ORIGINAL RESEARCH

A Novel Online System Implementation to Enhance Team-Based Learning at a Medical School

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Introduction: Team-Based Learning (TBL) is an effective learning model utilized in education to address the concerns of student active learning, participation, critical thinking and teamwork. However, faculty members must invest significant time in preparing TBL sessions, creating appropriate material and assessments, preparing paper answer sheets for group tests, and managing the logistics of student groups.
Methods: We have designed, developed and implemented a novel TBL online system at our institution by integrating the standard TBL process into a customized IT solution. The objective of this research is to identify important items in the requirements analysis based on sound pedagogy, describe the developed system while highlighting benefits and obstacles faced, and gauge user feedback of the system.
Results: The system reduces the burden on faculty by guiding in the preparation of assessments, randomizing students into groups containing students from all academic levels, allowing students to take the individual and group tests efficiently and with instant grading, providing a mechanism for answering questions in the group test in such a way that indicates to students that their answer is incorrect and then allowing them to continue discussion until they reach the correct answer and then grade the question appropriately, allowing facilitator and students to view the progress of each group in the group exams in real-time on a projected screen, and giving an immediate indication on which questions are performing poorly so that immediate discussion and feedback can occur.
Conclusion: The system has demonstrated its value in enhancing the learning experience for medical students and has received positive feedback from both facilitators and students. By continuing to innovate, TBL has the potential to play an even greater role in the education and assessment processes of medical professionals.
Keywords: team-based learning, TBL, system implementation, medical education

Introduction

Team-Based Learning (TBL) is an effective knowledge delivery model utilized in the learning environment of medical schools to address the concern of learner active participation, critical thinking and teamwork. As opposed to the conventional approaches of didactic lecturing, TBL incorporates higher learner engagement in the form of initial and group assessment as well as group discussion. Stemming from constructivist educational pedagogy, TBL fosters independent learner preparation, readiness assessment in both individual and group format, and problem-solving within teams.[1] This method has been highly regarded as a flipped classroom method for developing not only concept mastery but also communication skills and readiness for teamwork among medical students.[2]

Team-Based Learning (TBL) has been adopted in medical education as an effective teaching method that focuses on learners' active participation, critical analysis and problem-solving abilities, as well as teamwork. Compared to the conventional teaching models, it is learner-centered as students participate in meaningful knowledge utilization to solve authentic issues.[3] Derived from constructivist educational paradigms, TBL aims at enhancing the learners' capacity to integrate and appreciate knowledge and its application making it ideal in medical education where learners' critical thinking and teamwork capacity are integral in their clinical performance.

TBL is fundamentally aligned with constructivist educational principles, which hypothesize that learners actively construct knowledge based on their experiences rather than passively receiving information.[4] The constructivist approach emphasizes several key elements, all of which are deeply integrated into the TBL process, which are introduced below.

In TBL, the teacher acts as a facilitator rather than a lecturer, guiding students as they interact with the material and with each other. This reflects the constructivist view of the learner-centered environment such that learners should be at the center of the learning process, actively engaging in problem-solving and critical thinking.[4]

In contrast to traditional didactic learning, TBL emphasizes active learning. In the first place, students study specific material on their own, complete the individual readiness assessment tests (IRAT) and work in teams on the group readiness assessment tests (GRAT); thus, students are more involved in the learning process.[5] This form of active learning demonstrates the effectiveness of material retention that takes place over an extended time period as well as better refinement of thinking skills as compared to other conventional approaches.

There are several studies that show that TBL gives better results in terms of performance and student satisfaction. In a study by Koles et al 2010,[6] they noted that medical students who underwent TBL earned higher marks than their counterparts who underwent traditional didactic teaching, especially on exams that involved analyzing, synthesizing and evaluating information. They also concluded that students in the lower academic segment may benefit more from this learning approach. In addition, student satisfaction is higher as they are more proactive and involved in the learning process as observed in TBL environment through the use of group work which makes learning more interesting.[7,8]

Despite its many benefits, implementing TBL in medical education is not without its challenges. Faculty members must invest significant time in preparing TBL sessions, including creating appropriate material and assessments as well as developing higher-level application questions.[9] With the group exam, facilitators traditionally must prepare paper sheets with options that can be scratched off revealing if the option is the correct one. In addition, the logistics of managing large groups of students, particularly in settings where space and technology may be limited, can be complex.

