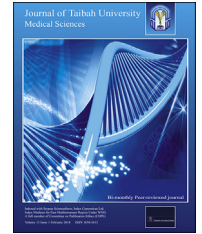




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Original Article

## Effectiveness of the team-based learning (TBL) strategy on medical students' performance



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### المخلص

**أهداف البحث:** يمثل 'التعلم المبني على فريق' استراتيجية تعليمية جديدة ومثيرة للاهتمام. فهو يساعد على تعزيز الكفاءات المهنية للطلاب، ويعمل بشكل مثالي لإعدادهم في سعيهم للتعليم مدى الحياة. الهدف من هذه الدراسة هو تقييم فاعلية 'التعلم المبني على فريق' كاستراتيجية تعليمية، على أداء طلاب طب يدرسون في منهج تعلم مبني على مشكلة.

**طرق البحث:** أجريت دراسة مقطعية من خلال استبانة ذاتية التصميم. شُيّد الاستبانة لفحص عدة جوانب من 'التعلم المبني على فريق'، بما في ذلك الإدراك، والمهارات الاجتماعية، ونظام التعليم في المدرسة الثانوية، والتنمية الذاتية. تمت دعوة 112 طالباً للمشاركة في الدراسة وأكمل 100 منهم الاستبانة. تم جمع نتائج كل من الاختبارات ضمان استعداد الفرد و'الاختبارات ضمان استعداد المجموعة' كما تم تحليل البيانات ومقارنتها بنتائج التقييم النهائي باستخدام البرنامج الإحصائي للعلوم الاجتماعية.

**النتائج:** وصف 52 طالباً (52%) 'التعلم المبني على فريق' بأنه ينبنى بيئة تعلم تعاونية. ووجد 64 طالباً (64%) أن المواد أسهل فهما عند مناقشتها فيما بينهم كمجموعة. وبالمقارنة مع نتائج الامتحانات النهائية، كان هناك ارتباط ذا قيمة إحصائية بين أداء 'الاختبارات ضمان استعداد الفرد' ودرجة الامتحان النهائي. وبالإضافة إلى ذلك، كان هناك ارتباط كبير بين نظام التعليم الثانوي ونتيجة 'الاختبارات ضمان استعداد الفرد'، حيث لوحظ أفضل أداء بين الطلاب القدامين من المدارس التي تستخدم المنهج البريطاني.

**الاستنتاجات:** كان التصور العام وموقف الطلاب تجاه نظام 'التعلم المبني على فريق' إيجابياً وواعداً. ومع ذلك، فإن هناك بعض الملاحظات ومجالات للقلق يجب إعادة النظر فيها ومعالجتها لتحسين 'التعلم المبني على فريق' كأداة تعليمية.

**الكلمات المفتاحية:** التعلم المبني على فريق؛ التعليم الطبي؛ التعلم المبني على مشكلة؛ اختبارات ضمان استعداد الفرد؛ اختبارات ضمان استعداد المجموعة

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### Abstract

**Objectives:** Team-based learning (TBL) represents a new and interesting educational strategy. It helps to enhance students' professional competencies and ideally works to prepare them in their pursuit of lifelong learning. The aim of this study is to evaluate the effectiveness of TBL as an educational strategy on medical students' performance in a problem-based learning (PBL) curriculum.

**Methods:** A cross-sectional study was conducted through a self-designed questionnaire. It was constructed to examine several aspects of TBL, including cognition, social skills, high school educational system, and personal development. A total of 112 students were invited to participate in the study and 100 completed the survey. Individual-readiness assurance test (IRAT) and group-readiness assurance test (GRAT) scores were collected and the data were analysed and compared to the results of the final assessment using Statistical Package for the Social Sciences (SPSS).

**Results:** A total of 52 students (52%) described TBL as fostering a cooperative learning environment and 64 students (64%) found the materials to be easier to understand when discussed among themselves as a group. Compared to final examination results, there was a significant correlation ( $p = 0.0001$ ) between IRAT performance and final exam score. In addition, there was a significant correlation between high school education system and IRAT score, where the best performance was observed among students coming from schools using the British curriculum.

**Conclusions:** The overall perception and attitude of students toward the TBL system was positive and promising. Nevertheless, there are some notes and areas of concern that must be re-examined and remedied to improve TBL as an educational tool.

