

Team-Based Learning (TBL) Implementation in General Embryology at the Faculty of Medicine – Jazan University, KSA

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ABSTRACT

Background and Objectives: Team-based learning (TBL) is composed of pre-class self-study, readiness assessment tests individually (iRAT) followed by readiness assessment tests in the team (tRAT), and peer feed evaluation. TBL was implemented in the course of General Embryology taught in the 2nd year in the Faculty of Medicine, Jazan University (FMJU), KSA, in the Male and Female Sections through the years 2015-2019. This study aims to analyze this experience in two aspects: whether it was implemented accurately, and whether it achieved the planned outcomes.

Method: TBL implementation at FMJU was calibrated against a Logic Model for TBL implementation. **Methods:** Data was obtained from records of students including the number of students, attendance, exam marks, and peer feedback. There was also a description of the facilities and faculty.

Results: TBL components were used, a multidisciplinary faculty was involved, and an electronic exam in iRAT replaced a paper exam, showing that there was room for improvement. **Conclusion:** The student shows a high percentage of attendance, high marks in the tRAT compared to iRAT and traditional exams, and high opinion about participation in teamwork.

Conclusion: We concluded that TBL deployment was successful in the early stages and achieved the desired results.

Keywords: Team-Based Learning, Self study, Faculty, Students

INTRODUCTION

TBL is considered an instructional method which is “powerful and versatile teaching strategy that enables teachers to take small group learning to a whole new level of effectiveness”¹.

TBL consists of five essential components: (1) Individual pre-work learning of a defined topic; a scenario of a problem (2) Test is to be answered individually (iRAT). (3) Similar test is to be taken by a group (tRAT) (4) Clarification session, instructors organize and open a discussion in the class and reach final correct answers to the MCQ of iRAT- tRAT².

TBL is implemented in the General Embryology course in the Faculty of Medicine, Jazan University (JUFM); KSA.

Jazan University was established as per the Royal Decree No. (6616 /M/B) issued on 12/5/1426 AH corresponding to 19/6/2005:

A large site was designated for the University City, with an area of (9,000,000) square meters on the Red Sea coast north of the town of Jazan, in the south –west of Kingdom of Saudi Arabia. FOM-JU in Jazan region was established in 2002, at that time it was affiliated with King Abdul-Aziz University. The faculty was joined to the University of Jazan in 2006. The Male Campus is located in the far north and the Female Campus in the far south of the Jazan Town, both ashore the Red Sea. The number of students admitted to the program at that time was 35 male students; this number has increased progressively as explained in table No.4.0.2.1.

Faculty of Medicine applied an integrated curriculum with the community orientation, which is conducted in 6 academic years, with additional one year in Jazan University internship program.

TBL in the course of General Embryology at JUFM started more than 5 years ago, and is still going on, through years 2015 - 2020. It was conducted at the same time in the male and female sections to ensure the confidentiality of the iRAT and tRAT quizzes. The analysis and evaluability process covered the facility, the human task-force, and the process of implementation the records of the marks of students, and the student perception to the TBL experience.

This study analyzed and evaluated TBL implementation in the course of General Embryology for 2nd class, medical students. TBL was paper-based through the years 2015-2018, and in the year 2019, electronic program to answer the team-test was added through Moodle Program. This might indicate the possibility of improvement of TBL at JUFM a year after year. This proves right, when in the days Corona Pandemic, the teaching changes to online programs, and TBL was successfully conducted through Blackboard Platform in the year 2020.

Baylor College of Medicine is the first place introducing TBL in 2001³, although Larry Michelson is the first one who establishes the basic concepts and terms, while at University of Oklahoma in the 1970s⁴. It is a well-defined instructional strategy used in business and science courses. Team-based learning (TBL) is an educational method that concentrates student knowledge through individual testing and group collaboration. This will encourage students by making them accountable to themselves and to one another, as well as exposing them to a variety of problem-solving strategies. (For example, 7:1)⁵.

Team-based learning consists of three phases: individual study, readiness assurance testing, and application of course concepts (Figure 1).

