



Review

A systematic review of online team based learning approaches in health professional education

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ABSTRACT

Aims and objectives: The purpose of this study was to systematically review studies related to the use of online Team Based Learning (TBL) platforms with a focus on health professional education. The objectives were to identify best practices, highlight what technological platforms are effective for TBL processes and evaluate educational outcomes in terms of student experience, learning and preference.

Design: A systematic review of published TBL research was undertaken between August and October 2021 and supplemented in September 2022.

Data sources: ERIC, PsycINFO, Scopus, Embase, Medline, and Cinahl databases were used. The keywords were identified from researchers' knowledge and PICO/PICo framework.

Review methods: Titles and abstracts were screened individually by two reviewers for eligibility. Data extraction was undertaken by two researchers independently and checked for consistency by discussion between the two. Articles were appraised using the Mixed Methods Appraisal Tool (MMAT).

Results: Out of 656 articles 14 were involved in the final review. All others were rejected due to duplication, ineligibility, or poor quality. The studies were from a range of countries and focussed on a range of health professionals including nursing. Inconsistencies in approaches for TBL, platforms used and mixed results in terms of outcomes were noted. There was no real consensus other than that TBL was equally as effective if carried out online or face-to-face, with no clear differences to outcomes related to satisfaction in online or traditional TBL approaches.

Conclusions: It is recommended that further research is carried out into the outcomes of TBL on learning and experiences of students in health professional courses. The development and appraisal of integrated TBL platforms should be invested in and infrastructure and resources are put in place to support this.

1. Introduction

For several years now, Team Based Learning has been growing in popularity as a pedagogical approach to develop active learning among students (Ruder et al., 2021). Parrish et al. (2021) argue that Team Based Learning is designed to engage and motivate students within collaborative, structured approaches, using instructional frameworks which require individual preparation and application of material by teams. It is an approach which has been used extensively within the educational programmes of health professionals in recent years as the application aspect of the process make it appealing to health professional educators (Langer et al., 2021).

For universities, without a strong online presence, the COVID-19

pandemic meant that universities on a global level had to quickly re-organise and re-structure their approaches to learning and teaching to maintain their viability and respond quickly, moving many courses into an online domain (Crawford et al., 2020). For those employing face-to-face Team Based Learning as a pedagogy, hasty decisions had to be made about how to move into a mainly online domain whilst maintaining the benefits of individual work, teamwork, active learning, and transferable collaborative skills.

Parrish et al. (2021) suggest that critical thinking and problem-solving are addressed in online learning, but that communication and teamwork are less developed, supporting the need to examine these challenges in using Team Based Learning online. A systematic review by River et al. (2016) suggested there is a paucity of relevant research

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studies related to online delivery of Team Based Learning and a notable lack of supporting evidence for the blending of technology into Team Based Learning approaches, particularly in nursing. Since the [River et al. \(2016\)](#) review, higher education has experienced a much more widespread move to online learning due to the pandemic ([Crawford et al., 2020](#)), however it is acknowledged that some programmes and educational approaches were using online approaches and blended learning before 2020.

The aim of this study is to systematically review studies specifically related to the use of online Team Based Learning platforms with a focus on health professional education. The goal is to identify best practices and evaluate educational outcomes in terms of student experience, learning and preference related to Team Based Learning delivered using online technologies.

2. Background

Team Based Learning is an active learning approach that aims to promote learning via a structured sequence of phases including individual preparatory work, teamwork, immediate feedback, and application of knowledge into practice ([Levine and Hudes, 2021](#)). These stages are identified as the preparation phase, the readiness assurance phase, the application phase, and followed by peer evaluation ([Roossien et al., 2022](#)). Due to this structured approach, students are prepared for working in teams, synthesising, applying information, and developing transferable communication skills ([Burgess et al., 2021](#)).

The preparation phase requires students to independently access learning materials and resources provided by their instructors, either physically or within virtual learning environments (VLE) such as books, articles, videos, and exercises. The readiness assurance phase requires them to then undertake individual and team readiness assurance tests (iRAT and tRAT), where the 'immediate feedback assessment technique' (IF-AT) is used. This provides a simplistic, yet a quick way, to provide feedback and enhance social learning ([Schmulian and Coetzee, 2019](#)). The aspects students didn't answer correctly, or disputed during these processes, can then be discussed, and clarifications sought with the teacher. The final phase is the application phase (tAPP), where knowledge is applied to scenarios relevant to their field, by way of a case study/scenario. The same significant problem is given to each of the teams within the whole class, to promote demonstratable problem solving, critical thinking and teamwork. Peer evaluations are used to demonstrate accountability and feedback on the quality of contributions to the team ([Parrish et al., 2021](#); [Simkins et al., 2021](#)).

