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Original Article

Pharmacology Section

Impact and Perception of Virtual Team-based Learning in Comparison to Online Lectures in Pharmacology- A Randomised Crossover Interventional Study

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ABSTRACT

Introduction: Competency-based Medical Education (CBME) emphasises small group teaching; henceforth, more innovative educational strategies are needed to stimulate student learning. Team-based Learning (TBL) is structured small-group teaching featuring student preparation out of class to acquire critical concepts. In the current study, TBL was carried out on a virtual platform using commonly available web applications.

Aim: To evaluate the impact and perception of virtual TBL compared to online lectures in Pharmacology.

Materials and Methods: The randomised crossover study was conducted from September 2021 to January 2022, in the Pharmacology department of Tirunelveli Medical College, Tirunelveli, Tamil Nadu, India. The students were assigned into two groups in the ratio of 1:1 by simple random sampling. Students in group A attended TBL sessions, whereas group B attended lectures on the same topic via Google classroom for the first session. A crossover of groups was done for the second session. At the end of both sessions, a questionnaire with Multiple Choice Questions (MCQs) to assess knowledge recall and Short Answer Questions (SAQs) to assess critical analysis was sent to both groups in Google forms, and responses were collected and evaluated. A validated 33 item TBL Student Assessment Instrument (TBL-SAI) was used to determine the student perceptions. An unpaired t-test was used to compare the scores of both groups to assess performance. Mann-Whitney U test was used to compare the student accountability, preference, and satisfaction scales of TBL-SAI.

Results: Out of 130 students, 125 were taken up for analysis as five failed to attend the sessions or complete the questionnaire. TBL group scored significantly better than the lecture group in MCQs {(15.8±2.2 vs 12±2.6) and (12.7±3.5 vs 6.4±2.2)} and SAQs {(5.4±2.1 vs 2.3±1.4) and (6.1±2.0 vs 3.3±1.9)} in sessions 1 and 2, respectively. TBL-SAI subscale and total scores were higher than neutral scores in both groups, indicating a positive attitude toward virtual TBL.

Conclusion: Implementation of virtual TBL in synchronous setting in Pharmacology course established proof of high student accountability and satisfaction. Students preferred online TBL to online lectures. Virtual TBL sessions were more effective than online lectures.

Keywords: Critical analysis, Google classroom, Innovation, Knowledge recall, Small group teaching

INTRODUCTION

Pharmacology is one of the basic sciences in medical education, which teaches all aspects of drugs and their uses. The ultimate goal of pharmacology is to make the undergraduate competent to apply the foundational knowledge acquired in classes for critical thinking and active decision-making. This can be achieved by dynamic learner-centered pedagogical approaches rather than passively transferring information with didactic lectures. A substantial transformation in Indian Medical Education ensued in 2019 with the National Medical Commission (NMC) launch and the implementation of CBME. Medical education in India for a long time was teacher-centric and time-oriented. The introduction of CBME has pivoted it to be learner-centric and outcome-oriented [1]. It downplays time-based training and offers greater flexibility until learners accomplish the desired competencies [2].

Teaching-learning activities are improved in design and function to attain the predefined outcomes in CBME, underscoring the role of the learner [3]. The new curriculum concentrates more on small group teaching-learning methods superseding the traditional didactic lectures. Innovative teaching-learning approaches incorporating transformations of formal passive instructor-paced classes into active learner-paced courses are encouraged and embraced. The new CBME curriculum emphasises lifelong learning, where the learner is in the driver's seat and is responsible for the learning process [4]. The TBL, an active pedagogical approach developed by Larry Michelson (2004), is an instructor-led but student-centred flipped classroom model that promotes individual and group accountability [5,6]. In typical in-class TBL, the learners acquire the basic knowledge through preclass preparation and then work individually and in teams to build upon this initial knowledge through readiness assurance tests. Finally, TBL prepares the learners to solve problems using collaborative learning and decision-making, improving content acquisition and critical thinking [7,8]. This application of the abstract to concrete situations naturally highlights essential contextual factors and analysis challenges. Students accomplish the desired learning experience and academic performance when they collectively engage in planned discourse in teams. Traditional in-class TBL effectively allows students to apply their foundational knowledge through collaboration and assessment [9] and is more effective than formal lecture-based learning [8].