Resistance from both faculty and students can also pose a challenge. Faculty accustomed to traditional lectures may be reluctant to adopt a more student-centered approach, while students unfamiliar with TBL may initially struggle with the increased responsibility for their own learning. However, as students become more familiar with the process, studies show that they tend to appreciate the depth of learning and engagement that TBL provides.[7,10,11]

Keeping these benefits and challenges of TBL in mind, we set out to develop and implement an online system that is pedagogically sound and helps with the running of TBL sessions in a more automated manner and with less burden on the TBL facilitator. The objective of this research is to identify important items in the requirements analysis based on sound pedagogy, describe the developed system while highlighting benefits and obstacles faced, and gauge user feedback of the system.

Methods
Theoretical Framework for TBL Implementation

The implementation of TBL and the supporting IT solution in our context is guided by a number of well-established learning theories that collectively enhance knowledge acquisition, critical thinking, motivation, and teamwork. By integrating cognitive dissonance, social learning, cognitive load management, self-determination, reflection, and situated learning, TBL fosters an active, learner-centered environment that prepares students for collaborative medical practice.[12,13]

Cognitive Dissonance Theory

Rooted in constructivist learning, meaningful learning occurs when students recognize discrepancies between prior knowledge and new information. TBL fosters this through the Group Readiness Assurance Test (GRAT), where peer discussions expose learners to diverse perspectives, prompting cognitive conflict and resolution. This process helps students refine their reasoning and achieve deeper conceptual understanding.[14]

Social Learning Theory

Peer interaction is central to TBL, aligning with Bandura's Social Learning Theory, which posits that knowledge acquisition occurs through observation, modeling, and social reinforcement. By engaging in collaborative discussions, learners share expertise, challenge misconceptions, and co-construct knowledge, reinforcing deeper learning through group engagement.[15]

Reflection and Feedback

Constructivist learning is incomplete without reflection, a core component of TBL. The multiple feedback opportunities during GRAT and instructor-facilitated discussions encourage students to critically assess their understanding. This reflection process not only clarifies correct responses but also enhances metacognitive skills. Additionally, students develop proficiency in giving and receiving feedback, fostering self-regulated learning and professional growth.[16]

Cognitive Load Theory

TBL optimizes learning by distributing cognitive load among team members. The structured phases of TBL ensures that learners can process complex medical concepts effectively without cognitive overload. Group discussions and immediate feedback further support knowledge retention and application.[5]

Self-Determination Theory (SDT)

TBL enhances student motivation by fulfilling the three key psychological needs identified in SDT-autonomy, competence, and relatedness. The structured yet flexible nature of TBL fosters autonomy in decision-making, group discussions build competence through problem-solving, and peer interactions satisfy the need for relatedness.[6]

Situated Learning Theory

TBL aligns with Lave and Wenger's Situated Learning Theory, which emphasizes that learning is most effective when it occurs within a social and contextual framework. In medical education, TBL mirrors real-world clinical decision-making by engaging learners in authentic case-based discussions, enhancing their ability to apply knowledge in practical settings.[7]

Context and System Development

We have developed an online TBL system, which incorporates the TBL process to help facilitate the conducting of TBL sessions. The system is developed in-house and is integrated with previously developed in-house learning and assessment systems at the College of Medicine and Health Science, United Arab Emirates University.[17] The College has adopted a six-year MD Program utilizing an integrated curriculum and using student-center instructional methods including PBL and TBL. The developed TBL system uses the current curriculum system timetable to create individual and group test containers, it also uses the current assessment system to help the facilitator fill them with used and new question. Full understanding of the TBL process and the completion of a local requirements analysis were used as guidance in developing the system. Local experts in medical education and assessment as well as medical students who have conducted TBLs manually in the past were asked to identify required features of an effective electronic TBL system.

The requirements analysis resulted in the identification of several requirements for conducting TBL effectively using an electronic system, which are as follows:

1. Selection of questions and addition of new questions into the system by the TBL facilitator should be user-friendly and follow clear education and assessment guidelines including choosing questions that match course outcomes and session objectives.
2. Student groups should be formed with each group having diverse student academic levels with 6–8 students in each group.
3. The manual paper scratch-off method for group test should be replaced with an electronic method in which the selected answer by the group is immediately revealed as being correct or incorrect, deduct the appropriate mark, and allow the group to continue answering.