In a systematic review conducted by [Swanson et al. \(2019\)](#) Team Based Learning demonstrated a moderately positive effect on the content knowledge of the students when compared to traditional methods of teaching. [Ngoc et al. \(2020\)](#) in their review on performance in the readiness assurance tests phases of Team Based Learning, demonstrated that students' results were significantly higher in the tRATs compared to the iRATs, suggesting positive collaboration, dialogue, and engagement with others. [Dearnley et al. \(2018\)](#) similarly suggested that the application of Team Based Learning led to moderately positive outcomes in performance, particularly for lower achieving students. [Chen et al. \(2018\)](#) in their meta-analysis showed significant improvements in students' positive attitudes towards their learning after exposure to Team Based Learning approaches. A study by [Burton et al. \(2021\)](#) found that students showed moderately positive results in learning, engagement, and satisfaction scores, and the Team Based Learning experience was preferred when compared to traditional lectures. [Burgess et al. \(2019\)](#) using community of practice theory as a framework suggested that the Team Based Learning approach created a situation whereby students were engaged in enriching and rewarding learning environments where they were able to show motivation, and application of knowledge and learning. [Simkins et al. \(2021\)](#) suggested that the combination of the structured approaches used in Team Based Learning within a comprehensive course design makes Team Based Learning a potentially

powerful learning and teaching strategy.

At the time of these reviews many universities utilised face-to-face Team Based Learning approaches in classroom settings. One of the cited benefits of Team Based Learning has been its cost-saving whilst instructing large groups, whereby a single facilitator can manage multiple groups within larger lecture-type settings ([Hawkins, 2014](#)). Due to the COVID-19 pandemic in 2020, those universities that facilitated face-to-face Team Based Learning classes had to reconsider their approaches and strategies to remain economically viable. To support effective learning and teaching experiences for students under difficult circumstances, these universities had to quickly respond, with many organisations hastily adopting online delivery methods ([Crawford et al., 2020](#)) for classes previously offered in face-to-face mode. As [Moja \(2021\)](#) highlighted, higher education institutions had to rapidly reimagine their daily activities and organisational leadership had to be shown, so emergency measures were taken to ensure that students could continue to progress with their academic studies. To facilitate a continuation of learning, students were required to be taught online from home. This affected the choices of pedagogies available to teachers in online situations. Given the structured nature of Team Based Learning, its organisation and management were a consideration that needed to be made.

[Silva et al. \(2022\)](#) in a comparative study found that using Team Based Learning synchronously in an online setting as a response to the pandemic was received favourably by students. [Anas et al. \(2022\)](#) found that attendance, irrespective of delivery mode, face-to-face or online, enhanced the performance of health professional students in coursework and exams, evidenced in student evaluation score increases for satisfaction.

This review aimed to appraise the literature available on Team Based Learning in online situations in a systematic way, to facilitate a comprehensive understanding and synthesis of qualitative, quantitative, and mixed methods sources. A secondary aim was to evaluate the platforms used to support online Team Based Learning.

3. Methods

Drawing from quantitative, qualitative, and mixed methods sources, a systematic review was undertaken to address the study aims. The review questions were: 1. What are the best practices in online Team Based Learning delivery? 2. What technological platforms are effective for Team Based Learning processes? 3. What are the educational outcomes from online Team Based Learning approaches? Studies employing quantitative, qualitative, and mixed methodologies were included in the review if they met the inclusion criteria. This strategy was deemed important to ensure a breadth of review and a comprehensive synthesis of available evidence. See [Table 1](#) for inclusion/exclusion criteria.

3.1. Search strategy

To create a robust search strategy that identified relevant keywords, the process was guided by the 'Patient/Participant/Population; Intervention/Exposure; Comparison; and Outcome' (PICO) framework, for

Table 1
Inclusion and Exclusion Criteria.

Inclusion Criteria	Exclusion Criteria
<ul style="list-style-type: none"> Peer-reviewed journal articles Published in English Published between 2016 and 2022. Primary empirical studies Team Based learning focus Focussed on health professional education Using various forms of online technology. 	<ul style="list-style-type: none"> Non Peer-reviewed In a language other than English Published before 2016. Non empirical, Lacking a TBL focus, Non-health professional related Not using online technology.

quantitative studies, and 'Population/Problem; Interest and Context' (PICO) framework, for qualitative studies (see Table 2). The mix of these frameworks provided a focus regarding online Team Based Learning delivery whilst also acknowledging studies with comparisons to face-to-face approaches. Primary research studies were located in ERIC, PsycINFO, Scopus, Embase, Medline, and CINAHL databases between August and October 2021 and a repeat search was also conducted in September 2022.

An expert librarian supported the search strategy undertaken. An initial search in Embase gave an understanding of keywords used in educational and health databases. The key terms guiding the search strategy were: AB (tbl OR 'team based learning' OR 'team-based learning' OR 'collaborative learning') AND TI (tbl OR 'team based learning' OR based learning' OR 'Collaborative learning') AND AB (online OR distance OR web-based OR e-learning OR virtual OR technology), with limiters – Scholarly (Peer Reviewed) Journals; Date of Publication: 01.01.2016–30.09.2022. This date restriction was chosen to identify any relevant method/technology used to deliver online Team Based Learning, that was published after the systematic review by River et al. (2016). This strategy supported the identification of additional terms as well as MESH Subject Heading (MeSH) to facilitate a breadth of literature capture.

The reporting of the search strategy was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page et al., 2021). Following duplicate removal, two authors independently manually screened all retrieved articles online by title and abstract. Any disagreements were discussed until consensus was achieved. This process was repeated for the full text review with further decision by the two authors. When eligibility of a study was unclear, this was saved in a 'maybe' section for full text screening.