Coronavirus Disease 2019 (COVID-19) has pushed medical schools to conduct exclusive online and virtual teaching at unprecedented and unseen levels, creating a new need for effective pedagogical teaching methods for online learning. Classes can entirely be delivered on a digital platform with modern technology and advancements. The changeover from face-face classes to a virtual basis is challenging in various aspects, and it should not compromise the learning process. Learners regarded TBL as engaging and enhancing critical thinking

and problem-solving togain profound insight into the subject in face-face sessions [10,11]. However, more analyses are required to uncover the students' perceptions of TBL in a virtual environment. Hence, the present study examined the effectiveness of virtual TBL and students' perceptions of virtual TBL compared to online lectures.

MATERIALS AND METHODS

The randomised crossover interventional study was conducted at the Department of Pharmacology, Tirunelveli Medical College, Tirunelveli, Tamil Nadu, India, from September 2021 to January 2022. The two teaching-learning formats (TBL versus Lectures) were studied using a randomised control trial design in the virtual mode in a synchronous setting using web-based video conferencing applications. The study was commenced after due permission from the Institutional Ethics Committee (TIREC-1818/Pharma/2020), and after obtaining informed consent from all the study participants.

Out of 250 second-year MBBS students from the academic year 2021-22, 130 students were assigned to groups A and B, in the ratio of 1:1, by a simple random sampling technique using a computer-generated sequence. Faculty members of the department of Pharmacology trained in TBL sessions constituted the team of facilitators.

Interventions: The topic chosen for the initial session was the pharmacology of 5-hydroxytryptamine agonists and antagonists. The pre-class learning materials, to accomplish the learning objectives of the initial session, were sent to both group A and B via Google Classroom before the initial session.

- Group A: Students attended TBL sessions.
- Group B: Students attended lectures on the same topic via Google classroom.

Study Procedure

Virtual TBL execution: The link for the TBL session was sent to the individual mail IDs of the participants. The session was initiated with the individual Readiness Assessment Test (iRAT), consisting of 10 MCQs to assess the basic understanding of each student for 10 minutes. To each virtual team breakout room, 10-11 students were allocated to discuss the questions and arrive at answers, and this discussion lasted for 30 minutes. Then they were instructed to answer the ten minutes- team RAT (tRAT) after arriving at a consensus. One facilitator was assigned to each break-out room to monitor the session. The facilitator provided an introduction, orientation on the initiation of the session, and feedback after tRAT. The readiness assessments with feedback and scores were administered through the KAHOOT quiz link. After addressing the queries and clarifications, an application exercise based on a clinical case scenario of the given topic with a set of five questions was given to each subgroup for discussion with a 30 minutes timer. Each team presented its answers to the application exercise and received feedback and clarifications from the facilitator.

Virtual lecture execution: Live online lecture-based classes for group B students were conducted via a separate link provided to the students in Google classroom. The learning objectives were specified at the beginning of the lectures, and the learners were engaged in virtual class by MCQs displayed on polls in Google meet.

Crossover of the groups was done for the second session; students from group B attended TBL sessions, and group A attended lectures. The topic for the second session was the pharmacology of thyroid hormones and their inhibitors. The best team and team members were acknowledged for promoting student participation and motivation in the sessions.

Outcome measures: At the end of both sessions, a questionnaire comprising 20 seconds MCQs, each carrying a score of 1 to assess knowledge recall (maximum score was 20), and five SAQs in the form of clinical case scenarios each carrying a score of 2 (maximum score was 10) to evaluatecritical analysis was sent to both groups in Google forms. A time limit of 20 minutes was given to complete the questionnaire, and responses were collected and evaluated.

