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Original Article

Does team-based learning affect test scores of the basic medical sciences students in a modular curriculum?

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ABSTRACT

Objectives: The aim of the study was to determine the effectiveness of team-based learning (TBL) sessions as a learning tool and to assess the satisfaction level of medical students towards TBL in modular curriculum.

Methods: Using the quasi-experimental study design, TBL sessions were conducted, involving students of 1st and 2nd year of Bachelor of Medicine and Bachelor of Surgery. The TBL infrastructure comprised of pre-class preparation, in-class individual readiness assurance pre-test and post-test, before and after group discussion, respectively. The responses of the students regarding TBL satisfaction were recorded through a structured questionnaire (5-point Likert-type scale) while Wilcoxon signed rank test was applied to measure the effectiveness of TBL sessions.

Results: Out of 192 students, 85% agreed or strongly agreed that TBL helped them think critically, identify their knowledge gaps, boosted their confidence, and motivated them in group participation. Significantly better post-test scores were found in all modules where TBL was used as a teaching tool (Z range = -5.33 to -11.81, $P < 0.00$).

Conclusion: TBL increases the post-test score in majority of the students, indicating improved learning process. It not only keeps students engaged throughout the learning process but incites critical thinking, problem solving skills, and confidence. Further studies are required to see long-term benefit of TBL in students' learning.

Keywords: Active learning, effectiveness, problem solving skills, students' satisfaction level, team based learning

Introduction

With an exponential increase in the amount of information and continuous advancement in medical knowledge,[1] it has become difficult to rely on passive transfer of the knowledge. The medical curriculum has been changing around the world from a traditional discipline oriented to integrated one with multiple disciplines aligned on similar themes. Due to the belief that active learning results in enhanced knowledge retention and skills application, there is a growing interest in active learning strategies in the health profession programs,[2] but this has not been fully implemented so far.[3] Team-based learning (TBL) is an interactive form of learning that replaces the passive learning process to an active learning strategy and encourages students to learn through active participation in the process for knowledge gain.[4] It is the structured form of small-group learning that focuses student's preparation before class and application of knowledge in the class. Students are organized into heterogeneous teams of 7–10 students and the team composition remains constant throughout the course.[5] The TBL infrastructure engages students in the learning process through a sequence of activities that include conceptual knowledge, individual work, the readiness assessment process, problem solving through team discussions, and peer's and facilitator's feedback to ensure accountability.[6,7] The studies suggest that TBL is an effective student-focused learning modality that enhances student's satisfaction in terms of a deeper understanding of course content and overall performance in assessments.[8-10] Unlike content-based, tutor-centered didactic lectures, TBL keeps students engaged during in-class activities, encourages them to take the responsibility for their own learning, and helps students in achieving course objectives while learning how to function in teams.[11,12] The modular system has been recently introduced in the medical schools of Pakistan with vertical and horizontal integration of basic and clinical sciences. Despite the fact that TBL is an effective teaching and learning strategy, to the best of our knowledge, it has not been adopted as a method of teaching in the medical schools of Pakistan. Therefore, this study was aimed to determine the effectiveness of TBL and the satisfaction level of the medical students toward TBL as a learning tool in our local setup. The findings of this study shall help to implement TBL at a wider scale and shift the learning process from traditional didactic lectures to more interactive TBL.