4. For the benefit of the TBL facilitator and students, a group progress dashboard should be projected so that everyone is aware of the answering speed of each group, performance of each group, and the difficulty level of each question.
5. After the group test is complete by student, the facilitator should be able to project the questions on the screen and have a discussion with the students on reasons behind choosing their answers.
6. Marking and psychometric calculations should be feasible to be conducted and evaluated by the facilitator before distribution of marks to students.
7. The system should seamlessly integrate with the current education and assessment system already in place.

The system is running on a local Windows server hosting the SQL database where all data is stored in a relational database design and is connected to the website which uses ASP and ASP.NET services. It is integrated with our Learning and Assessment Systems. The development and implementation of a novel online TBL system has enabled our institution to conduct more than 193 TBL sessions in the last four years by integrating the standard TBL process with a customized IT solution. A special TBL hall was set up to accommodate 100–150 students in 6–8 students per groups so that TBL sessions could be carried out. The hall has wireless Internet connectivity and has a teacher computer with projection on multiple boards. Projectors were deemed necessary so that the immediate feedback is given to all groups and facilitators during the group exercises.

Faculty and Student Evaluation

At the end of each course students evaluate their course experience through a questionnaire distributed to all students. Coordinators of the course prepare a course report highlighting strengths and challenges. We have reviewed these course evaluations for comments related to their TBL experience. To analyze this qualitative data, we employed thematic analysis, a method that allows for the identification, analysis, and reporting of patterns (themes) within data. To assist in managing the data and facilitating a more rigorous analysis, we utilized ChatGPT4o artificial intelligence (AI) software. This software employed natural language processing (NLP) techniques to help detect recurrent patterns and themes more efficiently. The AI's capabilities allowed for a faster initial analysis, which was then reviewed and refined by two of the authors to ensure the validity and reliability of the results. This dual approach ensured that the thematic analysis was both thorough and efficient.

Results
Theoretical Framework for TBL Implementation

The TBL implementation and the supporting IT solution in our context were guided by a number of well-established learning theories that collectively enhance knowledge acquisition, critical thinking, motivation, and teamwork. The system has integrated cognitive dissonance, social learning, cognitive load management, self-determination, reflection, and situated learning, to enable an active, learner-centered environment that prepares students for collaborative medical practice. This TBL theoretical framework was used as the guiding principles of the development of the system. We describe specific implementation examples of these in the next section.

Context and System Development

The developed system was built based on the requirements analysis study and has fulfilled them all. The college has conducted 193 TBL sessions during the last four years in all levels of the six-year MD Program. The developed TBL system was based on these results of the requirements analysis and the described theoretical framework:

1. Allow instructors to provide reading material for the TBL assessments ahead of time electronically.
2. Assist instructors in creating TBL assessments by utilizing an already built in-house assessment system, which allows instructors to select previously used questions by carefully analyzing the item psychometrics or by entering

newly developed questions into the system. All questions are of the type Single Answer Multiple Choice Questions.

3. Group students into TBL groups of reasonably selected sizes with a stratified randomization method, which guarantees placing the whole range of student academic levels into each group. These groups are kept the same for the academic year. These are recommendation from Burgess et. al, 2020[12] under Key Components of TBL Item 1 (Carefully formed and managed teams). The system also informs facilitators and students of these groups ahead of time.

4. Allow all students to securely log in to the assessment system using student ID and exam password and take the individual test once opened by the facilitator.

5. Allow any member of the group to securely login to the assessment system using student ID and exam password and start the group test on behalf of the group members once opened by the facilitator.

6. Group test items are Single Answer Multiple Choice Questions, which are the same questions of the individual test. However, in the group test, the system gives a visual indication, after discussion by the group members and answering by the designated group member, that the selected answer is correct or incorrect. If correct, students move on to the next question. If incorrect, the system allows the students in the group to select another option with a deduction of one mark for that question for the group, and so on until the group gets the correct answer. An example of this is shown in Figure 1 which shows that students chose options A and B first which were incorrect, the system gave them an indication that the answer is incorrect. Students then discussed further and chose option D, which the system indicated as correct. This is the recommendation from Burgess et. al, 2020[12] under Key Components of TBL Item 3 (Problem-solving) which allows students to develop problem solving and communication skills.

