PAPER

How Did We Deliver Team-Based Learning (TBL) Remotely to Overcome Digital Divide and Internet Access Inequality?

Adhari AlZaabi(✉)

Department of Human and Clinical Anatomy, College of Medicine and Health Sciences, Sultan Qaboos University, Muscat, Sultanate of Oman

adhari@squ.edu.om

ABSTRACT

The shift to online learning during COVID-19 has uncovered the existing internet access inequality in the world. Shifting an interactive team-based learning (TBL) session to online is even more challenging since it necessitates interactions and feedback. Choosing the proper digital platforms for online TBL is critical to ensure achieving the intended benefits of TBL. A face-to-face TBL course was transformed fully to online. The basic TBL elements, i.e., pre-reading materials, iRAT, tRAT, and the tAPPS, remained the same in online TBL. Platforms that use less internet bandwidth and are familiar to students were used such as Google meet, WhatsApp, and Google Chat. An online questionnaire was disseminated to all students at the end of the semester to get their feedback. Sixty-six students responded to the questionnaire (54% response rate). The majority of the students (85%) perceived the online TBL positively and reported good interaction and engagement without any major technical issues. They reported that the application exercises and the online discussion through WhatsApp and the use of emoji have helped them to interact and comprehend the topics. Therefore, the use of technologies that operate at low internet bandwidth is an option to provide an equitable access to active learning.

KEYWORDS

team-based learning, digital divide, e-learning, online learning, WhatsApp

1   INTRODUCTION

Public health outbreaks such as the COVID-19 pandemic necessitate the implementation of strict social distancing measures, which force many schools and universities to shift to distance learning [1]. In the current age of the internet and the rapid advances in information and communication technologies, electronic learning (e-learning) is considered a powerful solution for distant or remote learning that enhances the learning experience and supports continuous and self-centered

learning, one of the 21st-century skills that students should master [2]. There are several obstacles that might hinder the usefulness of the e-learning experience that are related to learners, educators, systems, or infrastructure [3].

One of the biggest concerns about e-learning is that it is thought to aggravate the sociodemographic inequalities in educational progress due to the digital divide. Scholars have classified the digital divide into 3 levels: the digital access divide [the inequality of access to information and communication technology] (ICTs) [4] the digital capability divide (the ability to use the technology), and the digital outcome divide (exploiting and benefiting from the ICT access and usage). When conducting e-learning sessions, these three levels should be seriously considered to ensure the success of the experience. Current wireless technologies and the broadband internet provide promises to reduce such divide especially in places with inadequate resources [5].

In fact, the transition to online learning is considered somehow smoother for traditional didactic lecture-based courses. This is because the tutor can simply share a pre-recorded lecture asynchronously or even run lectures synchronously through video-conferencing platforms. It is a bit challenging when the session is an active learning format such as team-based learning (TBL). Such a session needs prior preparation and readiness from the students and educators and is highly dependent on the level of participation and engagement by the students during class [6], [7]. If not done properly, it might increase the 3 levels of digital divide.

TBL is a form of flipped classroom that is learner centered and instructor directed [8]. It combines active learning with collaborative learning to ensure engagement and team interaction. The class time is shifted away from learning facts toward the application and integration of information. TBL sessions rely on providing the learners with pre-class materials that prepare them with the knowledge to use in class. The class time is composed of 3 main tasks: individual readiness test (iRAT), team readiness test (tRAT), and team application exercises (tAPPs). After being provided the reading material, students are commonly asked to solve 10–20 multiple choice questions, the iRAT. Students are then assigned to answer the same questions when working together in teams, the tRAT. Once done, the rest of the session wiis directed toward tAPPs, where application exercises are discussed with frequent questions posted for students, which are answered after a team discussion. Studies reported the efficiency of TBL in improving in-class students' engagement, knowledge acquisition, and learner satisfaction [9]–[11]. TBL in medical education has been growing steadily across different specialties [10]. The existing body of research on the effectiveness of TBL in health profession education has proven its effectiveness, with a reported positive attitude of both educators and learners toward the TBL experience [10].