Methods

This study was conducted at the Basic Sciences Department of Liaquat National Hospital and Medical College during the period of January 2019 till February 2020 after getting approval from Research and Ethical Review Committee Ref: App. 0464-2018-LNH-ERC. The study design applied was quasi-experimental design of type "one group pre-test and post-test." Individual readiness assurance pre-test score (IRAT-pre) and post-test (IRAT-post) score of students were compared before and after group discussion.[13,14] Effectiveness of TBL was measured by comparing pre- and post-individual readiness assurance test scores (IRAT-pre and IRAT-post) in a TBL session of each module and change in mean scores was measured to detect the effectiveness of TBL. Our study population comprised of 1st- and 2nd-year medical undergraduate students. The students who were unwilling to become part of study or were absent in the TBL sessions were excluded from the study. The purpose and procedure of the study were explained and written informed consents were taken. Typically, a TBL involves three phases, but depending on the content and demands of the course, we conducted a modified form of TBL focusing on Phases 1 and 2.[15] In Phase-1, at least 1 week before the TBL session, students were assigned objectives from the past 2 weeks of the module, to prepare independently outside the class. In Phase-2, a 2-h session was conducted in a lecture hall. During this session, a case scenario covering the assigned objectives was given to the students followed by aMCQ test (IRAT-pre) to assess their grasp of the knowledge and concepts learned in Phase-1. This test comprised of ten one-best choice questions with four plausible options. Immediately, after IRAT-pre, students were divided into (pre-assigned) teams of 8–10 for the next 45 min, to discuss the clinical scenario and questions and rationalize their individual answers. Students then were ungrouped and a different version of the same test was given to the students (IRAT-post). The teams had to justify the answers with the facilitators clarifying any misconception. In Phase 3, students had to solve clinical problems based on the application of knowledge related to the objectives covered in TBL. The performance scores of the pre-test and post-test were tabulated and compared to determine the difference between the post-test score and pre-test score. Demographic data and the responses of the students regarding TBL satisfaction were recorded through a structured questionnaire (5-point Likert-Type Scale).[16] The data were entered and analyzed using Statistical Package for the Social Sciences version 22.[17] Mean and standard deviation were recorded for continuous variables such as age, whereas, frequency and percentages were calculated for categorical variables such as year of education, premedical schooling system, gender, and place of residence. To measure the effectiveness of TBL in learning, the scores of pre-test and post-test were compared to find out the percentage of students showing improvement in post-test. As the data were not normally distributed, Wilcoxon signed rank test was applied to investigate any change in scores from pre-test to post-test. $P \leq 0.05$ was considered significant.

Results

A total of 192 students participated in this study. None of the students deferred participation. Table 1 is showing the demographic characteristics of the study participants. The mean age of the students was 19.3 years with range from 17 to 21 years. More than two-thirds of the students were females. Table 2 is showing the satisfaction level of the study participants. When asked to rate TBL as learning resource, 63% of study participants agreed or strongly agreed that TBL was helpful in understanding the subjects. In a focused evaluation on TBL, students believed that TBL helped them to think more critically, improved their clinical approach, kept them active during session, helped them in team work, boosted their confidence, and motivated them in group participation. The majority of the participants agreed that TBL helped them in identifying their knowledge gaps during group discussion by team members or facilitators and helped them perform better during the exams. Table 3 shows that there was significant increase in test scores from IRAT-pre to IRAT-post assessments ($P < 0.001$). This improvement in test scores was sustained in all modules. Wilcoxon signed rank test [Table 3] revealed statistically significant difference in the test scores between IRAT-pre and IRAT-post tests of all modules in which TBL strategy was conducted (Z range = –5.33––11.81, $P < 0.00$).

Discussion

Since there is an increasing number of female admissions in medical schools of Pakistan,[18-20] the majority of the study participants in our study were females, with a male to female ratio of 1:2.5. However, the studies done outside Pakistan do not show any significant difference between the gender composition.[8,13,21] Regarding understanding of the topic and clinical application of the theoretical concepts, the majority of the students in our study agreed that the TBL sessions helped them in understanding the importance of basic facts and their

Table 1: Demographic characteristics of medical students participated in the study

Variable	Frequency	Percentage
Age (year)	Mean=19.31	Standard deviation=0.84
Gender		
Male	54	28.1
Female	138	71.9
Premedical school		
Cambridge	61	31.8
Intermediate	131	68.2
MBBS year of education		
1st year	97	50.5
2nd year	95	49.5
Residence		
Hostel	26	13.5
Home	166	86.5