4. Results

The searches in the different databases retrieved an initial 656 studies. Following the removal of 181 duplicates, and a further 448 following 'title and abstract' screening for eligibility against the inclusion and exclusion criteria, twenty-seven studies were included and retrieved for full-text appraisal. Of those, a further eleven studies were rejected for not meeting the inclusion criteria, leaving a total of sixteen. The PRISMA flowchart presents the search strategy and refining processes in Fig. 1. Reasons for exclusion at the full-text stage included non-empirical studies ($n = 4$), non-TBL focus ($n = 3$), non-health professional focus ($n = 1$), and non-online delivery ($n = 4$). Two further articles were also rejected following appraisal due to poor quality and lack of clarity. A total of fourteen studies were finally included in the review dataset.

Table 2
PICO/PICO Eligibility Criteria.

Criteria	Definition
Participants	Tertiary health profession related students, Tertiary health course teachers/professors/faculty taking part or conducting Team Based Learning (TBL) in an online platform.
Intervention/ Interest	Any technology used to facilitate the delivery of online TBL. Or experience of participants using technology to facilitate delivery of online TBL.
Control/ Context	Same course delivered in a different format. Studies without a control were also eligible for inclusion if the other criteria were met.
Outcomes	Student and staff (teachers) experience of online delivery. Student learning and health professional education.
Other studies	All study types were considered – experimental, survey or observational, and mixed methods designs.
Other	Search was limited to articles published between 2016 and 2022. This date restriction was chosen to identify any relevant method/technology used to deliver the online TBL, that was published after the systematic review by River et al. (2016), that examined the effectiveness of blended-TBL in higher education health disciplines.

4.1. Quality appraisal

4.1.1. Quality assessment

The Mixed Methods Appraisal Tool (MMAT) was adopted to assess the quality of the retrieved studies. It is a validated tool developed for assessing the methodological quality of empirical mixed methods studies in a review to ensure they are trustworthy, valid, and reliable (Hong et al., 2018; Pace et al., 2012). Two authors independently assessed and discussed the quality of each source using the MMAT tool. Fourteen of the articles selected did meet the MMAT criteria for studies. Arcila Hernández et al. (2021) showed a lack of clarity in relation to the adopted research approach, data collection and analysis methods, Chu et al. (2019) showed a lack of clarity related to selected variables and had little mention of the Team Based Learning approach used, hence these two articles were rejected. Other articles were deemed sufficiently rigorous to be included in relation to design, data collection, analysis and interpretation, although there were inconsistencies in some studies related to non-response bias (Coyne et al., 2018; Ganotice and Chan, 2019; Yu et al., 2021; Silva et al., 2022), and poor identification of confounding variables in their designs (Anas et al., 2022; DeMasi et al., 2019; Franklin et al., 2016; Hsieh et al., 2022). The final fourteen articles were included on the basis that they did propose clear research questions and collected data that would allow for those questions to be answered. See Table 3.

Data extraction was documented independently and checked for consistency by the two reviewers. The final articles for review were searched and citations checked to capture a comprehensive review of available articles. Extracted data included author(s), country, health discipline, sample, design, aims of study, use of online technology, student/staff experiences and educational outcomes (see Table 4).

4.2. Location and methodologies

The final analysis included fourteen studies, five (36 %) were conducted in the United States of America, two (14 %) in Hong Kong, and one each in Australia, India, Japan, Portugal, Saudi Arabia, Taiwan, and the United Kingdom (7.14 % respectively). A variety of research designs were employed. Seven used survey methods (Al-Neklawy and Ismail, 2022; Coyne et al., 2018; Ganotice and Chan, 2019; Gazave and Hatcher, 2017; Govindarajan and Rajaragupathy, 2022; Silva et al., 2022; Yu et al., 2021); Two used quasi experimental designs (Anas et al., 2022; Hsieh et al., 2022); Two used descriptive comparative designs (DeMasi et al., 2019; Franklin et al., 2016); There was one micro-ethnography study (Bridges et al., 2020) and 2 mixed methods studies (Currey et al., 2020; Shimizu et al., 2022). Five (36 %) studies were published before the pandemic and nine (64 %) during or shortly after it.

4.3. Samples

There were discrepancies in terms of the sample sizes of participants in the studies. Across all the articles there was a total sample of 2567 of which 2541 (99 %) were students and 26 (1 %) were faculty members. Three studies, Bridges et al., 2020, Currey et al., 2020, and Yu et al., 2021, included faculty as part of their studies. Coyne et al. (2018) had 18 participants, while Ganotice and Chan (2019) had 531 participants. The mean sample size was 187.

