session	Group	Test Type	Mean	Std. Dev.	P-Value
Session 1	**Group A (Exposed)**	Pre-test	51.93	7.99	0.0001
		Team test	66.25	7.83	
		Post-test	80.37	5.58	
	Group B (Non-Exposed)	Pre-test	41.37	4.06	0.084
		Post-test	41.81	3.66	
Session 2	**Group A (Non-Exposed)**	Pre-test	39.06	4.78	0.0835
		Post-test	39.66	4.04	
	Group B (Exposed)	Pre-test	61.26	6.87	0.0001
		Team test	73.53	6.89	
		Post-test	84.73	6.44	

To calculate the effectiveness of the FC and TBL method, statistical analysis using unpaired T test of the pre-test scores of exposed and non-exposed groups in session 1 and session 2 was done, The score of the exposed group was found to be statically significant which suggests that the students exposed to the FC and TBL had some basic knowledge of the topic as compared to the students who were exposed to the traditional method as in table 2.

Table 2: The comparison of the pretest and post-test scores of both groups in sessions 1 & 2

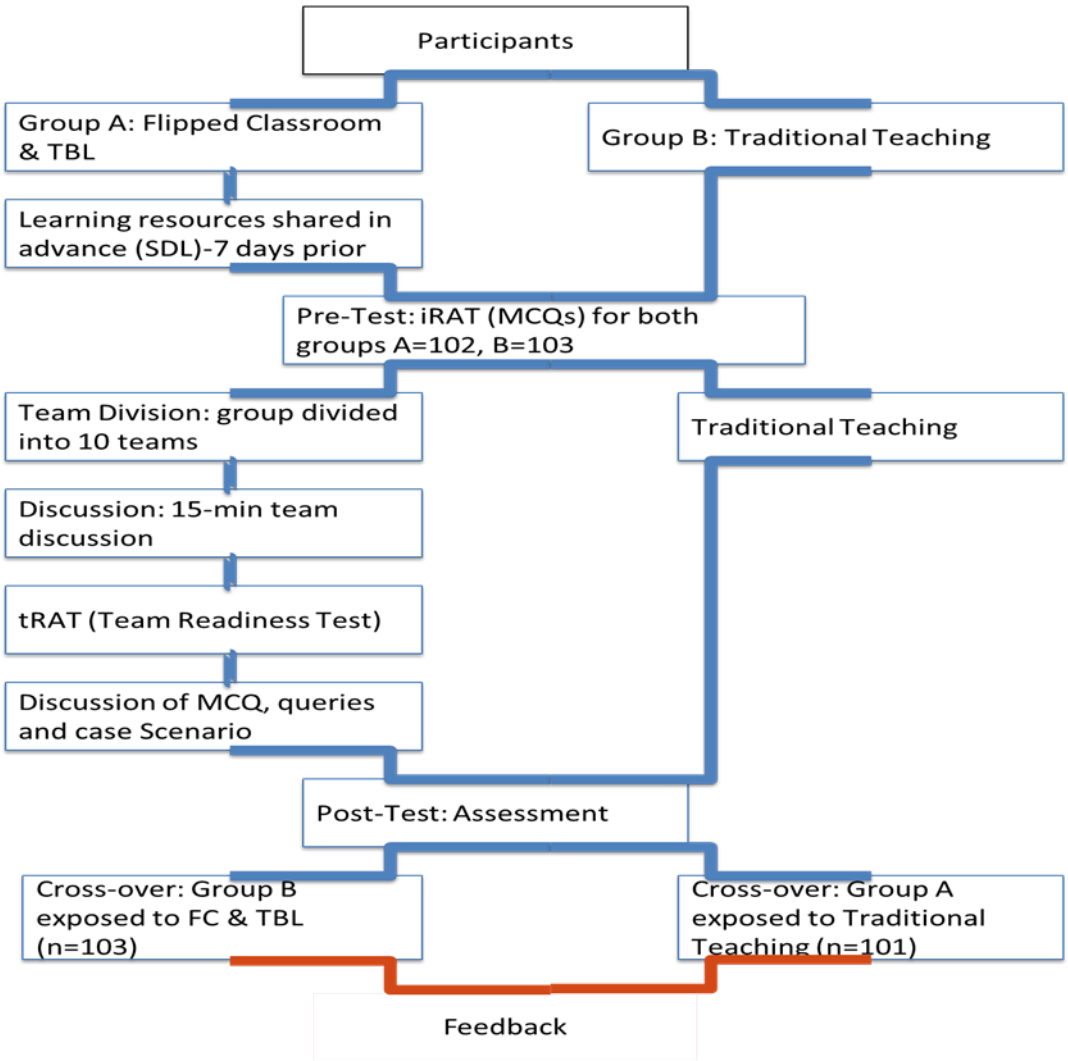
Session	Test Type	Exposed Group (Mean ± Std. Dev.)	Unexposed Group (Mean ± Std. Dev.)	P-Value
Session 1	**Pre-test**	**51.93 ± 7.99**	**41.37 ± 4.06**	**0.0001**
	Post-test	**80.37 ± 5.58**	**41.81 ± 3.66**	**0.0001**
Session 2	**Pre-test**	**61.26 ± 6.87**	**39.06 ± 4.78**	**0.0001**
	Post-test	**84.73 ± 6.44**	**39.66 ± 4.04**	**0.0001**