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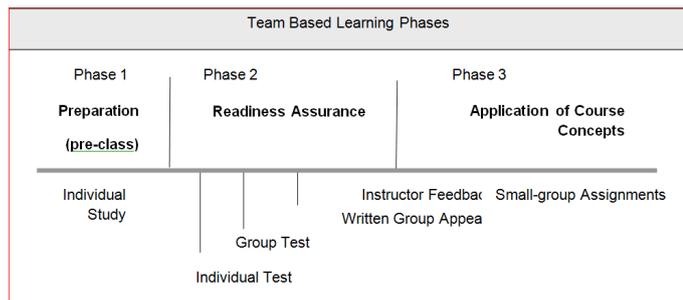


Figure 1: Description of the main steps involved in TBL

Michaelsen & Richards describes four principles to properly conduct TBL in order to achieve its goals. 2005⁶

1. Students should be in groups of equal distribution of good students among them.
2. It enhances individual learning and team work.
3. Team assignments should encourage learning and team evolution.
4. Perennial and instant feedback should be given to students.

DESCRIPTION OF THE TBL PROJECT AT (JUFM)

TBL implementation at JUFM is a pilot project that took place in the past years. It was decided to introduce this instructional method in the repertoire of teachers of the faculty in order to maintain active learning, problem solving and concept application as an alternative to other more resource-demanding strategies. TBL implemented in the module of embryology; a one-credit-hour- module, was learned by the second year medical students. The students receive a "priceless" TBL "General Instructions" and "Assignments", examples are shown in Annex 3, 4; and attend an "Orientation Session". The class sessions consist of "iRAT" and "tRAT", an example is shown in Annex 5. After each session, a brief meeting was held by the module committee for documentation and drawing lessons with a feedback forwarded to the medical education Department⁷.

Rationale: The implementation of TBL in the Embryology module at the Faculty of Medicine Jazan University, KSA was described before in two posters 11, 12, but none of them conduct a thorough evaluation and they didn't answer the question whether TBL was applied properly or reach the intended learning outcomes, although these studies included description of the process of TBL, the marks of the students, and has results of high student satisfaction about the experience.

OBJECTIVES

General Objective: To analyze and evaluate TBL Implementation in General Embryology at the Faculty of Medicine – Jazan University, KSA through the years 2015-2020.

Specific Objectives:

1. To evaluate the Implementation of TBL against a standard logic model.
2. To obtain feedback from students on TBL.

METHODOLOGY

This is a descriptive study using mixed method model with quantity and quality options, in implicit design. Evaluation will be against a standard "Logic model"⁸.

Study Period: The study was conducted in the academic year 2019-2020.

Study Setting: Medical College, Jazan University.

Population: Targets are batches of 2nd year students on which TBL in General Embryology was implemented in the male and female sections through the year 2015-2020.

Inclusion criteria: student registered in the module of General Embryology in the year 2015- 2020

Exclusion criteria: withdrawal students will not be included.

Sample Size: 79- 116 per batch, with total of 590 male and 82- 108 per batch with total of 598 female (1188 students- total covering of 2nd year students). The target population and sample population are the same.

Data Collection: The data was collected using the student records of attendance and results, and student feedback survey. The first one is the student satisfaction survey. This survey aims at evaluating the TBL which was introduced for the first time in this school. The results should hopefully inform decisions as to whether TBL is effective as an instructional method and whether it can be used for this or other modules in the future. It is composed of 25 statements, the student is asked to rate his degree of agreement/or disagreement with the statement, by ticking the corresponding box, which is ranged from (1) completely agree to (5) completely disagree. The statements cover the inquiry of the students about; the clearance of instructions before the beginning of TBL, the time allowed for both iRAT and tRAT and the material given. Also, the survey stresses on the degree of achievement of the objectives of the TBL session and participation in group discussion. In addition to that, some statements are to clarify the degree of the arrangement of the TBL session and the fairness of the assessment. Finally, the few last statements are for feedback and the recommendation of the TBL use in the other modules in the future (Figure 2).

The second survey is a quantitative assessment about the student peer feedback. Variables are students mark students and feedback evaluation. Instruments: mark reports and evaluation survey.

Evaluability Assessment: In order to inform decision making, evaluation should undergo evaluability assessment. It is a process that involves 6 steps⁷. These are: 1) involve deliberate users and other participants, 2) Shed light on the program composition, 3) study program reality, 4) assess if the program is plausible 5) Discover whether the program is agreed upon or needs any change in the design of its implementation. 6) get agreement on intended use and evaluation focus.