**Keywords:** GRAT; IRAT; Medical education; PBL; TBL

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## Introduction

Trends in medical education are shifting from passive to active learning, the latter of which is thought to result in a better understanding of learning contents and the development of new skills. The inefficiency of traditional lectures to stimulate active participation has prompted the development of new interactive teaching strategies.<sup>1</sup> Problem-based learning (PBL) is a student-centred learning strategy that engages medical students by presenting a health problem early in the learning process.<sup>2–4</sup> Team-based learning (TBL) is a strategy that was formulated to make classroom learning more active. This method is helpful in situations where students might feel uninterested in standard or traditional learning strategies. In comparison to many traditional learning strategies, such as lectures, case-based learning, and PBL, recent studies highlight the importance of TBL as an educational alternative that is often more active and less resource intensive.<sup>5</sup> The TBL method comprises three stages: (1) advanced preparation by the students, (2) the individual readiness assessment test (IRAT) and the group readiness assessment test (GRAT), and (3) application, which includes whole-class discussion and reasoning.<sup>6</sup> The primary goal of TBL is to support a high level of learning, improve the application of learning at both the quantitative and qualitative levels, and support the development of students' interpersonal and teamwork skills.<sup>7</sup> Furthermore, a study has revealed that TBL promotes individual student accountability, engagement, and teamwork.<sup>8</sup> In addition, prior research has identified five key elements for the successful implementation of TBL, which include buy-in, expertise, resources, time, and course characteristics. Thompson highlighted the importance of buy-in from faculty, students, and administration.<sup>8</sup> Furthermore, TBL has an advantage over other group learning strategies, in that a single instructor is sufficient to effectively attend to a greater number of students.<sup>9</sup> TBL is based on social learning theory and appears to have real pedagogical value. Several studies have demonstrated the positive attitude of students toward TBL as a learning method.<sup>10</sup> Teaching faculty have also demonstrated their support and favourable perception of TBL as a useful learning tool.<sup>10,11</sup> Considering the rising interest in the use of TBL in the field of health professional education, as well as the increased number of studies that have been

published on this subject recently, it is both appropriate and necessary to provide a more meaningful assessment of the effect of TBL on medical education.

The research question of this study is as follows: "In a population of medical students, is TBL a useful learning tool in a PBL-oriented curriculum?" The variables include the students' performance, acquisition of knowledge, attitude, and perceptions of TBL. The objectives of the study were to explore the effectiveness of TBL in a PBL curriculum, and how it affects the students' knowledge, skills, and personal development in a learning setting using a PBL curriculum.

## Materials and Methods

The participants of this study were students at the College of Medicine of the University of Sharjah, UAE, which uses a PBL curriculum that is body-system-oriented and distinguished by a significant degree of integration between disciplines. The students attend weekly review sessions, in which they receive instructions from their subject matter experts through TBL. Undergraduate students from year three were asked to participate in this cross-sectional study. The students participated voluntarily, and written, informed consent was obtained. The students' performance was assessed by comparing their scores on both the IRAT and GRAT for each review session during the semester, and then those scores were compared to their end-of-semester final examination scores. The grading system of the TBL and final examination were based on the following five categories: "Excellent with honours" represented a score equal to or greater than 90, "Excellent" represented 89–85, "Very good" represented 84–80, "Good" represented 79–75, and "Other" represented a score of less than 75.

For assessing the efficiency and effectiveness of TBL as a learning tool, students were asked to answer a 22-item questionnaire. The questionnaire included both open-ended and closed-ended questions (five open and 17 closed-ended questions) regarding the TBL method. The questionnaire consisted of two parts. Part 1 collected the students' demographic information, such as their age and gender. Part 2 addressed the research aims of this study, and included questions regarding the students' educational background and experience, their perceptions of and reactions to TBL, their development of personal and interpersonal skills through TBL, and their level of engagement in TBL.

The participants were asked to express their level of agreement or disagreement with each item using a 5-point Likert scale. Several previous studies were referred to when designing the questionnaire.<sup>12–15</sup>

Before starting the survey, the researchers briefly explained the aim, objectives, and significance of the study while emphasizing the importance of voluntary participation and anonymity. Both the link to the online questionnaire on Google Forms and the consent form were emailed to 112 third-year students using their university email addresses. Google Forms was utilized in the present study due to its convenient, fast, and easy-to-use interface.

Data collection was conducted in January 2017 during the winter break to avoid the effect of exam stress on student responses. The study obtained ethical clearance from the University of Sharjah Research Ethics Committee. No

ethical issues were encountered during this process. The total number of enrolled students in year three was 112; of this total number of students, 100 participated in the data collection. This represents an 89% response rate.

