Effectiveness of team-based learning methodology in teaching transfusion medicine to medical undergraduates in third semester: A comparative study

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Abstract:

BACKGROUND: Team-based learning (TBL) combines small and large group learning by incorporating multiple small groups in a large group setting. It is a teacher-directed method that encourages student–student interaction. This study compares student learning and teaching satisfaction between conventional lecture and TBL in the subject of pathology.

AIMS: The present study is aimed to assess the effectiveness of TBL method of teaching over the conventional lecture.

SETTINGS AND DESIGN: The present study was conducted in the Department of Pathology, GMERS Medical College and General Hospital, Gotri, Vadodara, Gujarat. The study population comprised 126 students of second-year MBBS, in their third semester of the academic year 2015–2016.

METHODOLOGY: “Hemodynamic disorders” were taught by conventional method and “transfusion medicine” by TBL method. Effectiveness of both the methods was assessed. A posttest multiple choice question was conducted at the end of “hemodynamic disorders.” Assessment of TBL was based on individual score, team score, and each member’s contribution to the success of the team. The individual score and overall score were compared with the posttest score on “hemodynamic disorders.” A feedback was taken from the students regarding their experience with TBL.

STATISTICAL ANALYSIS USED: Tukey’s multiple comparisons test and ANOVA summary were used to find the significance of scores between didactic and TBL methods. Student feedback was taken using “Student Satisfaction Scale” based on Likert scoring method.

RESULTS AND CONCLUSIONS: The mean of student scores by didactic, Individual Readiness Assurance Test (score “A”), and overall (score “D”) was 49.8% (standard deviation [SD] 14.8), 65.6% (SD 10.9), and 65.6% (SD 13.8), respectively. The study showed positive educational outcome in terms of knowledge acquisition, participation and engagement, and team performance with TBL.

Keywords: Conventional lecture, self-directed learning, team-based learning, transfusion medicine

Introduction

The importance of transfusion medicine cannot be undermined. Blood collection, blood grouping, screening, preservation, storage, cross matching, and appropriate use of blood and its components are an integral part of safe transfusion practice. Considering that a large number of medical students will prescribe blood components in the course of their health services, it is mandatory to impart sound knowledge and practical training to them. The lack of knowledge in blood transfusion can reduce transfusion safety and cause significant harm to the patient.

Lecture is an efficient way of transferring knowledge and concepts to a large group
of students. However, it is a one-way communication in which students largely remain passive. When the students are actively engaged in a learning process, the learning outcomes are better. There is a need for instructional methods that foster active participation.

The Medical Council of India realized this and through its Regulations on Graduate Medical Education, 1997, amended up to August 8, 2016, recommended that lectures alone are generally not adequate as a method of training. They are a poor means of transferring/acquiring information and even less effective at skill development and in generating appropriate attitudes. Students should be encouraged to learn in small groups and through peer interactions. Every attempt should be made to encourage students to participate in group discussions to enable them to develop personality, character, and expression, which are necessary for a medical graduate to function either in solo practice or as a team leader when he/she begins his/her independent career.

Team-based learning (TBL) is one of the methods of actively involving the students in a large class. It is a structured type of cooperative learning that has growing application in medical education. This method was first used in business education, dating back to 1970s. TBL was, however, introduced in medicine at Baylor College of Medicine in 2001. The aim of TBL is to achieve higher levels of cognitive learning using personal knowledge within a collaborative team.

TBL broadly consists of three repeating stages. In the first stage, learners’ study reading material provided to them before coming to class. According to McKeachie, instructors do not need to lecture when concepts are available in printed form at an appropriate level for the students. Instead lecture should be used when the content cannot be learned through self-paced methods, such as reading. The backbone of TBL is self-directed learning. Preclass preparation provides learners with a foundation on which they can build connections. As students are familiar with the subject, learning occurs more quickly and more deeply. The second stage measures students’ knowledge individually and as a team of 5–7 learners. In lecture classes, there is no need for students to be accountable to anyone. By contrast, TBL requires students to be accountable to individual and the team. If members of the team come unprepared to the class, it will not only hinder individual performance but also group’s success. No amount of discussion can overcome absolute ignorance. During the third stage, the same teams work on assignments that provide opportunity to apply knowledge gained in stage 1 and 2 to real-world problems. Rather than being filled with libraries of “inert knowledge” from which students have to extract the needed information, the students walk away with TBL courses having already begun the practical problem-solving process of learning.

TBL requires changes in the roles of both instructors and students. The instructor’s role shifts from dispensing information to designing and managing the whole process, and the student’s role shifts from being passive recipients of information to one of the accepting responsibilities for the initial exposure to the course content so that they will be prepared for the in-class teamwork.