7. Allow facilitators to control the pace of groups answering questions in one of two ways. Either by opening the questions for answering one by one whenever the facilitator wishes to, or by displaying a visual representation of group answering progress, which is projected on a screen visible to students and facilitator (Figure 2). The students and facilitator can quickly see from this which group is lagging behind in answering questions and the score for each group in each question, which can be used after each question or after the group test to guide facilitator discussion.
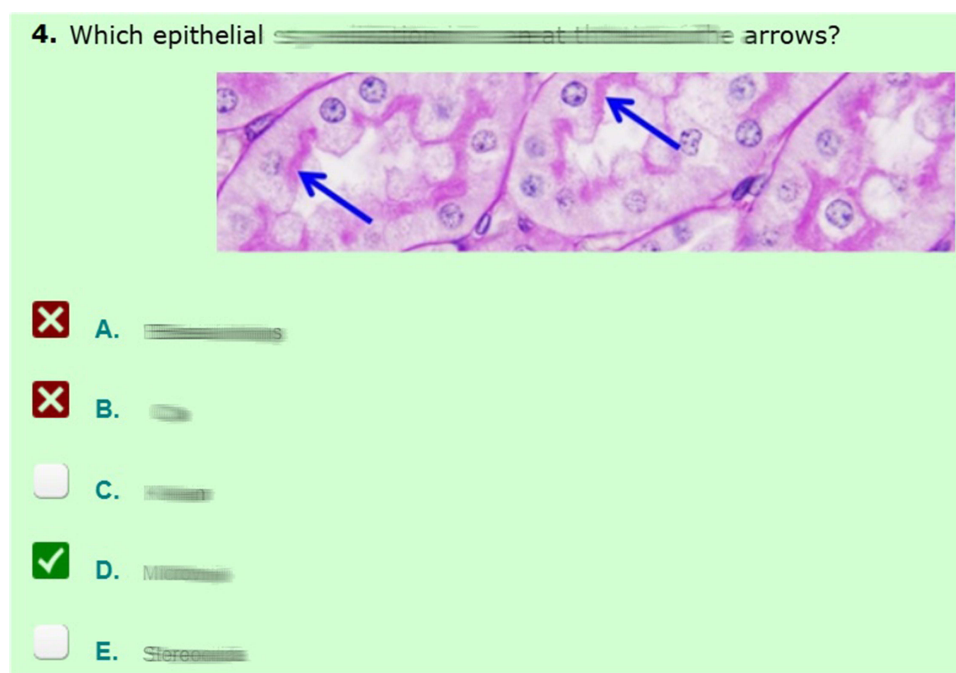

Figure 1 TBL student view of question with answering in a group.

Groups	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Total
M1	5	5	5	5	5	5	5		100%
M2	5	5	5	5	5				100%
M3	5	5	5	5	5				100%
M4	5	5	5	5	5	5			100%
F1	5	4	5	5	5	5	5		97%
F2	5	5	5	4	5	5			97%
F3	5	5	5	5	5	5			100%
F4	5	5	5	4	5	5			97%
F5	5	5	5	5	5	5			100%
F6	5	5	5	3					90%
F7	5	5	5	5	5	5	5		100%
F8	5	5	5	5	5	5			100%
F9	5	5	5	3					90%
F10	5	5	5	5	5	5			100%
F11	5	5	5	4	5	5	5		97%
F12	5	5	5	5	5	5			100%
Average	100%	99%	100%	91%	88%	75%			

Figure 2 TBL Group Test display of progress.

8. Immediate and timely feedback or clarification is given by the facilitator after each question is answered by the group or after the group test is complete. This is the recommendation from Burgess et. al, 2020[12] under Key Components of TBL Item 2 (Frequent and timely feedback) and is illustrated in Figure 3.

9. The application questions are conducted only in groups in the same manner as the group test but usually as a formative assessment with in-depth discussions.

10. Student peer evaluations are done to as the recommendation from Burgess et. al, 2020[12] under Key Components of TBL Item 4 (Peer evaluation) suggests, but they are not used for grading, only for formative peer feedback. Rather, grading for each student is taken from the individual test and the group test usually in equal weighing.

