Peer Reviewed **Original Article**

TEAM-BASED LEARNING AS AN APPROACH TO ENHANCE UNDERGRADUATE RADIATION THERAPY EDUCATION: A NARRATIVE REVIEW

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ABSTRACT

Background. Several teaching approaches such as team-based learning (TBL) have been developed with the aim of facilitating active learning. Although TBL's success has been recorded, to the best of the authors' knowledge, its suitability in undergraduate radiation therapy (RT) education has not been studied. This narrative review (NR) sought to establish whether TBL is a potentially suitable teaching approach for undergraduate RT education and whether it contributes to the development of an active, authentic, and inclusive learning environment.

Materials and methods. A narrative review was conducted, and six (6) online databases were consulted using EbscoHost to find studies on TBL. Studies were included if they were in English and were full-text peer-reviewed journal articles published between 2009 and 2019. The findings were summarised and synthesised according to identified key concepts, principles, and features, and integrated into the discussion.

Results. After all duplicates and yields that did not meet the inclusion criteria were excluded, the search resulted in a total of 35 (n=35) papers to be reviewed. The papers reviewed yielded results that demonstrate that TBL could benefit RT education as an inclusive and active learning approach.

Conclusion. Underpinned by constructivism, TBL allows learners to be engaged in the learning process and construct knowledge, with learning that is embedded within a social context. Overall, TBL is a promising approach for RT undergraduate education. However, more scholarly investigations are needed to further demonstrate its suitability and potential for this discipline.

Keywords: active learning, collaborative learning, pedagogy, social constructivism, teams

LAY ABSTRACT

This narrative review turns to the literature to explore TBL as a potentially suitable teaching approach for undergraduate RT education. The review suggests some potential benefits for using TBL in undergraduate RT education, however, more studies are recommended to generate evidence for the use of this teaching approach in undergraduate RT education.

INTRODUCTION

Radiation therapists (RTs) are part of a multi-disciplinary team that cares for people living with cancer. Their training generally involves theoretical and clinical competency components within accredited programmes. Such programmes need to be able to develop healthcare professionals (HCPs) with the necessary knowledge, skills, and attitudes to provide person-centred care in complex environments.[1,2] Further, RT is a rapidly advancing discipline, which requires practitioners to be self-directed and lifelong learners. RT education requires consideration of teaching approaches that

will afford learners the opportunity to actively construct knowledge and become reflective, lifelong learners. The use of such teaching approaches aligns well with health professions' education, which has been evolving in response to changing needs, advances in technology, and efforts to improve the learning experience, inter alia.[3-7]

With this evolution, is a growing emphasis on teaching approaches that are centred around learners and how they learn and promote active learning. Underpinned by constructivism, which acknowledges that learners learn by doing and constructing their own understanding and knowl-

edge of the world through their experiences and reflecting on those experiences,[3] team-based learning (TBL) is considered one such approach. It has been claimed to be a suitable approach for active and learner-centred learning due to its focus on learners and how they learn.[8] Learner-centred learning is learning that focuses on the mental representation of the information by a learner, which is an alternative to the teacher-centred learning whose goal is to transfer information from the teacher to the learner.[8] To the best of the authors' knowledge there is a scarcity of research on the use of TBL in RT education: both conceptual and empirical.

This narrative review (NR) seeks to explore whether TBL is a potentially suitable teaching approach for undergraduate RT education and if it can potentially contribute to the development of an active, authentic, and inclusive learning environment. The review focuses on TBL's concepts, principles, and features for potential use in RT education.

METHODS

This paper is a NR that seeks to explore the suitability of TBL for undergraduate RT education by gathering and integrating theories and principles for the use of TBL. Unlike systematic reviews, narrative reviews do not strictly follow predefined protocols in terms of search methods, inclusion criteria, data extraction and synthesis, and appraisal of sources.[9] They can still be useful in the initial exploration of research areas and topics, especially where producing concrete evidence is not an initial aim. Nevertheless, the rigor of this NR was improved by borrowing from some principles of the systematic review methodology to minimise bias in the selection of articles.[10]

Keywords were used to search for relevant journal articles in online databases. In total, six databases were consulted using EbscoHost as it allowed searching multiple databases simultaneously. The six databases that were consulted were: Academic Search Premier (ASP), Cumulative Index of Nursing and Allied Health Literature (CINAHL), Education Resource Information Centre (ERIC), Health Source: Nursing/Academic Edition, Medline, and PsycArticles. The search focused on health sciences databases because it was important to align it with health sciences education rather than education in general. Two databases for multidisciplinary research (ASP) and education research and information (ERIC) were included.