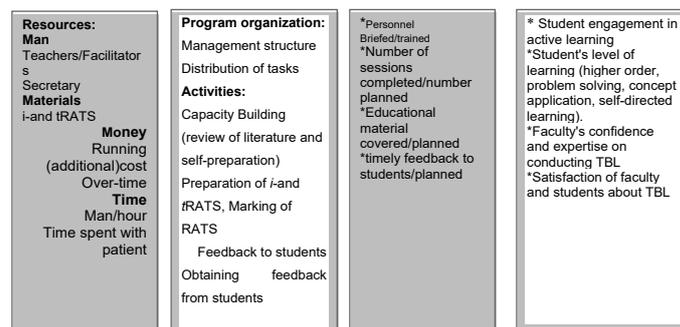


Figure 2: Logic model for TBL implementation⁸

Designs of Evaluation

In the general framework of the mixed methods model, the following designs were used:

1. Implicit designs modified by quasi-experimental techniques using theoretical comparison groups (for example comparing TBL with lectures in group interaction, self-directed and independent learning, resources needed and problem solving) and retrospective

comparison groups (i.e., using previous evaluations of the module).

2. Qualitative methods to provide depth and strengthen evidence through triangulation and to explore areas for improvement.
3. Using formative assessment to evaluate processes of program delivery.

Implicit Designs: Implicit design for the evaluation of TBL program:

Rationale for using implicit design:

We decided that implicit design is suited for the purpose of evaluation of our program for the following reasons:

1. It is not possible to divide students into treatment and control groups because the program can affect the results of achievements in examinations and one group could have an advantage, while the other is deprived from it. This is difficult to do when grades matter in decisions regarding pass/fail, Grade Point Average (GPA) and future job opportunities.
2. TBL was introduced sporadically in a few other modules, so maturation effect might come into play.
3. The variables needed to explore in our evaluation are numerous which rules out many experimental designs.
4. This exploratory/pilot program in addition to objective measures of achieving desired outcomes/impact needs to study in some detail the

processes of program delivery, and thus formative assessment can provide vital information about whether the program is suitable and replicable in the context of our medical school. The evaluation seeks to inform ways to improve the program⁸. Lastly: the implicit design is going to be augmented by other methods that can overcome some of its weaknesses. Combination of both qualitative and quantitative methods can mitigate some of the weaknesses of designs relying solely on objective-based approaches⁹.

RESULTS

The analysis of the TBL project in General Embryology at FMJU covered the followings: the TBL process as input; the marks and the student perception as outcome.

Components of the TBL Process: These are: (1) Description of the Facility, (2) Faculty shared in preparation and running of TBL (multi-disciplinary), (3) students- males and females (4) Study materials (5) the Readiness Assessment Tests (RATs+) (6) time of a session and the amount of sessions/year. They are shown in tables (1 and 2).

Marks: When compared to iRAT and the final test in General embryology, the tRAT scores in TBL were high, as seen in graph (1) below. The findings of peer feedback were excellent for all pupils.

Table 1: Components of the TBL process through years 2015-20: Students Information

Component/ year	2015	2016	2017	2018	2019	2020
Number of students	Male105: Female: 108	Male91: Female: 92	Male116: Female:111	Male115: Female: 103	Male79: Female: 82	Male84: Female: 102
% of student attendance inTBL1session	Male90.4: Female: 91.5	Male92.3: Female: 97.5	Male96.4: Female: 97.3	Male95.6: Female: 100	Male98.7: Female: 96.3	Male100: Female: 100
% of student attendance inTBL2session	Male88.5: Female: 89.5	Male94.6: Female: 95.2	Male94.2: Female: 97.3	Male94.8: Female: 98.0	Male96.2: Female: 92.7:	Male100: Female100:
No of groups of students	Male10: Female: 10	Male10: Female: 10	Male10: Female: 10	Male10: Female: 10	Male8: Female: 8	Male4: Female: 4
No of classrooms used	Male: 1Female: 2	Male:1Female: 2	Male:1Female: 2	Male:2Female: 2	Male:2Female: 2	Male0: Female:0 (online, no classrooms)
Faculty:	M-Section:4 F-Section3:	M- Section: 4 F-Section3:	M- Section2: F-Section3:	M- Section1: F-Section4:	M- Section3: F-Section4:	M- Section4: F-Section4:

Table 2: Components of the TBL process through years 2015-20: Learning Materials, iRAT and tRAT tests

Component/ year	2015	2016	2017	2018	2019	2020
Textbook of study material (Langman'sMedical Embryology, Sadler, T.W.,)	9 th Edition	9 th Edition	12 th Edition	12 th Edition	13 th Edition	13 th Edition
No. of questions in iRAT/tRAT	5	5	5	5	5	5
Timeto answer iRAT	5min	5min	5min	5min	5min	5min
Timeto answer tRAT	≥ 5min	≥ 5min	≥ 5min	≥ 5min	≥ 5min	≥ 5min
UsingPaper/ E-Moodle test for RATs	Paper	paper	Paper	Paper	iRAT: Paper tRAT: E-Moodle	iRAT, tRAT: Online-Blackboard

Numerical Data Analysis (GraphPad Software)-

Group	iRAT	tRAT
Mean	3.250	4.911
SD	0.935	0.665
SEM	0.088	0.063
N	112	112

Table 1: Paired t test results for student marks:tRAT- iRAT:

P value and statistical significance: The two-tailed P value is less than 0.0001 by conventional criteria; this difference is considered to be extremely statistically significant.

Confidence Interval: The mean of iRAT minus tRAT equals -1.661 95% confidence interval of this difference: From -1.886 to -1.435

Intermediate values used in calculations:

t = 14.5884
df = 111
standard error of difference = 0.114

Group	Male Students	Female Students
Mean	4.2436	4.3776
SD	0.4466	0.5524
SEM	0.0461	0.0570
N	94	94

Table 2: Male- Female:

Pvalue and statistical significance: The two-tailed P value equals 0.0551 According to traditional criteria, this difference is not statistically significant.

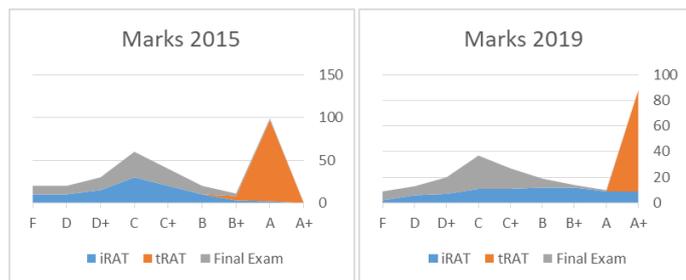
Confidence interval: The mean of Male Students minus Female Students equals -0.1339

95% confidence interval of this difference: From -0.2709 to 0.0030

Intermediate values used in calculations:

t = 1.9422
df = 93
Standard error of difference = 0.069

Graph (1) showing comparison between marks in the two years of this study (2015 and 2019)

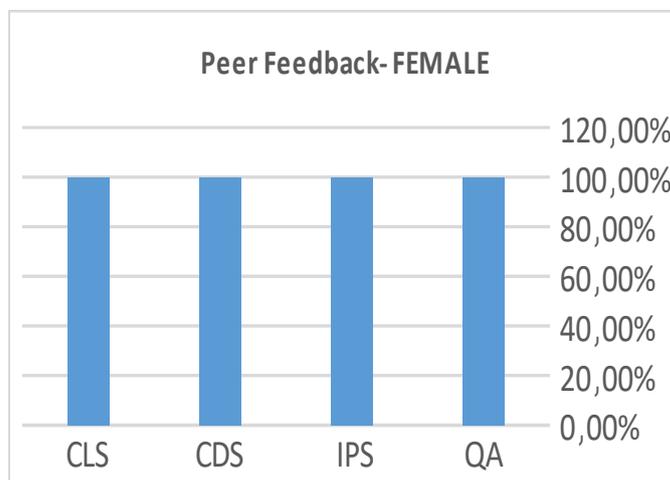
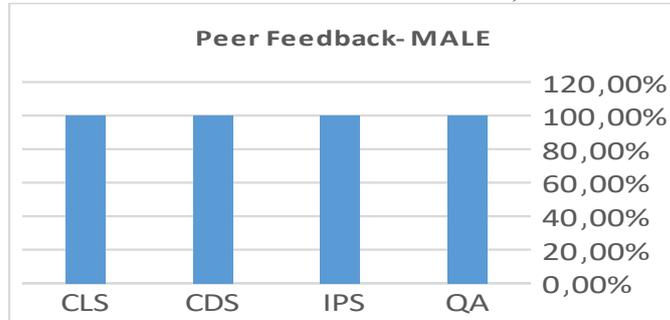


Graphs (2) showing TBL Peer Feedback, male and female students: The marks when approximated score 100% which express the opinions

of students in performance of each other).

