

Team-based Learning Strategy in Biochemistry: Perceptions and Attitudes of Faculty and 1st-Year Medical Students

Abstract

Background: Team-based learning (TBL) strategy has been widely adapted by medical schools all over the world, but the reports regarding the perceptions and the attitudes of faculty and undergraduate medical students towards TBL approach have been conflicting. **Aim:** The study aimed to introduce TBL strategy in curriculum of Biochemistry after evaluating its effectiveness through perceptions and attitudes of faculty and 1st-year medical students. **Materials and Methods:** One hundred and fifty students of first professional M.B.B.S and five faculty members participated in the study. Their responses regarding perceptions and attitudes towards TBL strategy were collected using structured questionnaires, focus group discussions, and in-depth interviews. Data were analyzed using Wilcoxon signed-rank test, paired sample *t*-test, and Mann–Whitney U-test. **Results:** Majority of the students expressed satisfaction with team approach and reported improvement in the academic scores, learning styles, and development of problem-solving, interpersonal, and professional skills. The faculty, however, recommended a modified TBL approach to benefit all sections of the students for the overall success of this intervention. **Conclusion:** TBL is an effective technique to enable the students to master the core concepts and develop professional and critical thinking skills; however, for the 1st-year medical students, a modified TBL approach might be more appropriate for the effective outcomes.

Keywords: Biochemistry, curriculum, instructional technique, interpersonal skills, team-based learning

Introduction

Team-based learning (TBL) strategy has been designed to provide students with both conceptual and applied knowledge. It is conducted in large group setting where the students are divided into multiple small groups. Problem-based learning shares similar features with TBL, including being conducted in small groups and promoting both active learning and problem-solving skills;^[1] however, TBL is considerably less rigorous in terms of faculty resources and infrastructure.^[2,3] This type of learning can strengthen the clinical reasoning skills needed in the delivery of health care.^[4]

TBL has been accepted worldwide by instructors in numerous schools of medicine, nursing, dentistry, pharmacy, and other health science disciplines, but the data regarding the effectiveness of TBL from students and faculty's perspective are insufficient, and the reports have been conflicting.

Therefore, the present study was carried out with an aim to introduce TBL strategy as a core component in biochemistry curriculum after evaluating its effectiveness through perceptions and attitudes of faculty and 1st-year medical students.

Materials and Methods

After the approval and the ethical clearance from the Institutional Review Board, TBL was introduced as a teaching–learning strategy to teach the 1st-year medical students. TBL sessions were held twice a month and each session lasted for 2 h. Four TBL sessions were carried out to cover the topic of “Study of vitamins.” TBL modules were prepared by the “Backward design.”^[5] In organizing TBL sessions, 150 students of 1st-year M.B.B.S were divided into 30 permanent teams, each comprising of 5 students. The distribution was made using the roll numbers based on alphabetical stratification system. A verbal consent was taken from the students for participation in the study. The validated questionnaires

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were used for collecting the responses from the students and faculty.

Each TBL session was carried out in three phases: preclass preparation, readiness assurance tests, and application of course concepts.^[6]

Preclass preparations

Students were informed of the topics to be covered in the TBL sessions 2 weeks before the session. Learning objectives for each session were clearly specified by the chief investigator, and the reading material was assigned to the students which consisted of information that they needed to master to meet the learning objectives. The reading material included book chapters, learning guides, and online modules. Students were expected to review and be prepared to utilize the information during the TBL in class session.

In class team-based learning session

Individual readiness assurance test

At the onset of the session, students took the individual test (individual readiness assurance test [iRAT]) consisting of 10 multiple choice questions (MCQs). Twenty minutes of time was allotted for the completion of the test at the end of which the students were asked to submit their answer sheets.

Group or team readiness assurance test

After collecting iRAT answer sheets, students were prompted to join their teams and take the exact same test as a team. The students were given 30 min for the team readiness assurance test (tRAT). During this time, team members were encouraged to collaborate, discuss, and reach at a consensus. After the tRAT, all teams were encouraged to simultaneously report the response for each MCQ using placards. The correct answers were provided by the instructor.

Appeal

Teams that did not agree or were unable to give the correct answer were allowed to appeal, and the instructor immediately clarified any misconceptions regarding their answers. The purpose of appeal was to motivate teams and clarify their understanding of the information they would need during the application phase of the TBL module.

Facilitator feedback or debriefing

The last component of readiness assurance involved a review of the RAT and discussion of any items that remained a source of confusion for the students.

Application of key concepts

The TBL session was followed by a session of application-based exercises. There were five questions

based on the application of knowledge. The teams spent 30 min for discussing different options before arriving at a “specific choice” and revealing their choice to the whole class (at the same time as the other teams revealed their choices).