On the other hand, there is limited evidence on the effectiveness of TBL in the online environment [12]–[15]. Online TBL requires the use of platforms that can facilitate interaction, communication, and discussion. Learners and educators are expected to have a degree of proficiency in the use of these platforms. The rapid transitioning to online learning during COVID-19 made it difficult to ensure all participants were fully prepared beforehand. The pandemic has nudged everyone to implement innovative teaching strategies to ensure the continuation of education, with extra attention toward maintaining learners' interaction, especially in medical fields [16]. Therefore, researchers are sharing their experience with different platforms used during online TBL to evaluate the feasibility of existing digital platforms for successful online TBL sessions. Furthermore, more research is needed to reflect students' and educators' perceptions of online TBL since it is still in its infancy [17].

Studies have found that the use of technology in education did not compromise the students' outcomes when used in online learning, but it might impact their satisfaction and engagement level [18]. It is found to be highly dependent on the type of students, the course, digital competency, and the technology used for the online learning [19].

Here we demonstrate the way we transformed the whole course into online during the emergency remote learning adopted during the COVID-19 pandemic in 2020, using familiar platforms and without the need for extra training or high-speed internet.

2 METHODS

2.1 Context

This cross-sectional study took place in the College of Medicine and Health Sciences at Sultan Qaboos University (SQU). The medical curriculum at SQU is integrated and student centered. It is a 6-year program, organized in three phases: phase 1 (one year) covers the foundation of medical sciences, phase 2 (2.5 years) covers integrated organ-system courses, and phase 3 is a clerkship phase (2.5 years) (Figure 1). This study assessed the implementation of online TBL in an integrated module course, which is taught in phase 2. In an integrated module course both horizontal (among the disciplines) and vertical (between basic and clinical sciences) integration is implemented. The course aims to apply basic science in clinical contexts to encourage application, clinical reasoning, and comprehension. It is composed of 6 clinical topics from 4 different courses running in the same semester: gastroenterology, urinary system, reproductive systems, and nutrition. There are four sessions assigned for every topic, each for 2 hours long, with a total of 8 hours per topic. The course used to be conducted in a live team-based learning format, where about 150 students register for the course every semester. During the pandemic, all TBL activities were converted online (Figure 2).
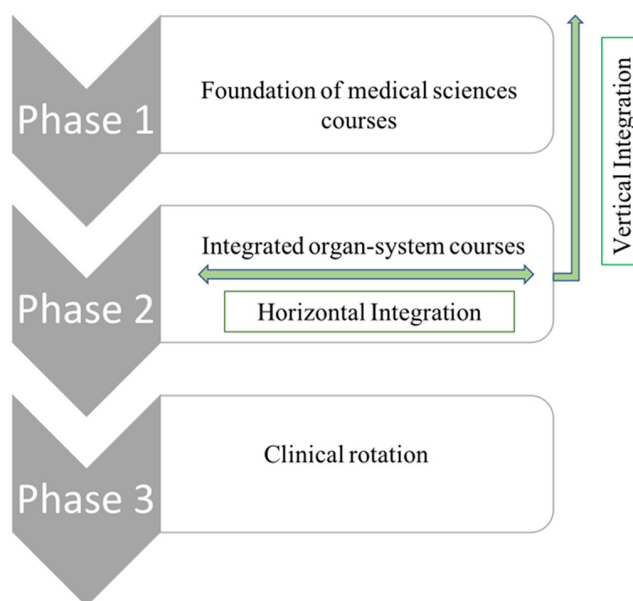