4.4. Health professional disciplines

The online Team Based Learning experience of a range of health professional disciplines were examined including biological sciences, Chinese medicine, medicine, nursing, optometry, pharmacy, psychology, engineering, and communication science. Comparative methods were adopted to examine Team Based Learning effectiveness across health disciplines within some studies (Al-Neklawy and Ismail, 2021; Currey et al., 2020; Silva et al., 2022). Bridges et al. (2020) and Ganotice

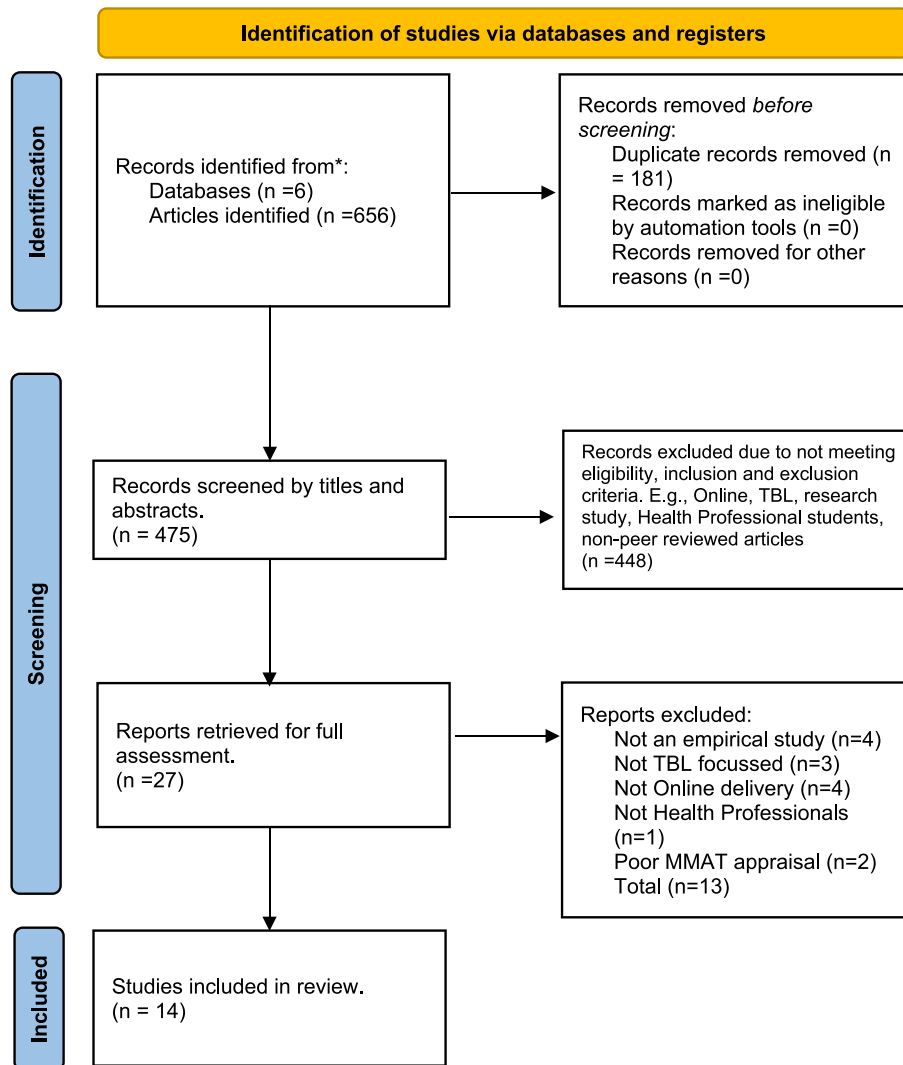


Fig. 1. The PRISMA flowchart for databases and registers.

and Chan (2019) utilised interprofessional groups, and the remaining studies focused on single health professional disciplines including biomedical/life sciences, medical sciences, pharmacy, and medicine.

4.5. Programme descriptions, length, and settings

There were differences in the length and number of the Team Based Learning sessions deployed. In some of the articles the number of sessions undertaken were unclear (Al-Neklawy and Ismail, 2022; Anas et al., 2022; Ganotice and Chan, 2019; Yu et al., 2021). Some studies were based on one single Team Based Learning session only (Bridges et al., 2020; Coyne et al., 2018). The remaining studies reported a minimum of two sessions to a maximum of thirty, across a single semester, or across a module/course. The average number of sessions was ten.

4.6. Best practices for team based learning

There were many differences in the approaches used in the delivery of Team Based Learning, although the studies selected did utilise the traditional approaches developed and espoused by Michaelsen et al. (2004) (Preparation, iRAT, tRAT, IF-AT, tAPP, appeals and clarification, and peer evaluation). The study by Yu et al. (2021) did not provide explicit detail about the Team Based Learning approaches used. The

studies by Coyne et al. (2018), DeMasi et al. (2019), and Gazave and Hatcher (2017) suggested that they used a ‘modified’ Team Based Learning, or Team Based Learning ‘with exceptions’ approach, where they changed some aspect of the processes, but mostly followed the traditional model. Bridges et al. (2020), Currey et al. (2020) and Ganotice and Chan (2019), specifically mentioned that they conducted peer review as per the traditional approach, but this was not utilised or highlighted in other studies.

It appears that approximately 90–120 min was the range of time in which the whole of the Team Based Learning process was undertaken (Coyne et al., 2018; DeMasi et al., 2019; Franklin et al., 2016; Gazave and Hatcher, 2017; Govindarajan and Rajaragupathy, 2022; Hsieh et al., 2022; Shimizu et al., 2022). The longest Team Based Learning process undertaken by Bridges et al. (2020) was three hours and forty minutes. The remaining six studies did not specify times.