Scoring

Every correct response in the MCQ test was awarded a score of one with no marks awarded for an incorrect response. The total score for each student was calculated weight of three components – iRAT (50%), tRAT (30%), and clinical application (20%). The weight of iRAT was deliberately kept on the higher side to provide incentive and ensure active learning among students.

Peer assessment

Peer assessment was the core component of accountability in TBL. Peer assessment was based on the validated questionnaire and was collected after the second and fourth TBL session.

Collection of feedback

Student feedback

The questionnaire-based feedback was collected from the students after the second and fourth TBL sessions to compare the differences in the perceptions and attitudes of the students regarding learning styles, behaviors, impact of team building, and professional development. The focus group discussions (FGDs) and in-depth interviews were also conducted to record their opinions.

Faculty feedback

Faculty feedback based on questionnaire, focused group discussions, reflections, and in-depth interviews was collected after the fourth TBL session.

Statistical analyses

Data were analyzed using IBM, SPSS statistic software version 24.0 for Windows (IBM Corporation, Armonk, NY, USA). The outcome of program was assessed by the student’s performance and validated structured questionnaire. Confirmatory factor analysis (CFA) and Cronbach’s alpha coefficient tests were used to assess the validity and reliability of the construct, respectively. The data for the pretest (iRAT) and posttest (tRAT) results were analyzed using paired sample *t*-test. The cutoff value for statistical significance was kept 0.05 ensuring 95% confidence in the results.

The student’s performances in successive TBL sessions were analyzed using the Wilcoxon signed-rank test. Numbers and percentage responses for each of the categories of the questionnaire were calculated. Median scores for individual items on the questionnaire in the categories of objectives for the class, impact of TBL, and value of peer assessment were calculated [Table 1]. A Mann–Whitney

Table 1: Differences in perceptions and attitudes of students towards team-based learning strategy - result of Mann-Whitney U-test

Serial number	Context	Session 2		Session 4		Mann-Whitney U-test	
		Mean±SD	Median	Mean±SD	Median	Z	Significance
Objectives for the course							
1	I understand the course content	1.74±0.604	2.0	2.246±0.886	2.0	-1.185	0.236
2	I am able to apply the course content	1.695±0.599	2.0	2.345±0.906	2.0	-4.926	0.000
3	I have developed interpersonal and group interaction skills	1.574±0.653	1.0	1.7458±0.807	2.0	-1.87	0.137
4	I have developed skills for life-long learning	1.94±0.835	2.0	2.333±1.10	2.0	-2.149	0.016
5	I enjoyed the course	1.395±0.642	1.0	1.889±0.971	2.0	-4.005	0.000
Impact of TBL							
6	The TBL approach was an appropriate way to structure this course	1.805±0.772	2.0	2.462±1.00	2.0	-4.882	0.000
7	The TBL approach enhanced my learning experience in this class	1.728±0.652	2.0	2.333±0.928	2.0	-4.766	0.000
8	With TBL, I have gained profound insights into my strengths and weaknesses as a learner	1.536±0.612	1.0	1.745±0.807	2.0	-1.608	0.108
9	TBL sessions have enabled me to develop healthy personally rewarding relationships with the teachers	1.61±0.622	2.0	1.889±0.971	2.0	-1.635	0.102
10	I recommend using the TBL approach in future courses	1.768±0.946	1.0	2.64±1.19	3.0	-5.234	0.000
Value of peer assessment							
11	The peer evaluation system encouraged effective team member involvement	1.760±0.768	2.0	1.964±0.899	2.0	-1.489	0.136
12	The peer evaluation system for this course enhanced my learning experience in the course	1.797±0.682	2.0	2.333±1.00	2.0	-3.727	0.000
13	The peer evaluation system promoted the development of self-managed learning teams	1.45±0.553	1.0	1.964±0.899	2.0	-4.235	0.000
14	I recommend using the peer evaluation system in this course for future courses	1.933±0.933	2.0	2.628±1.269	2.0	-3.805	0.000

TBL: Team-based learning; SD: Standard deviation

U-test ($P < 0.05$) was conducted to determine if changes in attitudes about TBL occurred between the second and fourth TBL sessions [Table 1].

Results

A total of 150 students and 5 faculty members participated in the study. Their responses were collected in the structured questionnaires. The validity and the internal consistency of the questionnaire were confirmed. CFA showed an adequate validity, and the internal consistency (Cronbach's alpha) for the 14-item questionnaire response was 0.973.