The received questionnaires were examined for completeness and consistency and the data were entered into the Statistical Package for the Social Sciences (SPSS) software version 22 for analysis. Some aspects of the analysis, such as prevalence, were analysed using the Google Forms analysis tool and the correlations between various variables were calculated utilizing IBM SPSS. For this study, a p-value of  $\leq 0.05$  was considered statistically significant. As the variables were categorical, a Chi-square test was used.

## Results

Of the 100 students who responded to the questionnaire, 64% were females and 36% were males. The students were asked about the type of studying resources they used to prepare for the TBL session, and the responses included lectures (89%), recordings (29%), books (42%), notes (39%), articles (2%), YouTube videos (43%), Internet sources (48%), and applications (1%) (Figure 1). However, the results showed no significant correlation between the type of studying resources used to prepare for TBL and IRAT scores ( $p$ -value = 0.466).

The students agreed that they gained knowledge (77%) and skills (60%) utilizing the TBL method. Moreover, the students responded that TBL helped them to develop skills such as organization (20%) and responsibility (24%), in addition to improving their understanding (42%) and memorization capabilities (22%). However, gaining new skills had no significant impact on IRAT score in the study ( $p$ -value = 0.316). In addition, 43% of the students stated that they required less time to solve a question while being part of a group.

Furthermore, 52 students (52%) described TBL as fostering a cooperative learning environment and 64 students (64%) found the materials to be easier to understand when

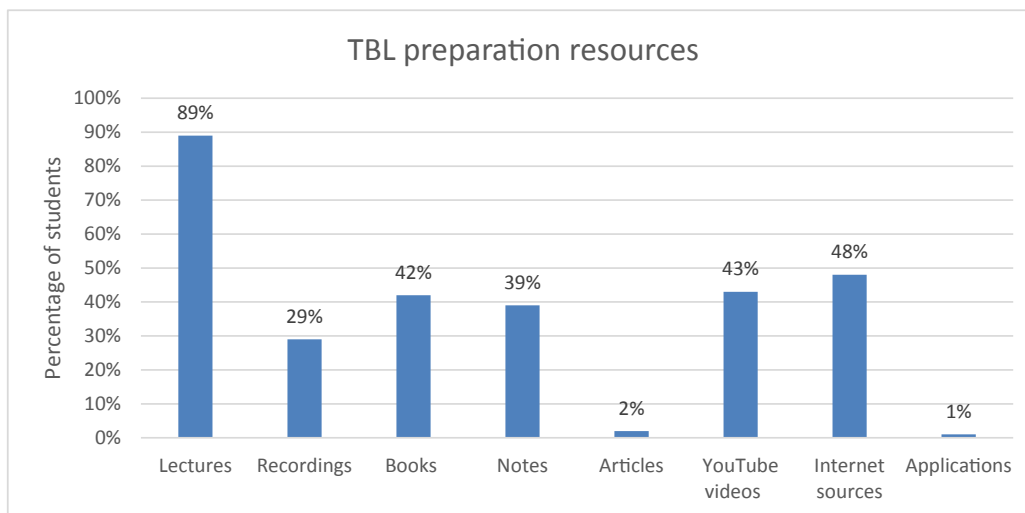
discussed among themselves as a group. A significant correlation was observed between GRAT scores and students who found the GRAT to improve cooperation between members ( $p$ -value = 0.004) and those who found that group discussion made the content easier to understand ( $p$ -value = 0.05).

Thirty-seven students (37%) mentioned that they faced problems with TBL. As expected, facing problems with TBL was correlated to IRAT score: those who had difficulties with TBL scored lower on the IRAT ( $p$ -value = 0.064). Interestingly, a significant correlation was also found between IRAT score and those who found it difficult to express their thoughts when working in a group ( $p$ -value = 0.009).