A validated 33 item TBL-SAI [12] was used to record students' responses on a 5 point Likert scale to determine the students' perceptions. Permission from Heidi Mennenga was obtained to use TBL-SAI in the present study. The instrument had questions to assess accountability, preference for TBL, and satisfaction. Among the 33 items, ten negatively worded items (Q4, 11, 13, 14, 16, 18, 21, 22, 28 and 30) in the scale were reverse-scored. Cronbach-alpha coefficient value of TBL-SAI was 0.8 for the 33 item TBL SAI questionnaire, 0.8, 0.78 and 0.8, respectively, for the instrument's accountability, preference, and satisfaction subscales reflecting the internal consistency.

STATISTICAL ANALYSIS

Data collected were analysed by Statistical Package for Social Sciences (SPSS) software version 23.0. The mean and standard deviation of scores for each team were calculated. Descriptive statistics were used to explore the scores of the TBL-SAI instrument. An unpaired t-test was used to compare the scores of both groups to assess the effectiveness of virtual TBL. Mann-Whitney U-test was used to compare the accountability, preference, and satisfaction scores for TBL.

RESULTS

Out of 125 students, 62 (49.6%) were males, and 63 (50.4%) were females (32 male and female students in group A and 30 male and 31 female students in group B). In session 1, the assessment scores of group A (TBL) (21.2±3.6) were significantly higher than group B (Lectures) (14.3±3.3), as shown in [Table/Fig-1]. When the groups were crossed over for interventions, group B (18.8±4.7) scored significantly better than group A (9.7±3.5), as shown in [Table/Fig-2]. The scores were higher in MCQs and SAQs for virtual TBL than in e-lectures, as evident from [Table/Fig-1,2].

Session 1 scores	Group A (TBL) n=64 (Mean±SD)	Group B (Lectures) n=61 (Mean±SD)	Unpaired t-test p-value
Knowledge recall (MCQs-20)	15.8±2.2	12±2.6	<0.0001
Critical analysis and application skills (SAQs-10)	5.4±2.1	2.3±1.4	<0.0001
Total score (30)	21.2±3.6	14.3±3.3	<0.0001

[Table/Fig-1]: Comparison of mean scores between virtual Team-based Learning (TBL) (n=64) versus virtual lectures (n=61)-(Session 1).

Session 2 scores	Group A (Lectures) n=64 (Mean±SD)	Group B (TBL) n=61 (Mean±SD)	Unpaired t-test p-value
Knowledge recall (MCQs-20)	6.4±2.2	12.7±3.5	<0.0001
Critical analysis and application skills (SAQs-10)	3.3±1.9	6.1±2.0	<0.0001
Total score (30)	9.7±3.5	18.8±4.7	<0.0001

[Table/Fig-2]: Comparison of mean scores between virtual Team-based Learning (TBL) (n=61) versus virtual lectures (n=64)-(Session 2).