The goal of this course redesign is to increase active student engagement and ensure that students get an opportunity to practice the course concept to solve problems. This study compares the levels of student learning and teaching satisfaction between conventional lecture and TBL.

Methodology

GMERS Medical College and General Hospital, Gotri, Vadodara, Gujarat, gives admission to 150 students for the course of MBBS every year. Pathology, a discipline that bridges clinical practice and basic science, is taught in the second year of MBBS, which spans over 1½ years (third to fifth semesters). Blood bank is a part of the Department of Pathology.

The study was conducted in GMERS Medical College and General Hospital, Gotri, Vadodara, Gujarat. The study population comprised all (126) undergraduate students of second-year MBBS, in their third semester, of academic year 2015–2016. “Hemodynamic disorders” were taught by conventional method and “transfusion medicine” by TBL method by the same instructor. Both the topics are covered in the third semester. This nonrandomized study was conducted after obtaining prior approval from “The Ethics Committee” of the institute. Students’ written consent was obtained.

Lecture method

“Hemodynamic disorders” were taught by conventional lectures. Eight didactic lectures were taken. The lectures were well prepared. The learning outcomes were defined at the beginning, which helped in focusing student’s attention. Audiovisual aids were used. The attention of the students is known to wander after the first quarter of a lecture. Interactive techniques such as asking questions were used to engage students. After the completion of the topic, a multiple-choice question (MCQ) test of 25 MCQs was conducted. The TBL method was introduced to the students during this last session.

Team-based learning method

“Transfusion medicine” was taught in TBL format. In a TBL course, students are strategically organized into
permanent groups of 5–7 members for the entire term. Any group dynamics textbook tells us that groups need time to develop into high-performing teams. For this reason, students should remain in the same group for the entire course.\textsuperscript{[8]} TBL requires that the instructor oversees the formation of the groups. In order for groups to function as effectively as possible, they should be as diverse as possible. The goal is to equip all the groups with a mix of student characteristics, for example, resourceful students and students with variable demographic characteristics such as gender and ethnicity so that all groups formed have equal resources, get the opportunity to develop into learning teams, and membership coalition is avoided. For TBL course, students of the batch were organized into 18 permanent and diverse groups comprising 7 members each ($18 \times 7 = 126$).

To redesign a course in TBL format, course content needs to be organized into five to seven 45–75-min units or Readiness Assurance Process (RAP) followed by 1–4 h sessions for group application assignments to promote high-level learning.\textsuperscript{[8]}

Each RAP has five major components:

1. **Preclass preparation:** Before any in-class work, students are given instructor-developed readings based on the course textbook and additional resources, which they must study before class. The material can be given in hard copy or e-mailed to them in soft copy.

2. **Individual Readiness Assurance Test (iRAT):** Each unit begins with the iRAT, which consists of 10–15 MCQs based on the key ideas from the readings that students complete as individuals. The individual test holds students accountable for learning the material before class.

3. **Team Readiness Assurance Test (tRAT):** The students take the same test again as a team (tRAT) coming to consensus on team answers. The team test provides an exciting opportunity for students to learn from one another.

TBL uses Immediate Feedback-Assessment Technique (IF-AT), which provides a real-time feedback to the teams.\textsuperscript{[8]} Finding a star immediately after scratching the choice gives a booster to the team, while finding a blank box lets them know that they have more work to do. IF-AT has two key benefits. First, it enables members to correct their misconceptions of the subject matter. Second, it motivates the teams to learn how to work together effectively, with no input from the instructor. The impact of IF-AT is immediate, powerful, and extremely positive.

4. **Written appeals:** The teams have the opportunity to write evidence-based appeals if they feel they can make valid arguments for their answer to questions that they got wrong.

5. **Instructor feedback:** The final step in the unit is a lecture, usually very short and always very specific to enable the instructor to clarify any misinterpretations that become apparent during the team test and the appeals.

Following RAP sessions, 1–4 h sessions are designed to provide students with the opportunity to deepen their understanding by having groups to solve application assignments. Designing these assignments is probably the most challenging aspect of implementing TBL.

TBL assignments are written to utilize the “Four S’s” to foster teamwork and group discussion.\textsuperscript{[8]} These are:

1. **Significant problem:** Assignments should always be designed around a problem that is significant to students.

2. **Same problem:** It is important that all groups work on the same problem because this enables a discussion both within groups and between groups. If each of the groups is working on a different problem, there is no common ground for discussion between groups.