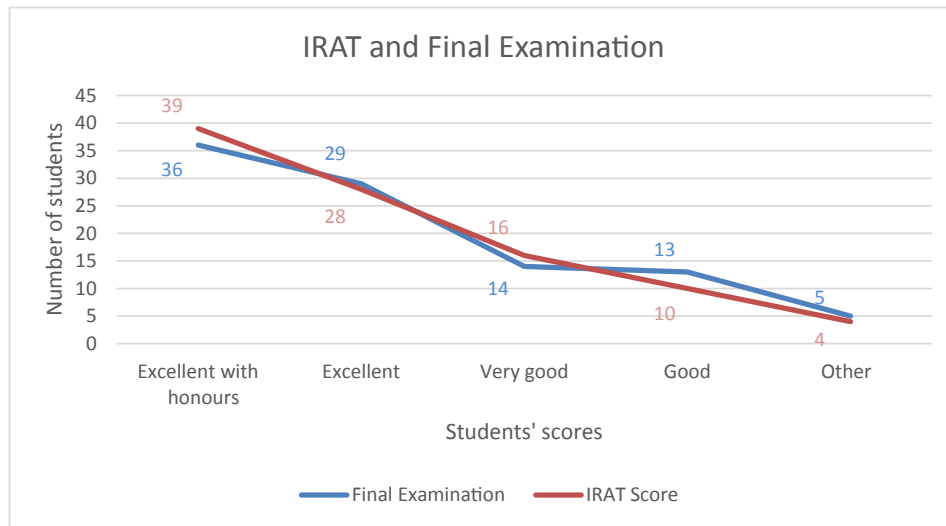
On the final examination, 36 students (36%) achieved excellent with honours, 29 students (29%) scored excellent, and 32 students (32%) scored below excellent, with a significant correlation ( $p$  = 0.0001) between performance in TBL sessions and final exam score.

Out of the 39 students who scored "Excellent with honours" on the IRAT, 35 of them also scored "Excellent with honours" on the final examination, while four scored "Excellent." Furthermore, only one student who scored "Excellent" on the IRAT achieved an "Excellent with honours" score on the final examination. Moreover, from the 28 students who scored "Excellent" on the IRAT, 25 also scored "Excellent" on the final examination. Furthermore, among the 16 students who scored "Very good" on the IRAT, 13 also scored "Very good" on the final examination, and all 10 students who scored "Good" on the IRAT also scored "Good" on the final examination. Finally, all four students who scored "Other" on the IRAT, also scored "Other" on the final examination (Figure 2). Additionally, no significant correlation was found between IRAT and GRAT ( $p$ -value = 0.746) scores, or between GRAT and final examination scores ( $p$ -value = 0.265).

The students who participated in this study graduated from various high school educational systems: 63 from Arabic governmental schools, 18 from British schools, 15 from American schools, and four from other curriculum schools. The results showed a significant correlation between



**Figure 1:** Student responses on the type of study resources used during the preparation phase of TBL. The most-used resource was lectures, while the least-used resource was applications.



**Figure 2:** Students’ IRAT and final examination scores. The graph illustrates the close correlation between IRAT score and final examination score.

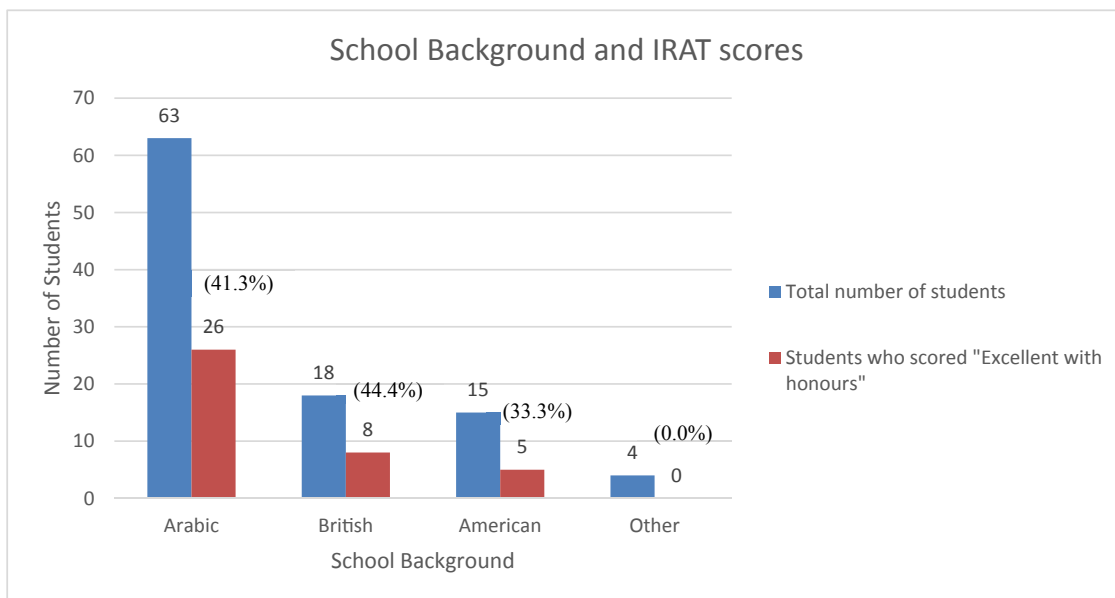
high school educational system and IRAT score, with a p-value of 0.017. Comparing the school system with IRAT score, 44.4% of students (8) with a British school background scored “Excellent with honours” on the IRAT, while this percentage was 41.3% for students with an Arabic school background (26), and 33.3% for students with an American school background (5). In contrast, none (0%) of the students from other school curricula scored “Excellent with honours” on the IRAT (Figure 3). The results of the questionnaire also revealed that 18 students (18%) were familiar with the TBL strategy from high school, with no significant impact on IRAT score (p-value = 0.534).