Overall findings of this study revealed significant improvement in the academic scores and learning abilities; development of critical thinking and professional skills; and satisfaction with team experience and peer assessment.

The academic performances of the students improved from TBL session 2 to session 4, but no statistically significant differences ($P = 0.076$) were observed in the results analyzed by Wilcoxon signed-rank test. In each of the TBL sessions, the iRAT and the tRAT results were analyzed statistically using the paired sample *t*-test. Statistically highly significant differences ($P < 0.001$) were observed

between the iRAT and the tRAT scores in each of the sessions indicating the impact of teamwork.

Majority of the students expressed satisfaction with TBL approach. The students were more positive in session 2 whereas mixed responses were observed in session 4. The differences in the perceptions and attitudes of students toward TBL strategy in sessions 2 and 4 have been shown in Table 1.

The content analysis of open-ended questions revealed five themes:

- (i) Improvement in the learning style and attitude,
- (ii) team spirit and personal development,
- (iii) more effective use of classroom time than didactic lectures,
- (iv) effective technique but needs modification, and
- (v) less effective than didactic lectures.

FGDs were carried out involving 8–10 students in one session. The items identified through component analysis have been shown in Table 2.

The students expressed positive attitude toward peer assessment and agreed to inclusion of TBL as an instructional technology in future biochemistry courses; however, they demanded more assistance from the

instructors regarding clinical discussions, pre- and postsession reading materials, and assessment of application process individual as well through team efforts as in RATs.

The faculty feedback was collected through questionnaire, FGDs, and in-depth interviews. Table 3 shows the perceptions and attitudes of faculty toward TBL approach.

The session of FGD was held with five faculty members of the department of Biochemistry after the last TBL session. The content analysis has been shown in Table 4.

The faculty expressed a positive response for all the components of TBL module and agreed to include TBL as an effective instructional tool not only in the curriculum of Biochemistry but also in all other disciplines. The faculty, however, expressed concerns for the weaker students, who were less benefited by the TBL approach. A modified TBL

approach to benefit all sections of the students for the overall success of this intervention was recommended by all the faculty members.

Discussion

The study found the improvement in the academic performances of the students by TBL approach. The students enjoyed the interactive sessions and found TBL approach better than didactic lectures. Many other studies have reported similar results; Koles *et al.*,^[7] Kolluru *et al.*,^[8] and Vasan *et al.*^[9] reported better academic performances and increased mastery over course contents of the students after TBL.

The analysis of the questionnaire revealed improvement in the learning styles of students [Table 1]. TBL's sequential process motivated learners to go beyond mere mastery of

Table 2: Items identified through content analysis of focus group discussion with students

Serial number	Theme	Representative items
1	Perception of TBL	<p>“TBL is better than conventional lectures, clinical discussions helped me in concept building”</p> <p>“Preclass preparation helped me to understand more during debriefing sessions”</p> <p>“I have been enthusiastic throughout, TBL is the best teaching technique. I would like to attend more such sessions”</p> <p>“TBL sessions were interactive and interesting. I enjoyed the learning process”</p>
2	Perception of teamwork	<p>“I am enjoying the fun of teamwork”</p> <p>“I get more clarity of facts by team efforts”</p> <p>“Our team is doing well and we shall try to maintain the excellence”</p> <p>“TBL has helped me in improving my reasoning skills”</p>
3	Value of peer assessment	<p>“I have started realizing my strengths and weaknesses as a learner”</p> <p>“Peer assessment has helped in improving my learning skills”</p> <p>“My peers were fair in judging my contribution to the team”</p> <p>“It helps in team building”</p> <p>“It is not reliable”</p>
4	The most important thing about TBL	<p>“Good clinically oriented questions to promote application of knowledge”</p> <p>“Enjoyable, interactive sessions, great team experience, concept building”</p>
5	The most important thing that would improve TBL	<p>“More support from instructor”</p> <p>“More time for clinical discussion”</p> <p>“Application process should have individual test and team test”</p>

TBL: Team-based learning

Table 3: Perception and attitude of faculty for team-based learning

Serial number	Context	Strongly agree, n (%)	Agree, n (%)	Uncertain, n (%)	Disagree, n (%)	Strongly disagree, n (%)
1	TBL prompts students to engage in the learning process	-	5 (100)	-	-	-
2	With TBL I don't have to worry about the classroom attendance of the students	1 (20)	3 (60)	-	1 (20)	1 (20)
3	I spend much more time listening and observing than making formal presentations	1 (20)	4 (80)	-	-	-
4	Compared to a traditional curriculum, TBL enables the weaker students successfully complete and stay on track in their coursework	-	3 (60)	1 (20)	1 (20)	-
5	With TBL, most students progress well beyond simply acquiring factual knowledge and achieve a depth of understanding	2 (40)	2 (40)	1 (20)	-	-
6	With TBL, I have developed personally rewarding relationships with students	-	5 (100)	-	-	-
7	TBL can be successfully employed in large classes	-	4 (80)	1 (20)	-	-