3. **Specific choice:** The assignment should be written so that the students have to make a specific choice (i.e., put a MCQ at the end of the assignment). If students are asked an open-ended question at the end of the assignment, they may come up with one or two answers and then end their discussion.

4. **Simultaneous reporting:** After group discussion, the groups are instructed to report their answer choice simultaneously. One of the methods used for simultaneous reporting could be giving each group an envelope that contains five colored note cards lettered A, B, C, D, or E. The groups are asked to raise the note card, which corresponds to their answer choice on the count of three. This allows the facilitator to immediately assess the overall performance of the class and prevents groups from choosing their answer based on what other groups think.

The course content for TBL on “transfusion medicine” was organized into six 60-min RAP and one 1-h session of group application assignment. For preclass preparation, the reading material was given to students through mail 15 days in advance, along with the RAP schedule. Students were asked to come prepared to the class. Each session began with a ten specific choice questions’ test, in the form of MCQ, true/false, one word answer, or match the following based on the reading material provided. IF-AT [Figure 1] or note cards comprising A, B, C, D, right and wrong [Figure 2] were given, which gave real-time feedback.
Evaluation
The marks scored in the 25 MCQ test conducted on “hemodynamic disorders” was converted into percentage. The grading system used in TBL is based on individual performance, team performance, and each member’s contributions to the success of the teams.

Individual score (iRAT): The individual performance was calculated from iRAT scores of the six RAP sessions. The scores were summed and converted into percentage (score “A”).

Team score (tRAT): The team performance was calculated from tRAT scores. The scores were summed and converted into percentage (score “B”). Score “B” is same for all individuals in the group.

Each member’s contribution to the success of the team: To accurately assess members’ contributions to the success of their team, it is imperative that students themselves are involved in peer assessment process. They are the only ones who have enough information to evaluate one another’s contributions accurately. Peer evaluation was done using the percentage method. Each person in the team evaluates the contributions of all the persons in the team except self (denoted as ‘x’ in Table 1), by distributing 100 points among them. The peer evaluation form [Figure 3][9] was given to the students at the end of the course. The points given to each person in the group are added. For example:

Table 1: Peer evaluation score

| Roll number | 1  | 2  | 3  | 4  | 5  | Total |
|-------------|----|----|----|----|----|-------|
| 1           | X  | 25 | 22 | 24 | 20 | 111   |
| 2           | 20 | X  | 18 | 16 | 20 | 94    |
| 3           | 20 | 15 | X  | 18 | 20 | 93    |
| 4           | 20 | 20 | 18 | X  | 20 | 98    |
| 5           | 20 | 20 | 22 | 22 | X  | 104   |
| Total       | 100| 100| 100| 100| 100|       |

How much weightage is to be given to individual activity and group activity was decided previously as 70% and 30%, respectively. The overall score of students for TBL, score “D,” was calculated by multiplying score “A” with 70 and score “C” with 30 and summing up the two. The overall score of individual student for TBL was calculated as shown in Flow Chart 1.

Individual score “A” and overall score “D” of TBL were compared with the percentage marks scored by lecture method. Students who did not attend four or more RAP sessions in TBL and those who did not give the posttest MCQ in lecture method were excluded from comparison.

The degree of student satisfaction in TBL compared to the lecture method was determined by a questionnaire “Student Satisfaction Scale” (SSS) having a set of 11 questions with 5 options according to Likert scoring method (5 = totally agree, 4 = agree, 3 = somewhat agree, 2 = disagree, 1 = strongly disagree).
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Results

The mean of student scores by didactic, iRAT (score “A”), and overall (score “D”) was 49.8% (standard deviation [SD]-14.8), 65.6% (SD-10.9), and 65.6% (SD-13.8), respectively, as shown in Figure 4. Tukey’s multiple comparisons test and ANOVA summary show a significant difference in means ($P < 0.0001$) between didactic versus iRAT and didactic versus overall score. However, the difference in score between iRAT and overall score was not significant.

Student feedback

At the end of the course, students’ feedback was taken using “SSS” based on Likert scoring method. The students were asked to give score ranging from 1 to 5 on the sessions, the instructor participation, and student satisfaction toward TBL method of learning. Mean was calculated. Most of the students gave a positive feedback [Figure 5], reporting that the sessions were well planned (4.4/5 or 88%). The reading material was simple (4.3/5 or 86%) and instructor feedback was linked to the reading material (4.2/5 or 84%). The sessions were interactive (4.1/5 or 82%) and MCQs were appropriate (4/5 or 80%).
Feedback was taken on how well the instructor conducted the session. Most of the students gave a positive feedback [Figure 6], reporting that the instructor helped the students (4.4/5 or 88%), the instructor was interested in the progress of the students (4.3/5 or 86%), and was an effective group leader (4.2/5 or 84%).