4.7. Technological platforms used in team based learning

Throughout the studies, there were twenty-six mentions of online technological platforms or software employed to facilitate Team Based Learning processes. These were used as a repository for students to access the preparatory materials, a tool for completing iRAT and tRAT, or a platform for full group working or working in their teams to complete the tRAT and application exercises. The main learning management

Table 3
MMAT for all study types.

MMAT (quantitative descriptive studies)	Yes	No	Can't Tell
Are there clear research questions?	6		
Do the collected data allow to address the research questions?	6		
Is the sampling strategy relevant to address the research question?	6		
Is the sample representative of the target population?	6		
Are the measurements appropriate?	6		
Is the risk of nonresponse bias low?	1	1	4
Is the statistical analysis appropriate to answer the research question?	6		
MMAT (quantitative non-randomised)			
Are there clear research questions?	5		
Do the collected data allow to address the research questions?	5		
Are the participants representative of the target population?	5		
Are measurements appropriate regarding both the outcome and intervention (or exposure)?	5		
Are there complete outcome data?	5		
Are the confounders accounted for in the design and analysis?			5
During the study period, is the intervention administered (or exposure occurred) as intended?	4		1
MMAT (qualitative studies)			
Are there clear research questions?	1	1	
Do the collected data allow to address the research questions?	1	1	
Is the qualitative approach appropriate to answer the research question?	1		1
Are the qualitative data collection methods adequate to address the research question?	1		1
Are the findings adequately derived from the data?	1		1
Is the interpretation of results sufficiently substantiated by data?	1		1
Is there coherence between qualitative data sources, collection, analysis, and interpretation?	1		1
MMAT (mixed methods studies)			
Are there clear research questions?	3		
Do the collected data allow to address the research questions?	3		
Is there an adequate rationale for using a mixed methods design to address the research question?	2		1
Are the different components of the study effectively integrated to answer the research question?	2		1
Are the outputs of the integration of qualitative and quantitative components adequately interpreted?	3		
Are divergences and inconsistencies between quantitative and qualitative results adequately addressed?	2		1
Do the different components of the study adhere to the quality criteria of each tradition of the methods involved?	3		

system highlighted was 'Blackboard' ($n = 4$; 50 %) with 75 % ($n = 3$) of these including the use of 'Collaborate' (Al-Neklawy and Ismail, 2022; DeMasi et al., 2019; Gazave and Hatcher, 2017; Silva et al., 2022). Some studies ($n = 3$; 38 %), outlined using bespoke learning management systems (LMS) (Bridges et al., 2020; Franklin et al., 2016; Ganotice and Chan, 2019). The latter had developed a bespoke Learning Activity Management System (LAMS) which they claimed functioned to manage the "complex but structured Team Based Learning Process" (Ganotice and Chan, 2019, p. 212). Currey et al. (2020) used 'Intedashboard', a bespoke platform for Team Based Learning that incorporates functions for all the stages in the Team Based Learning process.

As well as Collaborate ($n = 3$; 23 %) and Intedashboard ($n = 1$; 8 %) other virtual meeting apps were also used, namely Zoom ($n = 5$; 38 %), (Anas et al., 2022; Govindarajan and Rajaragupathy, 2022; Hsieh et al., 2022; Silva et al., 2022; Yu et al., 2021); Teams ($n = 1$; 8 %), (Shimizu et al., 2022); Adobe Connect ($n = 1$; 8 %), (Franklin et al., 2016), and Second Life (16 %) a virtual reality platform where students access a shared virtual space, (Coynne et al., 2018; Gazave and Hatcher, 2017).

There were several applications used for the iRAT and tRAT-tests. These included Blackboard ($n = 3$; 30 %) (Al-Neklawy and Ismail, 2022; DeMasi et al., 2019; Gazave and Hatcher, 2017), and Google forms ($n = 3$; 30 %) for the test elements (Govindarajan and Rajaragupathy, 2022; Hsieh et al., 2022; Yu et al., 2021). However, there was little clarity in how the branching/alternative answers approach was used in the immediate feedback assessment technique (IFAT) for the tRAT. Some 'Audience Response System' applications were also used. Anas et al. (2022) and Yu et al. (2021) used the 'Poll Everywhere' application for the tests, which can also be used as a virtual meeting space. Yu et al. (2021) used Kahoot, which is an audience voting system. Silva et al. (2022) used Vox Vote for testing. Franklin et al. (2016) used the quiz element of the Sakai LMS for their testing.

4.8. Educational outcomes

There were mixed results in relation to student experiences although a number ($n = 7$; 50 %), directly reported positive experiences for the students in relation to virtual Team Based Learning (Al-Neklawy and Ismail, 2022; Anas et al., 2022; Coyne et al., 2018; Currey et al., 2020; Govindarajan and Rajaragupathy, 2022; Hsieh et al., 2022; Silva et al., 2022). Bridges et al. (2020) although not directly reporting overall positive experiences outlined that the process had led to an increase in social cohesion across professional groups. Similarly, Franklin et al. (2016) noted an elevated level of interdependence forming through engagement in the Team Based Learning process. Ganotice and Chan (2019) noticed positive psychological links between Presage (perception), Process (experiences) and Product (outcomes) from Team Based Learning. Gazave and Hatcher (2017) observed that although there was no difference in engagement between males and females, males were more comfortable with the Team Based Learning process.