In response to the open-ended questions, the students recommended that more time should be allocated for interaction with the instructor to discuss the questions. Moreover,

the students thought that the format and difficulty level of the TBL questions was not consistent with the format and difficulty level of the final examination questions; therefore, they suggested that questions with a similar difficulty level to those of the final examination be used. Some of the student comments are displayed in Table 1.

**Discussion**

Our findings support the idea that TBL has a positive influence on students’ acquisition of knowledge. When the students were asked about their opinion of TBL, most approved of its inclusion in the curriculum, stating that it helped them to solidify concepts they had already learned



**Figure 3:** The correlation between school background and IRAT score.

**Table 1: Student responses to open-ended questions.**

## Students' comments

It is a cooperative learning environment.  
 TBL improves communication skills and allows me to express my ideas without being nervous.  
 TBL promotes teamwork and builds trust of others.  
 The group members help explain things that we don't understand.  
 I also learn when I explain the material to my group members.  
 The time allocated for discussion is not enough compared to the whole period of the TBL session.  
 Some questions are too easy and straightforward and are not effective in triggering adequate group discussion. Also, the TBL questions' difficulty level was easier than on the final examination.  
 Some instructors are not present during the entire TBL discussion period, which hinders the discussion.  
 Some aspects can be improved in terms of organization.

and acquire new knowledge. Similar results have been reported by previous studies, where students mentioned an increase in their knowledge of course content; this was confirmed by a corresponding increase in test scores.<sup>16</sup> Furthermore, TBL has been shown to enrich students' learning experiences while effectively targeting course learning objectives.<sup>17,18</sup>

The concept of preparing beforehand to be assessed individually using the IRAT encourages students to master the knowledge and objectives they are going to be assessed on. Should any deficiencies or lack of knowledge be detected by the IRAT, this can be addressed by the GRAT through group discussion and trying to reach a consensus on the best answer. Moreover, while engaging in deep discussion with their peers, students obtain the opportunity to respond to a question from various perspectives and to learn from one another.<sup>28</sup> In these ways, TBL fosters an active learning environment where peer-to-peer learning can lead to an improvement in student scores and performances.<sup>19–21</sup>

In the present study, most of the students who scored high on the IRAT scored high on the final examination as well. This may be attributed to the fact that the IRAT served as a very helpful self-assessment tool for the students, which allowed them to track their progress throughout the semester and improve their final examination scores. In addition, most students acquired new skills such as organization and responsibility utilizing this learning method. As reported by Parmelee and Michaelsen, accountability plays a critical role in TBL: Students are accountable for attending the session, preparing for the test, and investing time and effort working in their teams.<sup>22</sup> The high level of student accountability inherent in this learning method could account for the improvement in student organization and responsibility skills. Indeed, TBL has been shown to allow students to heighten their communication and team-work skills.<sup>16–18,23</sup> Moreover, as shown by the results, TBL promotes both student understanding and memorization skills. Furthermore, TBL has been shown to enhance students' critical-thinking and problem-solving skills.<sup>17,23,24</sup> Interestingly, it has also been found that when students share their opinions with their group members or other groups, this enhances their confidence and develops a sense

of being valued by others.<sup>23,25,26</sup> Additionally, TBL can be implemented in both the basic sciences and clinical phases of medical education programs, where it has been shown to improve clinical reasoning skills.<sup>18,27</sup>