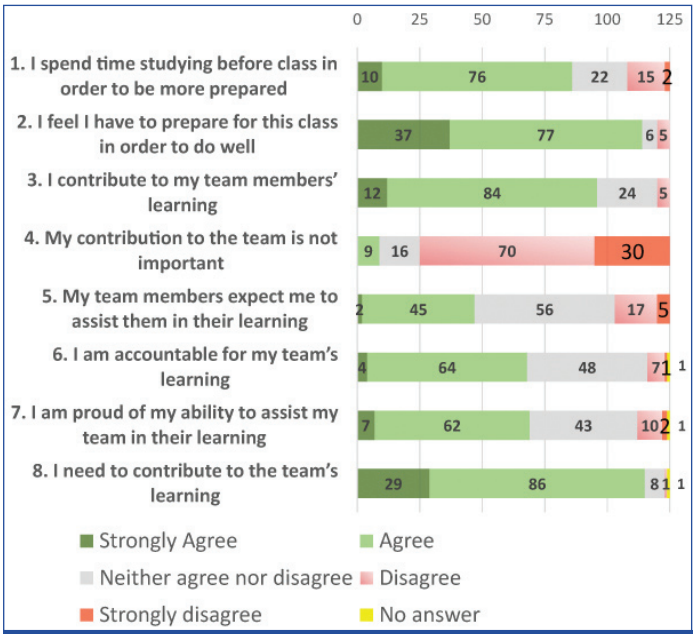
Descriptive analysis of the TBL-SAI instrument and respective subscales (accountability, preference for lecture or TBL, and student Satisfaction) are documented in [Table/Fig-3]. The total scores of the 33-item TBL-SAI varied from 33-165. The neutral scores are as follows: accountability, 24; preference for lecture or TBL, 48; student satisfaction, 27; and total score, 99. A positive attitude towards TBL is presumed when the scores are above the neutral scores. Median scores of accountability, preference, and satisfaction subscales were 31, 59, 37 and 30, 54, 36 for groups A and B, respectively.

Results as certained the positive attitude towards virtual TBL on the TBL-SAI in both groups (A&B). Mann-Whitney U test showed significant differences between group A and B in their accountability, preference, and satisfaction scales of virtual TBL [Table/Fig-3].

Scores	Group	Minimum score	Maximum score	Mean rank	Test statistic	p-value	Neutral score
Accountability	A (n=64)	24	37	72.52	1343.000	0.02	24
	B (n=61)	20	36	53.02			
Preference for TBL	A (n=64)	41	80	72.55	1341.000	0.003	48
	B (n=61)	45	77	52.98			
Satisfaction	A (n=64)	27	45	69.89	1511.000	0.029	27
	B (n=61)	23	45	55.77			
Total TBL-SAI score	A (n=64)	92	154	74.05	1245.000	<0.001	99
	B (n=61)	97	156	51.41			

[Table/Fig-3]: Comparison of Team-based Learning and Student Assessment Instrument (TBL-SAI) scores.

In the accountability subscale [Table/Fig-4], 91.2% (114/125) felt that preparation before TBL is needed, and 68.8% (86/125) spend time on preparation; 92% (115/125) felt the need for their contribution to their teams' learning, 76.8% (96/125) affirmed that they contributed to team members' learning and 54.4% (68/125) felt accountable for their team's learning. Only 7.2% (9/125) felt that their contribution is not important for TBL.



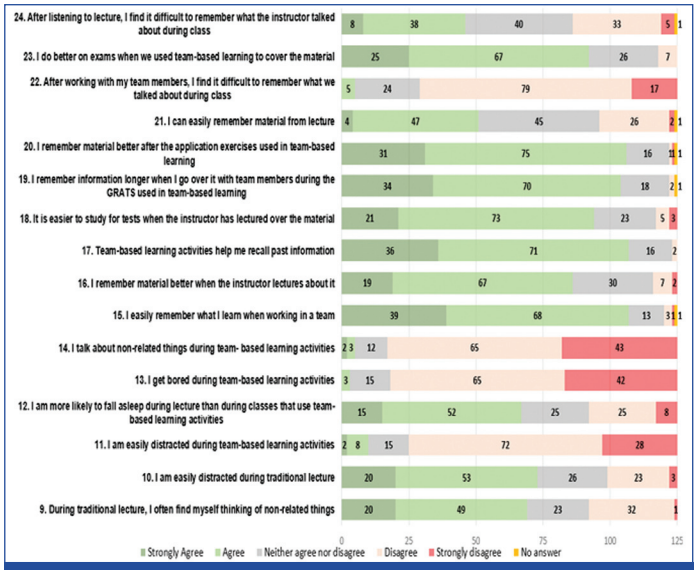
[Table/Fig-4]: Accountability Subscale (TBL-SAI).