Student Feedback Survey: These were analyzed in two parts: (1) Peer feedback of students on each other, which was taken during TBL sessions. Peer feedback displays High percentage of achievement of cooperative learning skills, self-directed learning and interpersonal skills in both male and female students as shown in graph 3.

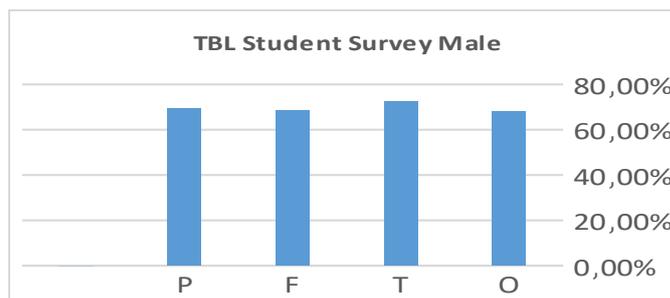
CLS: COOPERATIVE LEARNING SKILLS, CDS: SELF-

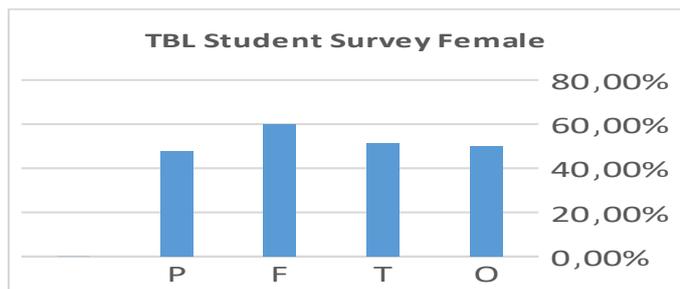


DIRECTED LEARNING, IPS: INTERPERSONAL SKILLS, QA: QUALITATIVE ASSESSMENT

(2) Student satisfaction Survey, which was taken later after the issue of the final results and includes points of satisfaction of students about TBL, the staff, and the marks. Both surveys seek the student feedback plotted in Likert scale from 1-5. (Graph 4). It shows more satisfaction in male compared to female students with high satisfaction in all parts of the survey (process, faculty, team and outcome) in male students and moderately low satisfaction in all elements of the survey among female students.

Graph (4) showing TBL Student Survey, male and female students: The % show the student satisfaction about each item, males were more satisfied than females)





P: Process, F: Faculty, T: Team, O: Outcome

DISCUSSION

The implementation of TBL in the Embryology module at the Faculty of Medicine Jazan University, KSA was mentioned before in two posters^{10,11}. The first poster¹² concentrates on the increase in marks of the group tests, and that the students have remarks about using suitable classes. The second poster¹² focuses on the building/training abilities and group learning of students; but none of them conduct a thorough analysis and they didn't answer the question whether TBL was applied properly or reach the intended learning outcomes¹²⁻¹³.

The Implementation Process of TBL: TBL in FMJU consists of five essential steps: (1) Individual pre-class learning of a defined topic, triggered by a scenario of a problem, and guided study material was specified from a text book of GE (2) Individual Readiness Assurance Test (iRAT) in which a student answers a set of MCQ questions individually (3) Team Readiness Assurance Test (tRAT), in which, after answering the iRAT, the students form teams and answer the same test within the team (4) Clarification session, in which instructors organize and run a discussion among teams to consider the possible solution to the application problem and end up with the final correct answers to the MCQ of iRAT- tRAT² (5) Peer feedback, in which students give feedback to which degree a member of their group is collaborative. These steps were the model of TBL adopted in other universities³, only some universities use scratch cards for tRAT. Two sessions were conducted each year, one hour for each session. The time of a session may extend for more than two hours, spent partly in redistribution of the groups of students, but most often because the students enjoyed the debates on explanation when they select more than one answer to a question. This brain storming is a high positive outcome of TBL.