Some studies pointed out issues and challenges with the virtual process. Currey et al. (2020) found that despite student positive experiences and engagement, student evaluations suggested students preferred the face-to-face approach. DeMasi et al. (2019) also indicated a preference for face-to-face approaches. Franklin et al. (2016) suggested there were some perceptions of lower levels of teamwork, and the authors pointed out that although online delivery is a useful approach, it is time consuming and costly to develop, requiring organisational support and the need to improve digital literacy. Similarly, Yu et al. (2021) found that there was decreased motivation and engagement because of a lack of training, preparation, the sudden transition to online Team Based Learning, and that it created logistical and technical challenges. Shimizu et al. (2022) found that there were recognised limitations in nonverbal communication aspects within the online Team Based Learning approach but highlighted that these were compensated for by increased verbal communication. Govindarajan and Rajaragupathy (2022) suggested that the phase of peer evaluation needed to be developed further. The efficiency and sustainability advantages of online Team Based Learning were noted in several reviewed studies (Al-Neklawy and Ismail, 2022; Bridges et al., 2020; Currey et al. (2020) and Coyne et al. (2018) commented on the advantage of being able to use a Team Based Learning in a distance learning-based approach.

In terms of student outcomes there was consensus that online Team Based Learning approaches supported improvement in performance. There were no significant differences found between overall student performance in both face-to-face and online Team Based Learning classes (Currey et al., 2020; Gazave and Hatcher, 2017; Govindarajan and Rajaragupathy, 2022; Shimizu et al., 2022 and Silva et al., 2022). Franklin et al. (2016) highlighted higher levels of interdependence, comparative scores in iRAT, and increased tRAT scores in the online cohort. DeMasi et al. (2019) reported improved outcome scores, while Anas et al. (2022) found enhanced exam and course work performance outcomes compared to the traditional approach, and Hsieh et al. (2022) reported significant post test scores.

There were two mixed method studies included which adopted a

Table 4
Data Extraction Table Key: Team Based Learning (TBL).

Author	Country	Health Discipline	Sample	Design	Aim of study	Study duration	Use of TBL online technology	Student/staff experience	Educational outcomes
Al-Neklawy, A. F. and A. S. A. Ismail (2021).	Saudi Arabia	Medicine, Nursing, D pharmacy.	Medicine ($n = 40 + 76$), Nursing ($n = 19$), D pharmacy (10).	Online Survey (30 Likert questions) and t-tests.	To evaluate the effect of online TBL on recall, engagement, and satisfaction among students in anatomy teaching on different programs	1 module (per profession) Unclear whether this is one or more sessions?	Blackboard and collaborate	Positive responses to experience of online TBL All responses in this study showed a statistically significant positive difference from the neutral mid-point response ($p < 0.05$). There were no significant differences among the mean responses of students on different programs for any question in the survey ($p > 0.05$).	None investigated but evidence was obtained of successful e-learning in conducting challenging interactive teaching strategies such as TBL
Anas et al. (2022)	UK	Biomedical/life sciences	Students 53 (21 f2f; 32 online).	Quasi experimental design	to investigate whether TBL can be incorporated (in-person or online) in a complex study block on endocrine disorders, if there are benefits from this approach for the learning experience/performance of undergraduate biomedical students, and whether the mode of delivery during the COVID-19 pandemic impacts on the overall performance.	Unclear optional sessions	Zoom, Poll everywhere	Positive experience and recommendation for use online	Enhanced performance in exams and course work compared to traditional
Bridges et al. (2020)	Hong Kong	Interprofessional	Undergraduate students 437, disciplinary experts/facilitators 9	Micro ethnography	To investigate how newly formed interprofessional groups synchronously engage with both face-to face and online learning processes in a large-scale multi-group TBL environment	3-h session	Face to Face and purpose designed learning management system (LAMS)	Social cohesion in interprofessional groups	Speed of answering application exercises
Coyne et al. (2018)	USA	Pharmacy	students 18	Survey	The aim of determining (1) the level of immersion and perceived engagement that students experience while working on application exercises in VR, (2) comfort level with currently available VR technology and (3) desirability of VR-TBL experiences.	1 session	Use of VR for application exercise	Positive experiences	Can be used in distance TBL
Currey et al. (2020).	Australia	PG Nursing and optometry	Students 121 (nursing 85, optometry, 36), faculty 8	Prospective Mixed methods survey pre and post comparison of students and educators transitioning from	To determine whether it was possible to improve the efficiency of delivery of TBL in a university setting, using a D-TBL platform	13–30 sessions across an 11-week trimester	Intedashboard iPad	Positive experience increased engagement the student evaluation suggests students prefer face to face.	Improved efficiency: DTBL improves the sustainability of TBL activities. The results from RATs suggest no

(continued on next page)

Table 4 (continued)