TBL: Team-based learning

Table 4: The items analyzed after focus group discussions with faculty members

Serial number	Factor	Representative item
1	Readiness assurance	“Multiple choice questions were highly conceptual” “Students were well prepared”
2	Group discussions	“Students actively participated in the group discussions” “Students looked enthusiastic and confident”
3	Changes in the learning behavior and academic performance of the students	“The learning styles of the students have been improved and they are more self-directed” “The above average and high scorer were more benefited by the TBL approach, TBL was less effective for the underachievers”
4	The most important thing about TBL	Group dynamics and accountability for good performance Productive use of classroom time
5	The most important thing that can improve TBL	“After TBL, session-specific reading material related to the exercises should be provided to help weaker students” “TBL should be supported by didactic lectures, especially for 1 st -year medical students”
6	Should TBL be introduced in the curriculum?	“A modified TBL approach would be more appropriate for 1 st -year students”
7	Should TBL be introduced in other medical disciplines?	“TBL is an effective teaching strategy, it should be introduced in all the disciplines”

TBL: Team-based learning

essential facts. TBL not only promoted total transformation of a student affecting knowledge, skills, and attitude but also helped in utilizing the classroom time in a judicious way taking the classroom discussion to a higher level. The similar results have been reported by other studies.^[8-13]

Some of the students, however, reported less effectiveness of TBL approach and preferred didactic lectures over TBL approach. Similar results have been reported by Punja *et al.*,^[14] according to the study students generally tend to seek the comfort of attending didactic lectures that deliver information and facts in the sequence and format in which they answer their theory questions; therefore, they find this method less useful.

In our study, the students expressed more positivity in the first two sessions of TBL. The major factors identified that could sabotage the success of team-based approach were as follows:

(i) inappropriate time of introduction of TBL, (ii) less motivated or immature students, and (iii) lack of incentive to the students.

A small percentage of students demanded supplementation of didactic lectures with TBL indicating their inability to indulge in self-directed learning. Some students demanded inclusion of subjective questions as assessment in RAT and application tests so that they could prepare the contents for their semester and university examinations. A few of the students expressed their inability to solve the clinical problems and demanded elaborated clinical discussions to develop the problem-solving skills. Lower rating of TBL was mostly expressed by low achievers and slow learners.

Lower rating of TBL by underachievers has also been reported by Vasan *et al.*^[15] According to the study, the

low rating could be attributed to student's difficulty in assessing their perceived learning needs in a new learning environment of TBL.

The general attitude of the faculty was positive towards TBL. The faculty members, however, suggested modifications in TBL strategy to make it more acceptable by students. The recommendations by the faculty were as follows: supplementation of TBL with didactic lectures, use of TBL during group discussion/tutorial time for assessment of the learned topics, provision of solved exercises to the students after the completion of the session, and to avoid introduction of TBL in the first two semesters.

To summarize, TBL uses the power of small group learning within the large classroom setting. It is highly cost-effective and can be successfully employed in large classes. TBL enables the learners to become more self-directed and gain profound insights into their strengths and weaknesses as learners. TBL focuses on the application of knowledge and building of skills. The students learn to solve problems while being part of a team, similar to real practice where health professional from different disciplines works in collaboration with each other to manage medical problems. With the increasing concern on patient safety in health-care settings, TBL provides students with many opportunities to learn communicate skills and collaborate in the team setting.

Limitations of the study

Each TBL session requires 2 or more hours for the completion of all the component steps, which is usually not a dedicated time for a conventional lecture. Therefore, a careful planning is needed to introduce this technique in the curriculum.

A lecture hall was used for TBL, which was not suitable for group discussions. A dedicated space exclusively for TBL could have made the sessions more comfortable for the students.

The study was cross sectional; the future impacts on collaborative medical practice remain to be evaluated. A prospective research design to compare learning outcomes of academically similar student cohorts exposed to the TBL strategy versus another active learning method might help to produce meaningful data to draw conclusions about the effectiveness of this teaching strategy.

Conclusion

TBL is an effective teaching-learning strategy to address the professional competencies of the health professionals. A modified TBL strategy might be more appropriate to improve the learning outcomes and development of skills in 1st-year medical students.

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Conflicts of interest

There are no conflicts of interest.

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