Some students suggested that it would be better to remove the individual assessment and spend the extra time on group discussion of the questions. However, the IRAT is an essential part of the process, as it ensures that all members prepare for the TBL sessions and participate in the content-focused discussion. Furthermore, Parmelee and Michaelsen mentioned that all parts of TBL are crucial for it to be beneficial.<sup>22</sup> Another recommendation the students made was to increase the difficulty level of the questions on the IRAT, and they suggested that a committee could design the questions to trigger more useful discussions. Furthermore, they also proposed to change the questions every year to avoid repetition and enhance the learning experience. Supporting these statements is the recommendation of Parmelee and Michaelsen, who suggested that TBL assignments should be designed in a manner to promote critical thinking and trigger deep discussion.<sup>22</sup>

Moreover, a useful tool for constructing assignments is utilizing the four S's, which state that the question should be *significant* enough to trigger content-focused discussion and teamwork, it should be *specific* enough to promote deep discussion, the *same* problem should be given to all groups, and there should be *simultaneous* reporting.<sup>22</sup>

Worthy of mention here is the role of the instructor in the success of TBL. As reported by previous studies, they can improve the effectiveness of TBL by providing constructive feedback that could enable students to achieve a higher level of academic success.<sup>28</sup> Instructors have also highlighted the importance of TBL in improving students' communication with each other and helping them to learn from peers in an encouraging atmosphere.<sup>29,30</sup> In addition, the instructors benefit as well from this process, as Michaelsen and his colleagues demonstrated.<sup>31</sup>

It is logical that enhanced preparation for TBL can improve student performance. However, it is fascinating to learn which resources the students used for their TBL preparation. The resources used were mostly lectures, followed by Internet sources (educational websites), YouTube videos, and books. The concept of self-preparation and extracting applicable information from various resources leads to the development of lifelong learning skills and continuing education.<sup>18</sup>

Another interesting finding of the present study was the impact of high school educational systems on student performance in TBL sessions, demonstrated by IRAT scores. Students from British curriculum schools scored higher on the IRAT than their peers from other education backgrounds. This result could be due to the organization of the British curriculum and higher standards of teaching in British schools. Thus, distributing students with a British educational background among the groups might be beneficial for students.

Previous exposure to TBL prior to university did not have a significant impact on IRAT score, which could indicate that TBL can be easily incorporated into university curricula. Nevertheless, an initial mini-course could be given at the beginning of the year to get students familiarized with the system and obtain the most educational value from it.

## Conclusions

It is evident that TBL is an efficient tool that influences medical students' academic performance. It has been shown to affect student achievement, and student perceptions of and attitudes toward the TBL system are generally positive and promising. Nevertheless, there are some aspects and areas of concern that must be re-examined and remedied to improve the TBL method, which will be reflected as an improvement in the curriculum in general. Allocating more time to interaction with instructors to discuss the questions is one possible area of improvement. Moreover, it would be beneficial if curriculum and assessment committees examined the difficulty level of questions used during TBL sessions to ensure that they are consistent with the difficulty level of the final examination questions.

## Recommendations

The authors recommend using harder questions during TBL, which would necessitate lengthier discussions and explanations. In this way, allocating more time for TBL sessions would be an effective way to improve student learning experiences, as mentioned by many students in their questionnaire feedback. Furthermore, the authors also advise changing the questions on a yearly basis to avoid the repetition of questions from previous years and to enhance student learning experiences. Furthermore, the authors suggest allocating a percentage of the overall final assessment mark to TBL to encourage students to adequately prepare and actively engage in the TBL sessions. Additionally, the authors advise that students use their TBL assessments to monitor their progress throughout the semester and focus on improving their weak areas. Some students were exposed to TBL before starting medical school, while others were only being exposed to it for the first time; therefore, it would be wise to organize an introductory mini-course where students would learn about the TBL method before starting the TBL sessions. This could help to minimize the students' adjustment time to the new learning strategy and help to enhance their performance. Finally, ensuring student diversity within groups, that is, placing students from different educational backgrounds in each group, would help to enrich group discussions and increase the learning benefits for all students. We believe that the findings of this study will help medical educators to make TBL a more productive and enjoyable academic experience.

## Conflicts of interest

The authors have no conflict of interest to declare.

## Authors' contributions

All the authors actively contributed to the manuscript preparation, data collection, and statistical analysis. HJ and MV conceptualized the study design. HJ, AJ, MV, DA, and NM actively participated in the study and prepared the draft manuscript under the supervision of MAE, who also helped to prepare the draft manuscript and revise it.

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