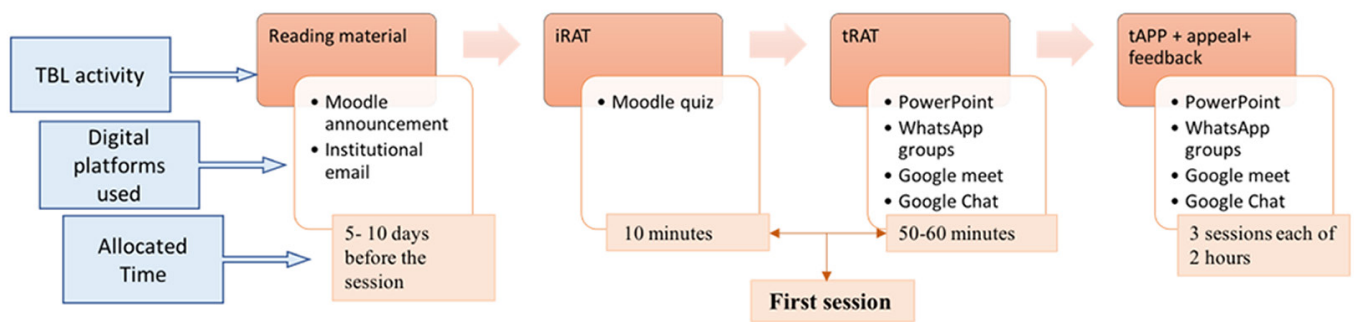**Fig. 1.** Phases of the medical curriculum at Sultan Qaboos University

Fig. 2. Sequence activities in an online TBL

2.2 Online TBL strategy

The online TBL started with the creation of 21 permanent teams composed of 7 to 8 randomly assigned students. The team size and students allocation to teams were done randomly by the course coordinator. The first session is usually for the online iRAT and the tRAT. The tRAT/iRAT questions were constructed by the course coordinator and edited by at least one clinician from the corresponding field of the topic of that session. In a few iRATS/tRAT and tAPPS, one multiple-choice question (MCQ) intentionally included two correct answers to encourage appeals from the teams. The subsequent 3 sessions are dedicated to the tAPPs covering the same topic. Pre-class reading materials in the form of research articles, videos, or assigned pages from a textbook were posted in Moodle (an online learning management system) for the students 5–10 days before the session. The session usually started with an online iRAT timed quiz using Moodle's quiz section.

Once students submitted the iRAT, students joined a Google Meet video conference, where questions for the tRAT were posted one by one, giving the teams time for team discussion. The tRAT questions were the same as the iRAT questions but they were is posted for team discussion instead of individual answers. Students were asked about their preferred platform for online team discussion. Breakout rooms were an option, and they were reported successful for online active learning [20], but they were not feasible for all students due to the inadequate internet quality. WhatsApp was the most accessible and preferred platform by the majority of students. Therefore, WhatsApp was used for this purpose, and 21 separate WhatsApp groups were initiated for the teams to ensure discussion and monitor engagement. To prevent "free-riding," it was mandatory for all students to score $>= 60\%$ in the iRAT to consider the tRAT score. If a student scored less than 60% in the iRAT, then the same score was considered for the tRAT. This was to ensure accountability and proper preparation for the iRAT.

After the team discussion, team leaders posted the team answer in Google Chat simultaneously, and all teams united with the tutor in Google Meet for the feedback session after every question. Afterwards, if there was inconsistency in the team's answers, a member of the team was asked to unmute himself and justify the team's answer. Here a verbal or written appeal was accepted with evidence-based justifications. Once tRAT was over, tAPP sessions started, where students were provided with clinical scenarios followed by MCQs and short-answer questions (SAQs) to encourage team discussion and collaboration. Students were encouraged to apply clinical reasoning to know how to construct an explanation for clinical findings based on their basic knowledge from pre-reading materials. All the students were exposed to the same problem and the same question at the same time to discuss and present their answers simultaneously.

The peer evaluation was omitted because students with slow typing skills and those with slower internet connection felt unfair to be evaluated by their peers who were not disadvantaged. There was a 96.5% attendance rate in the online TBL sessions.

2.3 Preparation for the online TBL

Preparation was essential during the online transfer. Students were given a clear direction on the plan for online TBL. They were informed about the technical requirements, the digital platforms to be used, and the scheduling of the online sessions. Familiarity with the platform is critical to the success of the online sessions and avoid a digital divide. Recent work by DeMesi et al. showed that students' negative perception of online TBL compared with face to face was mainly due to the lack of familiarity with the platform used [21].