The Facility & The Faculty: The FMJU's Male and Female Sections were housed side by side on one huge campus for the first three years of the study (2015-17), divided solely by prohibited-to-mix barriers. In the previous two years (2018-19) the Male Section was relocated in a new campus at the other end of the City of Jazan. This made the arrangement of the beginning-end time of the sessions only through telephones. The faculty shared in preparation and running of TBL were multi-disciplinary from Departments of Anatomy, Physiology, Pathology, Obstetrics and Gynecology. This gave a sense of integration with other disciplines, especially the Obstetrician staff, which provided the students with valuable clinical application on the cases. In TBL's most recent year, a single professor was able to lead the male class on his own without sacrificing "the effectiveness of small-groups working independently in courses with a high student-faculty ratio 4 - (115:1)."

The Students: The numbers of students show variation from year to year, but in all years the attendance to TBL sessions was high compared to lectures. The male and female students were planned to start the sessions at the same time, usually at 1 p.m., to avoid the iRAT questions being transferred. Male and female students maintain

continuous hidden phone connections, despite the fact that they are separated and not allowed to mix.

Study materials and the Readiness tests: The topics of General Embryology Course, e.g. Congenital Abnormalities, which were included in the TBL, were not being taught again in lectures and were completely self-learning. The Readiness Assessment Tests (RATs) were 5 best answer question of higher order classification. The text book used for study material was Langman's Medical Embryology, Sadler, T.W, and 9th Edition. Williams and Wilkins Co., Baltimore. The edition was updated up to 13th edition. Each session was formed of a set of 5 MCQs which students first had to answer individually (iRAT), then in groups (tRAT). Modification of using papers to print the tests took place from year to year. At first expensive colored answer sheets marked by machine were used. Then on the demand of the administration, a table was plotted in the question papers for the answers. In the year 2019, E-learning Moodle Program was used for tRAT which enabled students to use tabs and mobile devices to answer. In the year 2020, due to Corona Pandemic, the teaching changes to online programs, and TBL was conducted through Blackboard Platform. These were improvement in the cost- effectiveness with no harm to the core process of TB.

The Marks: TBL marks were added to the students' final grades in General Embryology, which inspired them and helped them take TBL seriously. Marks of the iRAT were like the marks of a student in other section of the final exam, some students were very high and some students low. Marks of tRAT were high, most often full mark, as they were the result of the work of many brains together, and this is a great positive outcome TBL is a "strong and versatile teaching method that allows teachers to take small group learning to a whole new level of effectiveness," according to the research. 1. When TBL marks are added to the other grades, the final grade improves. When marks of TBL were added to the other marks, they enhance the final grade in General Embryology, which was a great pleasure to the students.

Student Satisfaction: In the Peer Feedback the students seemed to have high opinion on each other, or they might benefit from this high opinion as Peer Feedback has a mark in the final grade The student satisfaction about the TBL as a whole is important in maintenance of TBL and for putting action plans for improvement, and of course research studies about TBL in FMJU.

The findings of the study show that the process followed the general line of TBL, the benefit for students of working in team to gain higher marks, the student satisfaction about other members in the team in peer feedback and about the process in student satisfaction survey. The findings also show the improvements like using electronic and online programs, indicating possibility about improvements year after year. But the results didn't cover topics like effect of working in teams on the students when they are transferred to succeeding years. This could be a recommendation for a following practical actions or scientific studies.

RECOMMENDATION

Innovation is taking place over the years in all medical education to shift from conventional to modern teaching and learning. Therefore, medical universities in my beloved country Sudan need to be aware that TBL is a vital approach in medical education that leads to a good understanding of the materials and concepts. Medical universities in Sudan should start bridging the self-educational gap and accommodate with the TBL growth worldwide. In addition, Team based Learning is a self-teaching approaches where students learn more and come to classes more prepared. Several positive benefits are elicited from the TBL on the instructor; it invigorates the classroom and makes teaching more

stimulating. There should be studies to determine the effectiveness of TBL approach on students after the basic sciences phase. As the studies are only done within the two years of basic sciences.

CONCLUSION

I concluded that the TBL implementation in FMJU was a successful, This was indicated by many points: it was applied continuously for 5 years; it improved by electronic tRAT; students show high percentage of attendance and scored high marks, that is, they were interested and gained valuable experience from TBL.

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Potential Conflict of Interest: None

Competing Interest: None

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