Table 3 shows the students' perception regarding the use of the FC and the TBL method of the teaching-learning methodology. Most of the students strongly agreed with the various aspects of TBL as depicted in the table. Most of the students have reported this experience to be an excellent one.

Table 3: Shows the feedback of the students' perceptions regarding the FC and TBL strategy.

Sr. No	Question	Strongly agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly disagree (%)
	Points	5	4	3	2	1
1	SDL promotes the learning of essential concepts or skill	112	53	24	2	4
2	TBL helped me to develop critical thinking skills.	104	60	25	1	5
3	FC &TBL should be offered more frequently in the curriculum	108	54	22	6	5
4	I will recommend FC &TBL to other students	106	63	19	2	5
5	TBL promoted effective cooperative learning & SDL	111	47	29	2	6
6	My ability to work in a team improved through TBL	105	51	28	7	4
7	TBL helped me develop leadership skills	112	46	33	0	4
8	FC & TBL increased my confidence in applying the course concepts	108	50	31	2	4
9	I feel more confident in expressing my ideas in a group setting after participating in TBL	102	58	25	4	6
10	FC & TBL motivated me to prepare more thoroughly for classes	110	46	31	4	4
11	FC &TBL promoted increased reading of the textbook by the students	102	66	19	4	4
12	Working in a team made the course more enjoyable	106	62	20	2	5

Flow Chart of the study



Discussion

Pharmacology is often perceived as a challenging and less engaging subject. It is essential to introduce innovative teaching methods to inspire students and enhance their learning experience, ultimately contributing to the effective management of patient care. FC and TBL methods are not new to the field of medicine; however, their implementation has gained prominence only after the introduction of the CBME curriculum which promotes conceptual and self- directed learning, A study by Malhotra et al. interpreted no difference in the test scores of students exposed to either FC or traditional teaching, however, it revealed the preference of students for a FC [13]. In contrast, some studies revealed enhanced effects when FC and TBL when used independently [9]. However, some studies reported FC-TBL increased learning, motivation, communication skills, self -study efforts and had a better ability of problem-solving and clinical reasoning [14]. Hence, the present study was conducted to evaluate the effectiveness and perception of the FC and TBL strategies in pharmacology when combined.

A significant difference in the scores is seen in the pretest, team test and post-test scores in the group exposed to FC and TBL method as compared to the non-exposed group. Similar results were found by Hashilkar et al. [15]. FC and TBL methods have a measurable impact on the outcome. This method of teaching not only strengthens the foundation of any topic but also encourages higher-order cognitive skills such as critical thinking. This is evident in the present study where the assurance test questions focused mainly on the fundamental concepts. The formation of teams also proved beneficial. Our findings align with this observation of Ofstad et al. [16] as teamwork fostered collaborative learning.

Student feedback indicated that learners viewed the interactive learning approach as more engaging, interest enhancer and promote active participation in the learning process. Similar results were found in the study by Attia et al. [10]. The majority of students demonstrated a positive attitude toward FC and TBL, highlighting its ability to enhance learner engagement, critical thinking and teamwork making it an invaluable approach in medical education. This integration also fosters learner autonomy, enhances

motivation and strengthens self-directed learning skills which are crucial for lifelong learning and significantly influence individuals' future growth. By accommodating the varied needs and learning preferences of students, educators can nurture a more inclusive learning environment and achieve improved outcomes. This aligns with the core principles of CBME, which highlight the importance of addressing diverse learning styles among students. Overall, consistent with previous research, our research had shown that this combined approach could improve students' various abilities.

Conclusion

This study supports the incorporation of FC and TBL approaches into medical curricula as effective tools for fostering interactive, meaningful, and inclusive learning experiences which will be useful in reducing the gap of theoretical knowledge and its application in real world, ensuring that students are better equipped to excel in dynamic healthcare environments. However, this method requires further exploration and optimization, and conducting long-term follow-up and evaluation in future.

Limitation

Our evaluation of students was limited to the end of the class, and we did not investigate long-term knowledge retention, so a long-duration study is required to confirm the long-term memory.

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