11. The system is fully integrated with the education and assessment system in place, which allows for student data such as groups and marks to be immediately transferred from and to all systems.
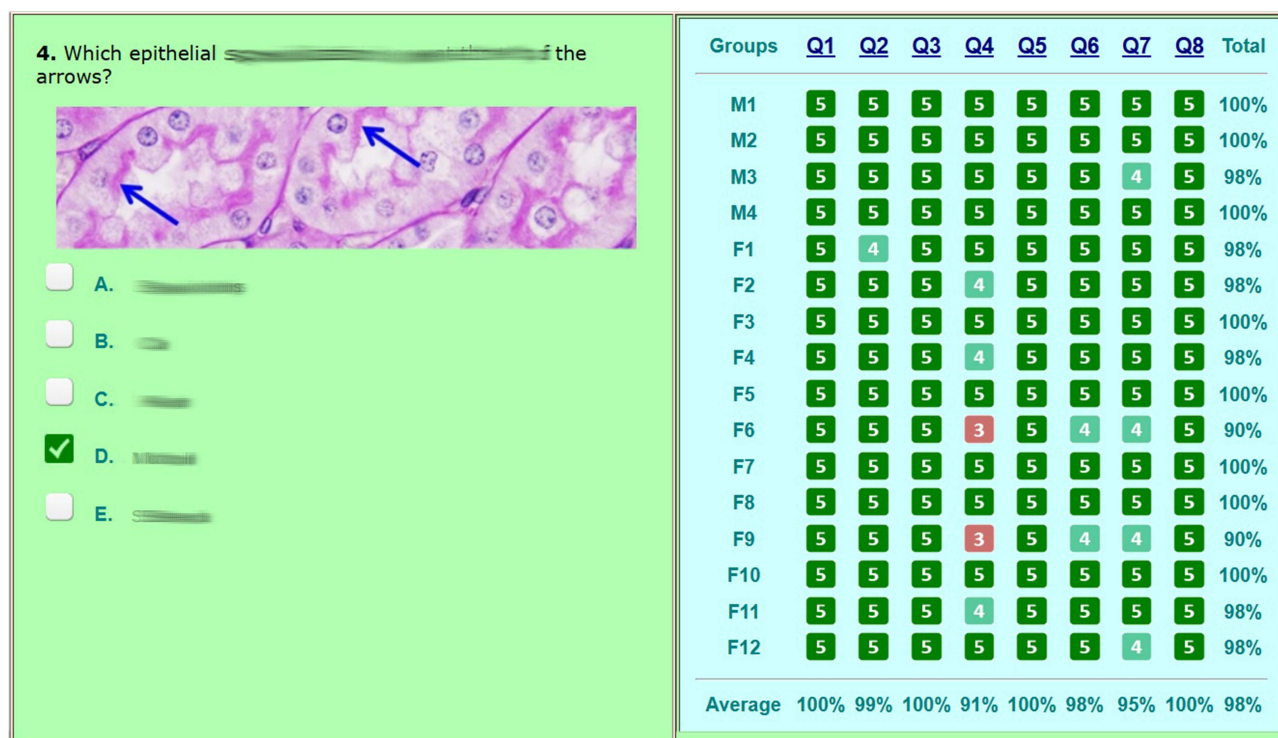
Figure 3 TBL Group Test question review and discussion.

Faculty and Student Evaluation

The feedback has been encouraging from both students and faculty. Course evaluation feedback by students revealed that TBL sessions are very well received by students. We used student course evaluations of 37 courses, which had at least one TBL session in the last four years. We focused on two questions in the course evaluation, which were as follows:

1. What aspects of this course contributed most to your personal development and learning?

Out of 6677 responses to this question in all courses for students who participated in the evaluation, there were 293 responses related to TBL. 289 of them were positive comments about TBL and only four were negative comments.

The common answer for the positive comments was simply "TBL" (76% of responses). Other positive comments were "TBL served as a great method for my personal development and the overall discussion between colleagues", "TBL made me grow and understand my mistakes", "TBL sessions were fun as I was challenged to study something in a new way and implement it with challenging questions while working on my teamwork skills", and "TBL system was very easy to use and showing the progress on the screen was exiting and made it competitive".

We used ChatGPT4o to further classify the 289 positive comments by providing these data and asking it to perform thematic analysis. The results were then verified by two of the authors. We identified five themes for the TBL positive comments which are Active Learning (with the majority of responses) then Practical Application, Collaboration and Teamwork, Assessment and Feedback, and Skills Development which were all mentioned very less frequently.

The negative comments were "It was difficult for me to adjust to TBLs", "We had material on the TBL which was not covered in lectures", and "Material for the TBL was not provided in handouts".

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2. How could this course be improved?

Out of 6,998 responses to this question in all courses for students who participated in the evaluation, there were 299 responses related to TBL. 251 of them were recommendations emphasizing existing TBL practices and 48 of them were recommendation to improve the existing TBL practices.