Feedback was taken on student satisfaction toward TBL method of learning. The percentage satisfaction for TBL method as compared to the lecture method was 78% (mean score, 3.9/5) [Figure 7].

Open-ended questions were also asked to students in the feedback form. Positive feedback was taken by asking the leading question, “what did they like best about this course?”
- Interactive sessions
- MCQ test

Only few studies have been conducted, where TBL is compared with other educational methods. These studies however have consensus on more active participation and student engagement in TBL. In the present study, considerable growth was observed from lecture score (mean 49.8) to score by TBL method (mean 65.6). In
addition to the comparison of levels of student learning between the two methods (conventional lectures and TBL), this study also employed SSS form. According to the results, students showed satisfaction from teaching with TBL as compared to the lecture method. In the present study, the mean of students recommending TBL was 3.9/5 (78%). Similar findings were reported by Jafari; mean of lecture score was 11.99/20 (59.95%), by TBL method was 14.06/20 (70.3%), and student satisfaction for TBL method was 81.30%.[4]

Four essential elements for a successful TBL are proper formation and management of groups, accountability of students for individual and group work, frequent and immediate feedback to students, and proper designing of team assignments.[5] TBL’s strategic sequence, when repeated multiple times during a course or academic term, encourages conscientious individual preparation while developing teams into cohesive learning groups.[5] Faculty often observes considerable energy and engagement of students during intra- and inter-team discussions. Gaps and deficiencies in understanding are improved as peers explain to their teammates why they favor specific answers to questions as the group works toward consensus for the tRAT. Revealing all groups’ answers simultaneously allows faculty to see which questions were not answered correctly. Faculty is then able to direct the discussion toward clarifying any difficult concepts. The culminating application exercises challenge each team to use their aggregate knowledge.[5]

TBL allows a single instructor to manage multiple small groups simultaneously in one classroom. TBL has therefore gained interest within the medical education community because of its potential to promote active learning without requiring large numbers of faculty facilitators.

While a pure application of TBL would include all phases, the method allows flexibility for instructors to use selectively one or more of the phases, depending on the contextual demands of the course or session. This flexibility has been especially important in medical education, due to the unique constraints inherent in many medical contexts.[6]

Various factors can influence the outcome of TBL, such as the effect of self-study and the effect of team cooperation in the learning process. However, students who arrive less prepared are not only enriched by their teammates’ knowledge and critical thinking skills, but they are also motivated by two factors to prepare more thoroughly for future sessions. First, the desire to achieve a better grade on the iRAT and second, their peers’ expectations that they will make valuable contributions to intra-team discussions. Peer influence assists the academically challenged student in mastering course content.[5]

Faculty and the educational environment were vital to the success of TBL.[6] In describing the kinds of activities that enhance long-term learning, Frank Smith argues that “we can only learn from activities that are interesting and comprehensible to us; in other words, activities that are satisfying. If this is not the case, only inefficient rote learning, or memorization, is available to us and forgetting is inevitable.”[6]

This study reveals the successful use of TBL in teaching “transfusion medicine.” There is no doubt that using new training methods such as TBL can increase the level of education achieved by students.

Several limitations of this study’s design and conclusions are apparent. A single faculty framing questions for lecture method and TBL method might have introduced an unmeasured error. The difficulty of a MCQ may be affected by structural features such as format, wording, complexity of the stem, and the number of distracters. A poorly written question introduces “artificial difficulty” that may affect students’ performance.

Conclusions

In many instances, inadequate and limited information of teachers about appropriate teaching techniques is a major obstruction to achieving a good level of education, increasing student learning and satisfaction. Today, more than 100 medical schools worldwide are using the methods of TBL to some extent.[11] TBL is also covered in faculty development programs. These sessions challenge the deeply held assumption that the teacher’s role is to impart knowledge to learners.

Several studies have provided empirical evidence of favorable learning outcomes associated with TBL. In TBL, class time is shifted away from learning facts and
toward application and integration of information. We and other schools plan to continue using TBL and expand its utility in new areas of curricula. Faculty experience with TBL method, confidence through repeated use, and exposure to quality professional development opportunities could have perceived positive outcomes.

More outcome-centered studies of TBL are needed to provide objective evidence of this active learning strategy’s effectiveness in medical education. Potential benefits for long-term learning need to be evaluated, such as performance in examinations administered several months after a TBL module or performance on comprehensive examinations assessing knowledge gained from several courses in which TBL was used.3

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Conflicts of interest
There are no conflicts of interest.

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