In the preference subscale [Table/Fig-5], 55.2% (69/125) agreed that they think about non related things during lectures, whereas, only 4% (5/125) agreed that they talk about non related things in TBL. A 58.4% (73/125) felt easily distracted during lectures, whereas, only 8% (10/125) felt distracted in TBL. The majority of the participants (107/125, 85.6%) affirmed easy remembrance and recall with TBL. An 84.8% (106/125) agreed that they remembered the material better after the application exercises in TBL.

In the satisfaction subscale [Table/Fig-6], 83.2% (104/125) enjoyed TBL activities, 73.6 (92/125) thought TBL activities to be fun, 85.6% (107/125) thought TBL was an effective approach to learning, (86.4) 108/125 had a good experience with TBL. About 72% (90/125) of participants thought TBL helped in improving their grades.

DISCUSSION

Digital literacy has become obligatory in medical education. Virtual courses supersede face-to-face lectures in this world of technology,



[Table/Fig-5]: Preference Subscale (TBL-SAI).

necessitating strategies to accomplish active pedagogical techniques in a digital platform to improve teaching-learning in medical education. Although the effectiveness of TBL is well-established in face-face settings, there is a need to explore the possibilities and perceptions of students on virtual TBL implementation.

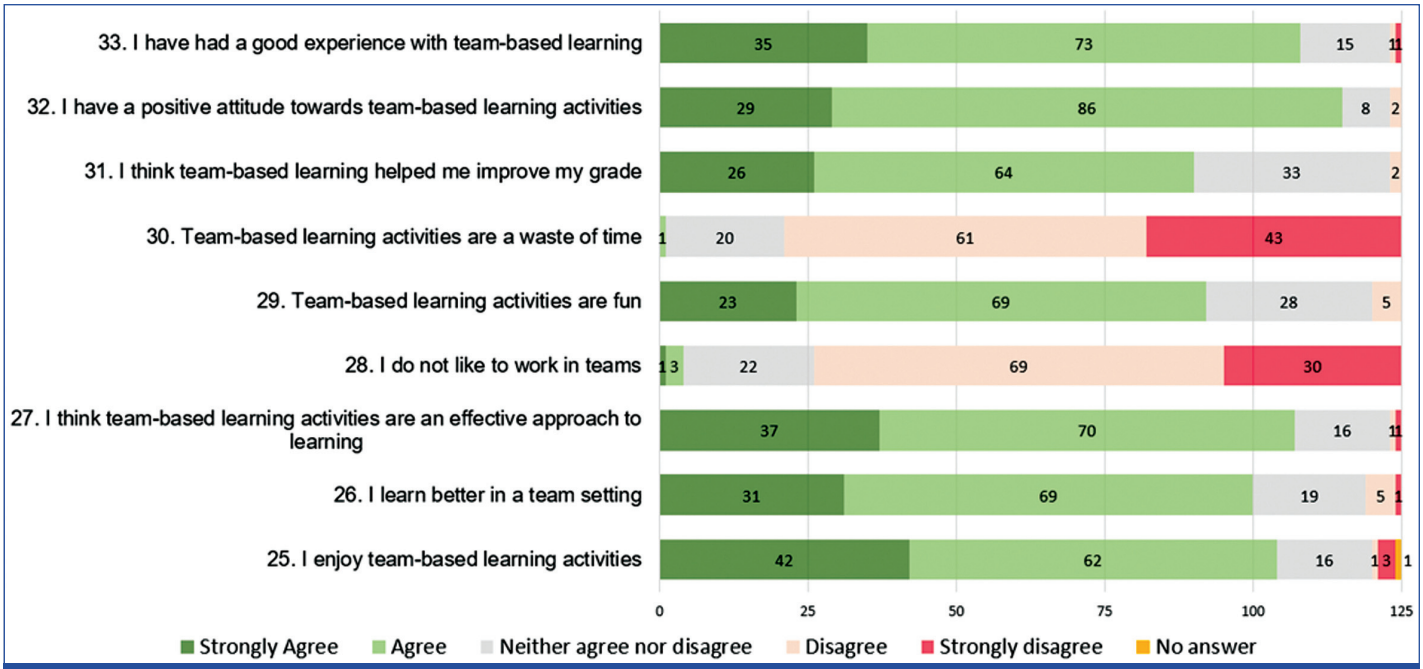
The present study results suggested that online TBL can be effective in a synchronous setting for teaching Pharmacology. The overall performance of virtual TBL groups is better than virtual lecture groups. The present study results agree with a meta-analysis by Liu SN and Beaujean AA in which TBL groups displayed better academic outcomes statistically than other teaching-learning methods [13].