Therefore, we tended to use familiar platforms such as WhatsApp and Google Meet for online TBL. The online TBL strategy was piloted in 2 sessions to assess the readiness and familiarity of the students, applicability of chosen digital platforms, and to solve raising challenges. The students needed to practice moving from one platform to another for each TBL activity. The online TBL sessions were implemented for all 6 topics during the course. To improve the experience, weekly feedback from students was collected and considered seriously for improvement. One of the most repeated challenges was the quality of the internet connection for video conferencing and lack of a social physical presence. Establishing a social presence is necessary to enhance online engagement and collaboration. Therefore, the educators always turned their cameras on during all the sessions and communicated promptly through WhatsApp and Google Chat. Turning the students' cameras on was not feasible due to the reported inadequate internet connections. We relied on turning the camera on only for those team members who presented the team answers or raised an appeal. Furthermore, the time given to the tAPP questions was manipulated according to the difficulty of the posted questions instead of allocating the same time for all questions, regardless of the difficulty.

2.4 Study tool

At the end of this online TBL trial, all enrolled students were invited through institutional emails to participate in a modified semi-structured survey that was implemented with permission from [22] to evaluate their experiences and perception. The questionnaire, which was validated earlier, has 22 items and aims to evaluate the students' perception toward the TBL sessions. The questionnaire is composed of six sections: demographics, motivation (6 items), team work (5 items), learning objectives (4 items), knowledge application (3 items), and facilitation (4 items). We have added five qualitative questions to allow students to express their feedback in their own words, (Table 1). The original survey was modified, where the words "online" or "synchronous" were added in different sections to tailor it to online setting. The Likert score was modified into five-point score 1–5 (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree). The study was approved by the ethical committee in the college of medicine and health sciences. Participants were asked for consent and informed about the goal of the survey in the preface of the online questionnaire. Participants were also informed that participation was voluntary, no personal information would be collected, and no harm to their academic performance would be assessed in case of refusal.

Table 1. Online TBL survey questions. A: Quantitative section. B: Qualitative section

A. Quantitative section
Motivation
I prefer TBL to normal lectures
Online TBL strategy motivated me to study hard
I look forward to learn again in an online TBL course.
Online TBL challenged me to give my best.
I felt sad when I missed an online TBL session.
Online TBL had a positive impact on my learning.
Teamwork
Online TBL helped me learn how to study in a group.
I would prefer to be in a mixed-gender TBL team.
I frequently study with my colleagues.
Discussion during synchronous tRATs helped me comprehend better.
Online TBL required more hard work by the students.
Learning objectives
The synchronous iRAT was a good test of my knowledge.
The course materials were essential for the online TBL.
I understood the learning objectives of the TBL.
I was able to achieve the learning objectives set.
Knowledge application
The synchronous tRAT was useful for applying knowledge.
Online TBL promoted understanding rather than memorisation.
Online TBL made me apply what I learned.
Facilitation
The online TBL course is well organized.
I was satisfied with this online TBL approach.
The online platforms used for online TBL was comfortable.
The duration of the online TBL was just right.
B. Qualitative section (open-ended questions)
Please share your views on the following:
1. How was your experience using WhatsApp and Google Chat to work with teams in online TBL?
2. How did teamwork in online TBL affect the quality of your learning?
3. If you have evaluated your team members, how did you find the experience of evaluating your colleagues?
4. In what way do you think online TBL helps your professional development as a future doctor?

Sixty-six students responded to the questionnaire, with a 54% response rate. Internal consistency (Cronbach's alpha) for the 22-item questionnaire response was 0.905 (Table 2). The results reflect that the subscales have an adequate level of inter-item reliability. The motivation subscale had the highest Cronbach score (0.839) while teamwork had the lowest (0.504) (Table 2).