The sourcing of articles began with a search for articles using the keywords "team-based learning" in the 'title' field. The search was set to look for an exact phrase, meaning that every single word was searched for in its place. The filters were set to include full-text and peer-reviewed papers published between 2009 and 2019. The article search was done in 2019 and considered publications published in the past ten years. The inclusion criteria were scientific papers related to team-based learning and restricted to English language publications. Duplicate findings, book chapters, letters to the editor, and expert opinion papers were the ex-

clusion criteria. The data sourcing process was documented using the preferred reporting items for systematic reviews and meta-analyses (PRISMA) model to guide the selection of studies for this review.[11]

RESULTS

The search initially yielded 175 publications, which were reduced to 94 after excluding all duplicates. Skimming and scanning reading techniques were used to evaluate papers for inclusion in the final review. Forty-three papers did not satisfy the inclusion criteria. A further eight duplicates, two abstracts, two 'tips' articles, one letter to an editor, one book chapter, one guide supplement, and one commentary were found and were excluded. This resulted in 35 research papers to be reviewed. A PRISMA 2009 flow diagram as shown in Figure 1 schematically demonstrates how the 35 journal articles included in the review were sourced. A summary of the data extracted is presented in Table 1.

DISCUSSION

From the results of the review, several key TBL concepts, principles, and features were identified. These encompassed areas relating to the theoretical underpinnings of TBL, the nature of TBL (i.e.,structure and process), the impact of TBL on academic outcomes, and the impact of TBL on learners (i.e.,their perception and experience of TBL and related behavioural aspects). These key concepts, principles, and features are discussed below with some considerations on how they could be useful for RT education.

• Theoretical underpinnings of TBL

TBL is underpinned by the constructivism learning theory[12] and specifically draws from social constructivism,[13] which states that learning takes place when learners construct new knowledge by reflecting on their experiences and existing conceptions in a social setting.[14] Consistent with social constructivism, TBL provides learners with an opportunity to create new knowledge by making the learning environment conducive for them to expose the inconsistencies between their existing and new understanding.[8,12,15] In particular to social constructivism, TBL allows the creation and exchange of knowledge in a social context.[16] Moreover, TBL allows for mediation of learning through collaborative learning.[17]