Online TBL groups scored significantly better than online lecture groups in MCQs, indicating that TBL can positively influence recall, similar to a study by Emke AR et al., [14]. Also, this is very much in agreement with a meta-analysis of 17 studies documenting the positive effects of TBL on content-knowledge outcomes [12]. Online TBL groups outperformed lecture groups in the case of critical analysis and applying the concepts in the present study. TBL enhances essential aptitudes of thinking in learners compared to other instructional strategies, as evident in literature, irrespective of the mode ofdelivery [15,16]. The present results indicate satisfactory and superior performance in the online TBL structure over online lectures; however, whether this learning method is sustainable and accomplishes the learning objectives similar to in-person TBL modules needs to be evaluated.

Active and collaborative learning can enhance critical analysis. As students are allowed to participate in virtual TBL actively, the level of student engagement is more. This can lead to better performance [17]. Better performance of virtual TBL groups than lecture groups may be attributed to active learning, availability of precourse materials, formative assessment with constructive feedback sessions, and collaborative learning, imbuing a sense of self-responsibility in education.

The students obtained statistically higher overall scores in TBL-SAI than the neutral values suggested by Mennenga HA, [12] and across all the three sub-domains of the scale. This positive perspective towards virtual TBL in the current study might be due to their first venture of the learners to perform as teams in synchronous online settings. The real-time discussions with web conferencing tools may add an edge to this positive attitude.

On evaluating the subscales, the learners showed high accountability, preference, and satisfaction with virtual TBL in online settings. Though many researchers have shown an approvingly positive perspective of learners toward TBL [18-20], conflicting outcomes



[Table/Fig-6]: Satisfaction Subscale (TBL-SAI).

such as low accountability, poor preference, and satisfaction have also been documented [21]. The positive attitude, high student engagement, and level of satisfaction in the present study might be due to the following reasons. The first and foremost reason might be due to the formal training of faculty members in the present study before executing virtual TBL sessions to familiarise the faculty with the essentials for conducting the TBL and motivate them to use the digital resources and technology to the fullest potential as the level of training of facilitator have an impact on the experience of the students [22].

Another reason may be the synchronous virtual TBL sessions in small groups simulating real-time face-to-face experience. A study done by Cross CE et al., Cross demonstrated increased student engagement in online synchronous TBL sessions [23]. Also, social presence with effective communication increases with virtual TBL. This sense of social presence enhances active and collaborative learning [24,25].

Limitation(s)

The present study results of virtual TBL are restricted to a few modules of the Pharmacology course and lack a more comprehensive appraisal of virtual TBL on a large scale. The feasibility of implementing virtual synchronous TBL classes on a broader scale encompassing an entire course period and enormous disciplinary scope is needed to check the validity.

CONCLUSION(S)

Implementation of virtual TBL in synchronous setting in Pharmacology course established proof for high student accountability and satisfaction. Students preferred online TBL to online lectures. Virtual TBL sessions were more effective than online lectures. Team-based learning in a synchronous online setting is productive and engaging for the learners. Further research exploring the possibilities and challenges of implementing and incorporating regular virtual TBL in Pharmacology courses and its impact on students' performance is needed to concede its entire prospect.

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