Table 2. Reliability scores of the survey subscales

Subscale	Cronbach's Alpha Score
Motivation	0.839
Teamwork	0.504
Learning objectives	0.839
Knowledge application	0.792
Facilitation	0.86

2.5 Data analysis

A descriptive statistic of mean, standard deviations, frequencies, and percentages was implemented for analysis. An independent-samples t-test and one-way ANOVA were used to investigate if the subscales scores differed significantly by participants' demographics.

3 RESULTS

The demographics of the participants are shown in Table 3. The mean age of the participants was 21 years, with a female-to-male ratio of 2:1. The majority (62%) of the participants had a GPA >3, 27% with GPA 2.5–3, and 11% with GPA <2.5. For all the participating students, it was the first time they were taking the course. Sixty-two percent of the participants had experienced the face-to-face TBL format of teaching in other courses. More than 50% of the participants had experienced online TBL sessions during this semester or earlier. The majority rated their internet connections as "good" during the sessions, without major interruption.

Table 3. Demographics of the participants

Category		Number (%)
Number of participants		66
Age	Mean	21.08
	Range	20–23
Gender	Female	44 (66.7%)
	Male	22 (33.3%)
Cumulative GPA	<2.5	7 (10.6%)
	2.5–3	18 (27.3%)
	>3	41 (62.1%)
Is this your first time taking the course?	Yes	66 (100.0%)
	No	0 (0.0%)
Have you had other online courses in TBL format this semester or previous semesters?	Yes	38 (57.6%)
	No	28 (42.4%)

Overall, the online TBL approach was well perceived by the participating students. The mean Likert score of the different subscales is shown in Figure 3. The average score of teamwork was the lowest, and the learning objective score was the highest. This was not significantly associated with either the GPA, age, or having previous face-to-face or online TBL classes (p-value >.05).
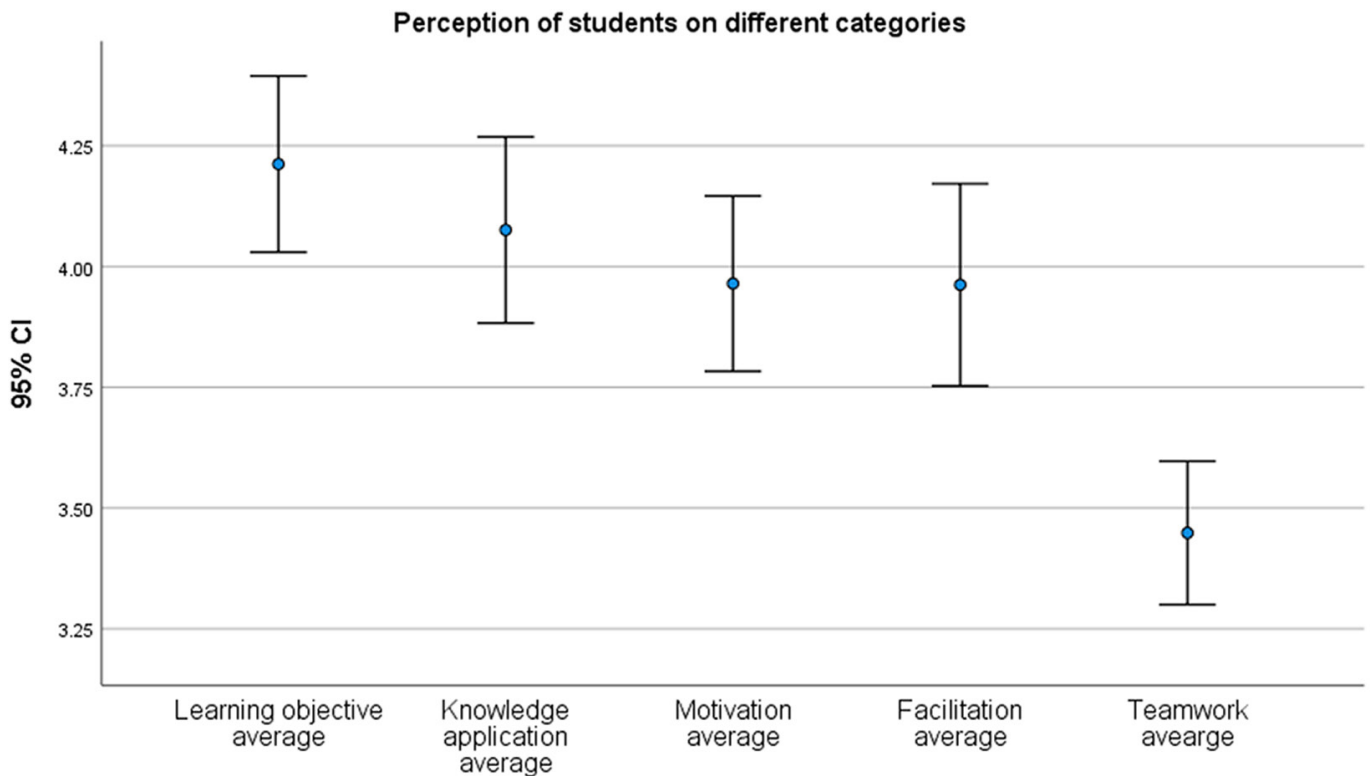