Author	Country	Health Discipline	Sample	Design	Aim of study	Study duration	Use of TBL online technology	Student/staff experience	Educational outcomes
				traditional paper-based TBL to D-TBL					significant differences between outcomes for online or in class, suggesting online approaches are equally useful for TBL.
DeMasi et al. (2019).	USA	Medical/Sciences: Immunology course	Students 55 (36 pre-med; 13 biology; 6 pharmacology)	Descriptive comparative. Groups used both online and face to face TBL and results were compared.	to examine the effectiveness of TBL in classroom-based versus online formats: examining student learning outcomes, preferences, and satisfaction; To compare student learning outcomes and preferences using a modified team-based learning (TBL) approach in classroom-based versus online formats in an upper-level undergraduate immunology course	4 modules 25 sessions @75 mins per session	Blackboard and collaborate	Preference for face-to-face discussion	Improved outcome scores
Franklin et al. (2016)	USA	Pharmacy	Students 292 (222 online; 70 F2F)	Descriptive comparative. Groups were placed into either online and face to face TBL and results of iRATs and tRATs were compared. Perceptions of teamwork, competency and interdependence was evaluated by Survey.	To compare the effectiveness of face-to-face and online team-based learning (TBL) to teach phenytoin pharmacokinetics. To determine whether face-to-face or online TBL better improved learner's understanding and application and a learning management system (LMS) could achieve comparable results to classroom instruction for learning content and making team decisions.	11 @2-h sessions	Sakai LMS and Adobe connect	Learners in online cohort perceived lower levels of teamwork. High levels of interdependence in all cohorts. Comparative scores in RAT results. Online cohort performed better on the tRAT. Online is useful but time consuming and costly to develop, Needs organisational support. Improved digital literacy	Comparative results increase in Trat
Ganotice and Chan (2019).	Hong Kong	Interprofessional	Students 531 (Chinese med 23; Med 195; nursing 210; Occ Therapy 8; Pharmacy 62; Social work 33)	Correlational surveys and path analysis	To examine the structural relationships of perceived presage, process, product (Biggs 3P)	Unclear 1 session? 1 module?	Learning Activity Management System (LAMS)	Identified links between presage, process, and product	Students who enjoy Computer learning and achievement
Gazave and Hatcher (2017).	USA	Medicine	Students 39	Surveys and content analysis of transcripts. Class participation for behavioural engagement.	To evaluate the level of engagement (behavioural, cognitive, social, emotional) of students in an anatomy course. Will it (virtual TBL) also prove to be an engaging strategy for online learning? what type of students would report the greatest	15 sessions @ 90 mins.	Blackboard and Second Life	No significant difference between performance and engagement level. Positive engagement with TBL (7.8/10). Males more comfortable with approach. Bur no differences in levels of engagement between M/F.	Same outcomes despite engagement

(continued on next page)

Table 4 (continued)

Author	Country	Health Discipline	Sample	Design	Aim of study	Study duration	Use of TBL online technology	Student/staff experience	Educational outcomes
Govindarajan and Rajaragupathy (2022).	India	Medical Students	Students 113	Survey	engagement, and whether a student's reported engagement scores would correlate with their demonstrated engagement in class. to implement and evaluate online TBL among first year MBBS students in Biochemistry.	3 sessions	Google forms (IRAT); Zoom	Positive experiences outlined. Peer evaluation needs developing.	Acceptable scores in tests
Hsieh et al. (2022)	Taiwan	Community Healthcare practitioners	CHPs 81 (+21 in focus groups)	Quasi experimental design	to develop a hybrid online TBL model that can be implemented during on-the-job training of CHPs in Taiwan and to evaluate its effectiveness	6 @ 90 min sessions	Google forms (IRAT); Zoom	Positive experience of familiarity, attitude and confidence in subject, and satisfaction with TBL. Some challenges with technology and equipment	Statistically significant post test scores.
Shimizu et al. (2022)	Japan	Medical Students	Quant 75; qual 17 (4 groups)	Mixed methods, survey, and focus groups	comparing online and face-to-face collaborative learning environments in a clinical reasoning class using team-based learning for medical students 1. To what extent does the degree of social interdependence in OCL differ from that in face-to-face environments? 2. What aspects affect social interdependence in OCL?	6 online and 6 f2f	Teams	Nonverbal limitations compensated by increased verbal comms	No significant differences between f2F and online experiences confirming non inferiority of online
Silva et al. (2022)	Portugal	Interdisciplinary including biology & psychology	Students 427 (Biological science 117; communication science 105; engineering 80; Psychology 125).	Survey, close ended questions	to describe the students' perceptions of TBL impact on the learning process, comparing in-class versus online sessions, different scientific disciplines, and gender.	2-8 classes	Blackboard collaborate, zoom, vox vote	A positive perception of TBL. No significant differences in f2f and online	Acceptance of TBL in f2f or online.
Yu et al. (2021).	USA	Pharmacy	Students 154, Faculty 18	Cross Sectional Survey of students (17q) n = 154 and faculty 14q) n = 18.	To describe student and faculty experiences and perceptions regarding the sudden shift to delivery of online team-based learning (TBL) due to the COVID-19 pandemic.	Unclear	Not discussed in depth, mentions zoom, kahoot and google docs.	Decreased motivation and engagement due to lack of training, preparation and sudden online TBL transition.	Logistical and technical challenges