The overwhelmingly common answer for the recommendations by students was "provide more TBL sessions" (87% of responses). Other positive comments were "Add more grades to TBL and less to exams", "TBL was the most useful session for me. We should have more TBL sessions".

The most common recommendations for improvement of the TBL process were "Please make sure that the questions come from the TBL material", "Material was sent two days before the TBL which is not enough time to read it", "TBL topics were very difficult and too long for the students to study as a self-study while the lectures covered with the tutor were much easier". These two comments were mentioned once "I'd rather have quizzes than TBLs", "convert TBLs to lectures".

All faculty in the College use this TBL system for conducting TBL sessions. Faculty have reported in their course review that TBLs conducted using an electronic system that fulfills the requirements can be very helpful in the learning and assessment processes. They stated that the system was user-friendly and that having the progress displayed on the projector to follow group speed and correct answering was very useful for fostering discussions. However, facilitators have reported significant time and effort needed to prepare for and conduct TBLs sessions, but less so using the electronic system.

Discussion

The implementation of TBL at our institution using a novel online system has demonstrated its value in enhancing the learning experience for medical students. Feedback from students and faculty is that these sessions have highlighted the need for higher-order thinking for an MD student. In addition, the real-time feedback provided during group activities has been pivotal in fostering an environment of active learning and continuous improvement.

Faculty have observed that while TBL sessions require more preparation than traditional lectures, the payoff in terms of student engagement and the quality of learning outcomes is substantial. Students remain more involved throughout the learning process and the interactive nature of the sessions encourages them to take ownership of their learning.

The system reduces the burden on faculty by guiding in the preparation of assessments, randomizing students into groups containing students from all academic levels, allowing students to take the individual and group tests efficiently and with instant grading, providing a mechanism for answering questions in the group test in such a way that indicates to students that their answer is incorrect and then allowing them to continue discussion until they reach the correct answer and then grade the question appropriately, allowing facilitator and students to view the progress of each group in the group exams in real-time on a projected screen, and giving an immediate indication on which questions are performing poorly so that immediate discussion and feedback can occur.

Many universities have utilized TBL and have shown enhanced performance in assessments requiring the application of knowledge to real-world medical problems.[18] They have also experienced various challenges in the use and application of TBL, especially in handling large group of students. Challenges like organizing group activities for students under a group and making certain that all the groups receive feedback on time have been a challenge. None, to our knowledge, has attempted to develop a system like ours to help alleviate these challenges. The integration of an effective online TBL system has helped our institution improve group interaction as well as foster feedback and discussion with large groups of students. The real time monitoring of students and feedback during the TBL's collaborative discussions has proven to be essentially important in the large class delivery of TBL.

From the time we started this project, we have discovered that there are some systems that are similar to ours, namely (InteDashboard™, OpenTBL™, and Canvas™ to some extent).[19,20] We compared the features and they are similar to the requirements analysis that we have recognized, especially the first two systems. The two major advantages of our system are that it's fully integrated with our in-house built curriculum and assessment systems, which makes it easier to manage and conduct TBLs, and the viewing of the student group progress on a projected screen is clearer and more conducive to keeping track of slow or fast groups as well as low or high performing groups and low or high performing questions. This fosters significant discussion after the group test with the whole class and the facilitator.

We faced some challenges during implementation such as faculty and student acceptance and buy-in. The Medical Education Department conducted several seminars on the benefits of TBL and this particular system to achieve initial buy-in to the system. The IT support for faculty and students on how to navigate the system, especially during the group tests was invaluable and an essential component of the success of this implementation.

Theoretical Implications

The introduction of an online Team-Based Learning (TBL) system in medical education encourages students to resolve differing viewpoints, improving their critical thinking and problem-solving skills. The system uses stratified group randomization and peer interaction, reinforcing social learning by fostering collaboration.[21] Faculty shift from traditional lecturers to facilitators, further supporting a learner-driven approach. Integrating technology into TBL strengthens educational principles and provides a more efficient and scalable model for active learning in health professions education.[22]