Fig. 3. The mean Likert score of different subscales with 95% confidence interval

The feedback on teamwork issues was reported again in the qualitative part of the questionnaire where students were asked "How was your experience with working in teams during online TBL?". The majority (85%) of the students had perceived it well and thought that WhatsApp had helped them to have a productive team discussion. The other 15% felt it was not convenient and even that it was a distractor and a source of tension and anxiety. They reported a preference for "breakout rooms" since they had experienced them in other courses during the same semester.

The use of Google Meet and WhatsApp, which were very accessible and familiar to the students, helped them overcome the first two levels of digital divide, i.e., the lack of access and skills. When considering the third level, the digital outcome divide, that is usually measured by evaluating the learners' behavioral and psychological engagement. As defined by [23], it is "the behavioral effort that learners expend in e-learning to participate in academic activities, master the knowledge, and pursue high-quality performance." It is closely related to students' persistence in and satisfaction with e-learning [24]. Here, we evaluated their engagement, interaction, and their perception about the experience. The overall perception was positive in the perception of teamwork, deep learning, and professionalism. The majority of the participants (80%) reported that team discussion helped them to get deeper learning and was effective in understanding and clarifying misunderstandings. Twenty percent of the students found it ineffective and that it did not add value to their learning

process since it was online and not real teamwork, as they described it. Almost all of the participants (98%) positively responded that online team discussion and facing the cases for the first time, plus evaluating the patient's scenarios as they arose in real-time, was very beneficial and it had helped them to brainstorm and apply their basic knowledge properly. It allowed them to discuss the scenarios with the team as if it was a real scenario in the hospital and then plan management accordingly. They felt more responsible and more appreciative of the need for strong communication skills with the team members for a better healthcare service.

4   DISCUSSION

e-learning is a comprehensive approach that involves the collaboration, preparation, and commitment of all stakeholders in order to ensure, access, familiarity, and engagement during the online experience. During the rapid shift to virtual learning during the pandemic, social scientists expressed their concern that such rapid transition would aggravate the digital divide across all levels in education, which was the case. This study aimed to evaluate the effectiveness of using multichannel technologies to overcome the digital divide. It was recommended earlier that a collaborative e-learning technologies should be used to ensure machine-human interactions and human-human interactions [25]. Here, we found that the use of multichannels improved the students' engagement and interactions. We intended to implement user-friendly and very familiar platforms in conducting online TBL sessions. WhatsApp is a widely used social platform that does not need any extra training and can work efficiently, even at low internet bandwidth.

TBL mainly aims to allow students to be actively involved in their learning process and to ensure social interaction, which is a critical element of the learning and development process according to the zone proximal development concept (ZPD). ZPD is a concept that necessitates a proper social interaction between the learners and educators to ensure a deeper acquisition of the transferred knowledge [26]. Furthermore, social cognitive theory states that proper learning can happen only through communicative interactions [27]. Knowing that the benefits intended from TBL are largely dependent on the social interaction at two levels—learners-learners and learners-educator—a successful online TBL should enhance this interaction through the use of available digital platforms without any complication to ensure productive engagement and meeting the needed outcome [28]. This largely applies to medical education, where teamwork is a critical skill for medical students [29].