Table 2: Students rating for team based learning as a learning tool

Questions	Percent responding[a]				Mean rating
	Strongly agree	Agree	Neutral	Disagree	
Help me in understanding the subject	17.6	46.1	35.2	0.5	3.81
Improved knowledge and thinking critically	19.2	65.8	14.5	0	4.05
Importance of basic facts and mechanisms	22.3	66.3	10.9	0	4.11
Scientific reasoning approach toward problem	19.7	63.7	16.1	0	4.04
Clinical application of correct theoretical concepts	19.2	67.9	12.4	0	4.07
Develop skills to make diagnosis	19.7	67.4	12.4	0	4.07
Enjoyable and keeps me active during the session	31.6	61.1	6.7	0	4.25
Taught me team dynamics	32.1	60.6	6.7	0	4.26
Develop friendly relationship with team members	32.6	52.8	14	0	4.19
Strengthened my confidence	26.9	62.7	9.8	0	4.17
Motivate to come prepare to participate in group	33.7	59.6	5.7	0.5	4.27
Correct knowledge gaps through discussion	31.1	63.7	4.7	0	4.27
Immediate feedback from facilitator	29.7	64	6.3	0	4.23
Helped me perform better in exam	19.8	72.9	7.3	0	4.13

[a]Students responded on a 5-point scale to each of the query items. 5: Strongly agree, 1: Strongly disagree, n=1

Table 3: Comparison of the IRAT-pre and IRAT-post scores measured using Wilcoxon signed rank test

Module	Mean (SD) IRAT-Pre	Mean (SD) IRAT-Post	Median IRAT-Pre	Median IRAT-Post	Negative difference	Positive difference	No change	Z	Sig (2-tailed)
Foundation (n=97)	5.64 (2.25)	8.08 (2.20)	6	9	3	80	14	–7.77	0.00
Locomotor (n=97)	5.29 (1.98)	8.14 (2.22)	6	9	0	91	6	–8.33	0.00
Head-and-neck 1 (n=95)	2.42 (2.37)	3.73 (3.49)	3	4	6	45	44	–5.33	0.00
Head-and-neck 2 (n=95)	3.53 (2.89)	5.98 (4.02)	4	8	3	58	34	–6.68	0.00
Neurosciences 1 (n=95)	2.77 (2)	4.98 (2.63)	3	6	3	68	24	–7.12	0.00
Gastrointestinal (n=95)	5.12 (3.01)	7.77 (3.67)	6	9	0	72	23	–7.41	0.00
Reproductive (n=95)	7.59 (2.56)	10.84 (2.64)	8	12	0	84	11	–7.99	0.00
Cardiovascular 1 (n=192)	4.97 (1.68)	8.28 (2.11)	5	9	0	182	10	–11.81	0.00
Cardiovascular 2 (n=95)	5.12 (2.39)	7.97 (3.41)	5	9	0	81	14	–8.0	0.00
Neurosciences 2 (n=95)	3.11 (2.33)	6.31 (3.48)	3	8	0	73	22	–7.44	0.00
Blood-1 (n=192)	5.09 (1.75)	8.38 (2.27)	5	9	0	180	12	–11.70	0.00
Blood-2 (n = 95)	2.57 (3.03)	3.93 (4.39)	0	0	1	42	52	–5.70	0.00