Practical Implications

The practical implications of implementing an online Team-Based Learning (TBL) system in medical education are multifaceted, enhancing both student engagement and learning outcomes. Online TBL has been shown to be preferred by students over traditional online class-based methods, as evidenced by higher engagement levels and improved test scores in studies involving medical students learning about surgical abdominal emergencies.[23] This preference is attributed to the interactive and collaborative nature of TBL, which fosters a deeper understanding of the material and enhances learning abilities. Furthermore, a scoping review of TBL in clinical disciplines highlights that while the implementation often varies, the method generally leads to increased student satisfaction and engagement, although results on knowledge retention are mixed.[24] The COVID-19 pandemic has further underscored the value of online TBL, as it has allowed for the continuation of practical training in a virtual environment while maintaining TBL learning and assessment principals as well as student satisfaction and understanding.[25] However, successful implementation of TBL requires robust faculty development programs to equip educators with the necessary skills for this pedagogical shift, emphasizing the importance of instructional design and team facilitation.[26] These programs are crucial for ensuring that TBL is effectively integrated into the medical curriculum, thereby enhancing the overall educational experience and learning outcomes for students.

Limitations

Online Team-Based Learning (TBL) in medical education has become more common, especially during the COVID-19 pandemic, but it comes with several challenges Technical and digital challenges pose difficulties, as both students and teachers need a stable internet connection and proficiency in digital tools, which can be a barrier if they are not well-prepared.[27,28] Effective implementation also requires adequate resources, space allocation, facilitator training, and administrative support, which can be challenging to manage.[29] Furthermore, the presence of content experts is crucial to maintaining the quality of learning.[28] Despite these challenges, online TBL provides flexibility and supports active learning, but addressing these limitations through careful planning, resource allocation, and proper training is essential to ensure its success in medical education.

Our setting is particular to an undergraduate MD program with only local students of this country's nationality. This is a common setting in the Arab Gulf region, but we are not sure if these results can be generalizable to other countries and settings. Also, the success of the TBL system is partially due to the foundation of in-house build IT systems involving the curriculum and assessments[17] which already exist in the College. The TBL system is integrated carefully with these system to make it work as they are all in-house built systems. We are not sure how feasible it would be to integrate such a system with existing curriculum and assessment system in other settings.

Future Research Recommendations

Future research in medical education should compare different computer-based learning methods, including team-based learning (TBL), to identify which approaches work best in specific settings. For example, understanding how computer-based learning compares to other computer-based learning techniques could improve teaching strategies.[30] Additionally,

studies need to explore how teachers decide to use TBL and what factors influence its success, as this could help optimize its use and improve outcomes in health professions training.[31]

Another area to investigate is combining TBL with other methods, like case-based learning, to strengthen curriculum design. For instance, TBL might be useful early in medical programs for teaching foundational science, while case-based learning could focus on building clinical reasoning skills later.[3] Blending technology with TBL also needs more attention, while adding tech tools is popular, their actual impact on learning and student engagement, especially online, remains unclear.[32]

Future studies should focus on comparing learning and assessments methods, blending TBL with other models and technologies, adapting it to various fields, and making it more efficient. These steps could make TBL more flexible and impactful across medical education.

Conclusion

The implementation of Team-Based Learning at our medical school using a novel online system which is based on sound pedagogical learning and assessment theory has had a profound impact on student engagement, self-directed learning, collaborative group learning, and critical thinking. Both faculty and students have recognized the value of TBL in enhancing the overall learning experience and appreciate the ease in which the system provides logistic help and fosters discussion and feedback. They have provided very positive feedback requesting more TBL session to be conducted using this system. The system was built on an extensive requirements analysis and sound education and assessment pedagogy. It has reduced the burden on faculty in conducting TBL sessions by guiding in the preparation of assessments, randomizing students into groups containing students from all academic levels, allowing students to take the individual and group tests efficiently and with instant grading, providing a mechanism for answering questions in the group test in such a way that indicates to students that their answer is incorrect and then allowing them to continue discussion until they reach the correct answer and then grade the question appropriately, allowing facilitator and students to view the progress of each group in the group exams in real-time on a projected screen, and giving an immediate indication on which questions are performing poorly so that immediate discussion and feedback can occur. By continuing to innovate, TBL has the potential to play an even greater role in the education and assessment processes of medical professionals.

Data Sharing Statement

The system is built in-house and is behind a firewall so making it available is not possible. There is no data in this research to be made available.

Ethical Approval

No ethical approval was needed for this research as no data from any subjects was used.

Consent for Publication

The authors give the journal consent to publish the manuscript. There are no identifiable details or images of individual persons in the manuscript.

Acknowledgments

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

There was no funding needed for this research.

Disclosure

The authors declare that there are no competing interests in this work.

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