qualitative component. Shimizu et al. (2022) commented on the challenges experienced in communicating when comparing face-to-face and online learning situations. Four themes were identified: communication; task sharing process; the perception of other groups and working facilities. Students identified they had to develop their verbal communication online due to a reduction of observable non-verbal behaviours and therefore manage tasks differently in the online setting. Learning in smaller groups and managing difficulties in identifying progress among other groups was also challenging (Shimizu et al., 2022). Currey et al. (2020) reported on students' positive comments related to digital Team Based Learning. This included the convenience and efficiency associated with online learning compared to face-to-face traditional learning and the immediate feedback processes. Some disadvantages related to the technical difficulties encountered. The micro-ethnographic study by Bridges et al., (2020) focussed on interpersonal and interprofessional dynamics employed during Team Based Learning sessions, concluding that there are challenges in fostering team approaches and cohesion, and the complex measurement of these processes.

5. Discussion

No substantial systematic review of online Team Based Learning approaches since River et al. (2016) has been undertaken. Given the subsequent pandemic period from 2019 to 2022, it was deemed beneficial to appraise Team Based Learning online approaches that proliferated during this time. Chu et al. (2019) had suggested that using flipped classroom techniques (including Team Based Learning) improved the outcomes and experiences of students and that there was a call to education institutions to increase the integration of such methods. This review demonstrates that since 2016 there is still a relative paucity of high-quality research available related to online Team Based Learning, although there is some evidence of further uptake of online approaches, particularly in response to the pandemic. Goh et al. (2020) suggest that adapting to online Team Based Learning delivery requires considered structuring of teaching activities to reduce costs and create effective learning experiences.

A rigorous approach was taken in the searching, appraising, and reviewing of the articles that focused on the online delivery of Team Based Learning for health professional students. The review considered the best Team Based Learning online practices, platforms and applications used, and student outcomes in relation to experiences, performance and learning. It was found that there were few high-quality research studies for review between 2016 and 2022, with many differences in implementing Team Based Learning approaches and platforms, mixed results, and methodological inconsistencies. The key findings of this review suggest that online Team Based Learning students are not disadvantaged in terms of learning nor performance by studying online, compared to more traditional face-to-face methods. Langer et al. (2021) suggest that although Team Based Learning does demonstrate positive outcomes, caution is required in considering longer-term learning effects. Positive experiences were outlined in some studies but there were also findings suggesting a preference for the face-to-face Team Based Learning approach.

There was some inconsistency in the Team Based Learning practices utilised across the studies, with some using a modified approach. Roossien et al. (2022) emphasised that each phase of the Team Based Learning process is important for knowledge development and subsequent learning performance. This would suggest that modified approaches should still include the main phases of Team Based Learning in a structured way to ensure effective outcomes. This was not evident in all studies, as some Team Based Learning processes were omitted due to the modifications.

There was also no real consensus supporting a particular platform to use for Team Based Learning delivery, and several studies had to use a combination of different platforms, software, and modifications to address all Team Based Learning processes. Single platforms or learning

management systems that enabled the integration of Team Based Learning phases and processed in one online place, indicated positive results. The use of different or single platforms in facilitating Team Based Learning and teaching needs to be considered further.

6. Limitations

This study focused on Team Based Learning using online delivery methods and platforms. The search criteria were focused on strict inclusion conditions. Despite the inclusion of qualitative, quantitative and mixed methods studies, findings were reported together, with no separation of the qualitative verbatim descriptors in some studies. There was a lack of methodological consistency and subsequent quality across the studies reviewed. This limited the ability to draw definitive conclusions that answer all the research questions posed in this review and limited generalisation of the findings.

7. Future research

Further research is required to better understand how online Team Based Learning approaches, now adopted as mainstream, impact knowledge, learning processes, academic outcomes, and the perceived experiences of students in health professional courses. Some studies identified the use of an integrated Team Based Learning platform rather than an ad hoc use of applications to facilitate teaching processes. This is worthy of future investigation as there is little literature that appraises how integrated Team Based Learning platforms provide the infrastructure and resources to support online facilitation and enhance student experience.

8. Conclusions

This study aimed to consider the experiences of students, the best practices employed in online Team Based Learning delivery, with the aim of evaluating the use of the platforms used in online Team Based Learning delivery and student educational outcomes. There were no definitive answers that revealed answers to the research questions posed other than an indication that Team Based Learning was equally as effective if carried out online or face-to-face, with no clear differences related to student satisfaction or performance. It is suggested that whether online or face-to-face, the considered structured phased approaches to Team Based Learning should be maintained. There was no conclusive evidence that any single platform best facilitated Team Based Learning facilitation, as most studies had to use a combination of platforms to manage all of the structured phases of Team Based Learning.

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Ethical approval

NA.

CRediT authorship contribution statement

Rob Burton: Writing – review & editing, Writing – original draft, Project administration, Investigation, Formal analysis, Conceptualization. **Ursula Kellett:** Writing – review & editing, Writing – original draft, Project administration, Investigation, Formal analysis, Data curation, Conceptualization. **Martha Mansah:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Deepa Sriram:** Methodology, Investigation, Data curation.

Declaration of competing interest

None.

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