SD: Standard deviation, IRAT: Individual readiness assurance

relevance with the clinical problem which is consistent with findings of the previous literature that has reported significantly greater enhancement in understanding, critical thinking, and long-term retention of the subject in a TBL environment as compared to other strategies including lectures.[22,23] When the students were asked about the integration of different subjects and theoretical concepts, 87% of the study participants agreed that TBL developed skills to help them reach to the diagnosis of the clinical problem. Schmidt *et al.* and few others have also recorded a significant improvement in positive approach toward reconnecting the concepts and consolidation of the knowledge even when 1st-year medical students were exposed to TBL and case-based learning to prepare them well to connect the pieces of information and build diagnosis in the future.[4,24,25] The majority of the students in this study have shown an agreement that, they identified their deficiency in knowledge, mistakes, and misinterpretation during the group discussion in TBL session and immediate feedback provided by the facilitators. Our findings are consistent with the findings of Tsai *et al.* and others.[26-28] The structure of the TBL process (Pre-class preparation, reading case scenario, solving IRAT-pre, group discussion, solving IRAT-post, and Facilitator's feedback) is such that almost all of the students agreed that the session was enjoyable and kept them active and engaged. Singh *et al*. and Burgess *et al*. have also described that this strategy is helpful for the students as they take an active role in learning and utilize their own creativity, curiosity, and intelligence.[4,12] Considering TBL as an important tool to develop an environment supporting shared leadership and team dynamics, more than two-thirds of students in our study believed that TBL helped them to develop a friendly relationship with team members and boosted their confidence. Such positive and beneficial

effects of team dynamics and facilitated learning have also been reported earlier.[12] The quantitative analysis of the test scores showed statistically significantly greater ($P < 0.001$) IRAT-post scores than IRAT-pre-scores. This difference was consistent throughout the modules of 1st and 2nd year Bachelor of Medicine and Bachelor of Surgery (MBBS) program. This improvement in the IRAT-post scores reflects that students identified their knowledge gaps during attempting the IRAT-pre, and these were readily filled through team discussions and immediate feedback provided by the facilitator. These findings of our study reflect the importance of guided and collaborative learning and problem solving as a result of group discussions. The results of the present study are comparable to the results by Faezi ST *et al,* which demonstrated statistically significant difference in the mean score of individual readiness assurance tests.[29] TBL process, that is, pre-reading material, individual readiness, group discussions, and feedback, is the basic psychological mechanisms which enhance, elaborate, and improve memory.[24] In our study, the most of the students agreed that TBL helped them, perform better in examinations which is also consistent with other studies showing a positive correlation of TBL scores and final examination scores.[26,30] Contrary to this, few of the studies have concluded that TBL does not influence the student's performance in final examinations.[31,32] Another study done by Carrasco *et al*. shows that poor performance in TBL may identify a population of students that will perform poorly in the final examination.[33] Therefore, TBL implementation may be used to an added advantage of identifying such students early in the academic session and refer for extra help to bring them topar with other peers.

Limitations of the study

This study was conducted at a single setting and it shows the effectiveness and students satisfaction for the TBL as teaching and learning strategy of 1st- and 2nd-year MBBS students.

Conclusion

TBL is an important and effective strategy that improves students problem solving and critical thinking skills, boosts their confidence, keeps them engaged, and motivated through self-directed learning. This study records an improvement in the scores of IRAT-post-test reflecting that the students corrected their knowledge gaps through TBL, thus improving learning process. However, further studies are required to evaluate the potential benefit of long-term learning through TBL such as performance in final examination scores.

Authors' Declaration Statements

Ethics approval and consent to participate

Ethical approval was obtained from Research and Ethical Review Committee of Liaquat National Hospital and Medical College. Ref: App. 0464-2018-LNH-ERC. Written informed consent was taken from all the participants.

Availability of the data and material

The data used in this study are available and will be provided by the corresponding author on request.

Competing interests

The authors do not report any conflicts of interest

Funding statement

None.

Author's Contributions

Professor Masood Ahmed: Conceptualization, final draft preparation, methodology, review, and editing; Dr Saima Athar: Methodology, data collection, and original draft write up; Dr Saima Zainab: Quantitative data analysis and results interpretation and writing; Dr Shaheena Akbani: Conceptualization, review, and editing; Dr Batool Hasan: Data entry and data collection; and Dr Uzma Hameed: Protocol writing.

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