It is thought that the greatest challenge in transiting a TBL class to virtual is maintaining students' engagement and organizing team discussion and interaction. The proper use of technology might facilitate such engagement and interaction, but it needs continuous, active involvement by the educator to organize the discussion. The absence of body language and direct discussion makes it hard for the educator to figure out any misunderstandings or confusion, or even to assess comprehension and professionalism [13], [30], [31]. In this study, students perceived the whole experience as positive, and the engagement was obviously outstanding. The students' ability to comment, use emojis, and express their opinions in Google Chat and WhatsApp maintained their engagement throughout the sessions and facilitated discussion. They clearly stated that they were highly engaged in the chat discussion and benefited from the real-time feedback from the team members and the instructor. The instructor connected with the students through a variety of interactive information channels such as videos, quizzes, documents, and chat, which collectively worked

perfectly in maintaining their engagement and contributing to the discussion. This proves the cognition theory that "the simultaneous use of text and video enhances the learning experience" [32].

Despite the overall positive perception, this trial was not without challenges. Students reported internet disconnection during some of the iRAT sessions in Moodle, which caused them anxiety. This was addressed by seizing their familiarity with the WhatsApp platform where the quiz link was sent through WhatsApp to avoid disconnection. Furthermore, WhatsApp discussion was not perceived well by some students, especially those with slow typing skills. WhatsApp was evaluated earlier for educational purposes, and studies have reported its effectiveness in improving learners-learners and learners-educator interaction and in continuation of education during COVID-19, in general, and in medical education, specifically [33]–[35]. The great benefit of WhatsApp is the feature of instant messaging to strengthen communication and discussion, which makes it an inevitable tool to merge in the medical education.

This study highlights the feasibility of conducting online TBL through the use of several digital platforms that are familiar to students and does not requires strong internet bandwidth. It reflects on the readiness of both the educator and learners to adopt fast digital solutions for the continuation of education. It further proved the possibility of combining different platforms to better conduct the education session to enhance interaction, engagement, and knowledge acquisition. This trial will pave the road toward the implementation of online TBL post–COVID-19 crisis. TBL sessions can be implemented in a blended form, where existing digital platforms can be used at different stages of TBL. It has been tried earlier by River et al., and students had a mixed perception for such a blended model of teaching [36]. Overall, Anas et al. reported that TBL can enhance the learning experience, regardless of the mode of delivery [37].

5   CONCLUSION

Collectively, the evidence so far is proving the feasibility and effectiveness of online TBL in medical education. The existing infrastructure and the prior experience of the students and instructors might be the main determinant of the platforms to be used. During the pandemic, different platforms have shown their robustness to ensure the continuation of active learning strategies. This indicates that online TBL can provide an opportunity for medical education continuation during a crisis or to provide a connection between the learners and educators, regardless of their geographical location. This experience can be improved with more training and be practiced even during semesters in non-crisis times, where online TBL can be blended with live sessions.

6   LIMITATIONS

There were unavoidable limitations in this study. The relatively small sample size of the participants hindered the generalization of the findings. Selection bias cannot be excluded as participants who completed the survey might be primarily the ones who had a good experience and were doing well in their studies. Perception and attitude surveys provide part of the feedback to online TBL, and a robust empirical study is needed to evaluate the influence of online TBL on students' performance and outcome.

7 STATEMENTS AND DECLARATIONS

7.1 Funding

7.2 Competing interests

The author has no relevant financial or non-financial interests to disclose.

8 ACKNOWLEDGEMENT

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10   AUTHOR

Adhari AlZaabi is a physician-scientist with an MD-PhD in early cancer detection and prevention. With a keen interest in emerging technologies in medical education, she has been at the forefront of integrating AI and related ethics into the medical curriculum at her institute. Additionally, she has played a pivotal role in the adoption of team-based learning, being among the first faculty members to implement it in the medical curriculum.