TBL is a highly structured type of collaborative learning that aims to achieve higher cognitive learning levels by using the learner's existing and personal knowledge in a collaborative team.[17-22] This is achieved by encouraging learners to use course content to collaboratively solve challenging and complex problems.[13,23] TBL takes care to present learners with complex authentic problems that they are likely to encounter in real-world situations.[16,24,25] This feature of TBL may be useful in the early phases of RT undergraduate education to better prepare learners for their clinical rotations where they will encounter real-world situations. This is especially because unlike the rest of the multi-disciplinary radiation oncology professionals who join the team
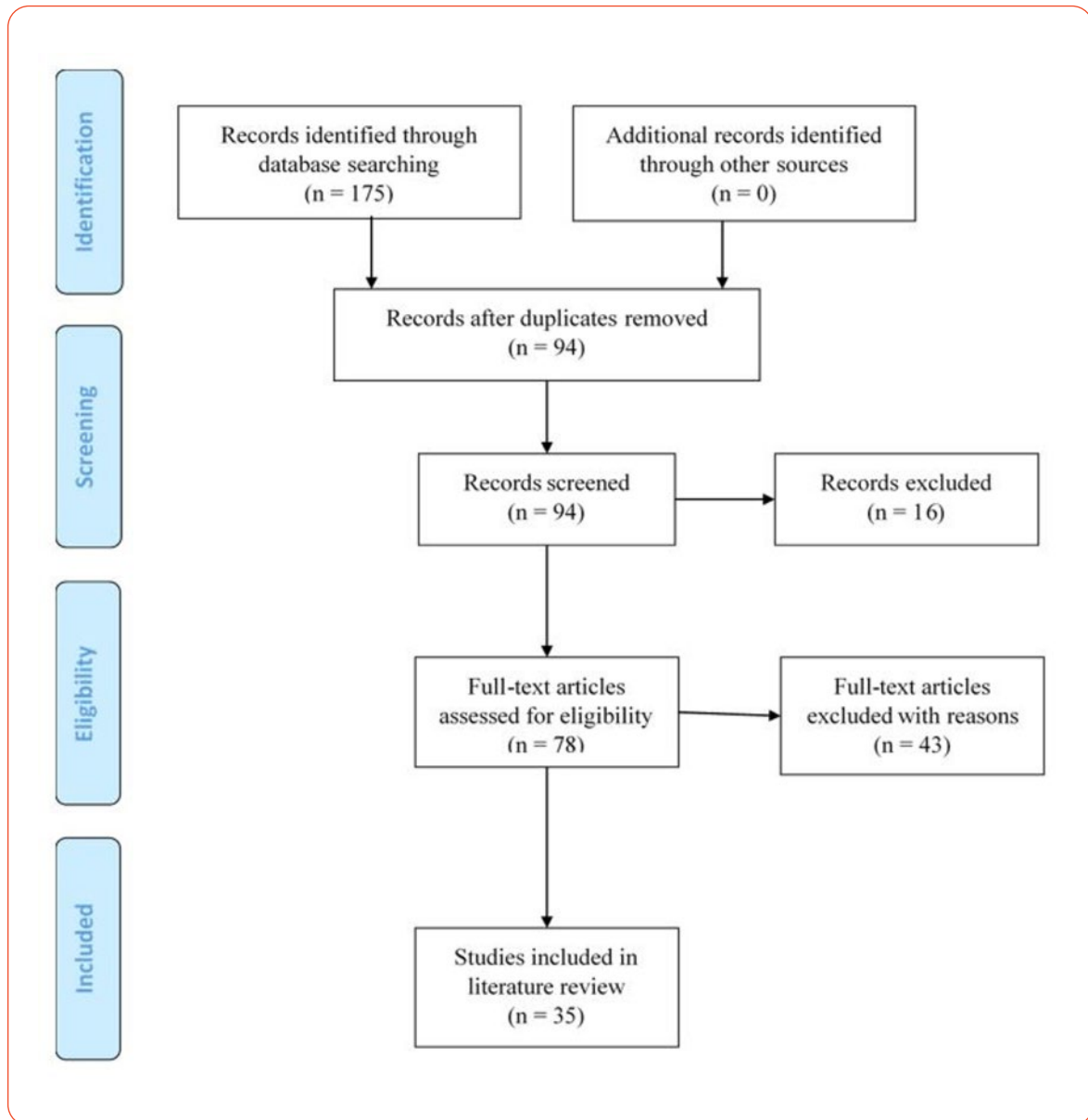
Figure 1. PRISMA flow diagram.

Table 1. Publications included for review

SOURCE	COUNTRY	TYPE/ METHODOLOGY	CONCEPT(S)	SAMPLE/ FOCUS	FINDINGS/CONCLUSION
Chung et al., 2009	Republic of Korea	Quantitative.	Evaluation of the impact of TBL on student engagement and satisfaction.	Medical ethics education.	The application of TBL improved student performance in medical ethics, with increased students engagement and satisfaction.
Parmelee et al., 2009	USA	Quantitative.	Compare how the students' attitudes about TBL changed between year 1 and year 2.	Medical students.	The attitude of students from year 1 to year 2 changes with the use of TBL. There was a decline in scores in the category of professional development. Students' satisfaction improved regarding team members' contributions and teamwork being a valuable experience.

Shankar & Roopar, 2009	India	Quantitative.	Evaluation of the students' perception of the modified TBL method when compared to lecture method.	First year general embryology MBBS curriculum.	Most of the students preferred the modified TBL method and felt that it was better at fulfilling the learning objectives, enabled better understanding of the subject and was more interesting when compared to didactic lectures.
Zgheib et al., 2010	Lebanon	Quantitative.	Examine the effect of teaching pharmacology using TBL on second year medical students' satisfaction and performance.	Second year medical students.	The students' feedback was positive and group performance was better than individual performance with the use of TBL.
Anwar et al., 2012	UAE	Quantitative.	Efficacy of TBL in a problem-based learning curriculum.	Undergraduate pathology course.	Group performance improved with the use of TBL for both regular source sessions (RS-TBL) and weekly review sessions (RVS-TBL). Individual and group performance was better in the RVS-TBL. Students reported that TBL enhanced their understanding of pathology concepts and critical analysis.
Bahrami-farid et al., 2012	Canada	Literature review.	Review of the application of TBL in medical education.	Medical education.	The use of TBL was found to be thriving with students and faculty appeared to view TBL favourably and satisfied with it.
Borges, et al., 2012	USA	Quantitative using the Workgroup Emotional Intelligence Profile (Short Version).	Examines changes in team emotional intelligence with the use of TBL.	Third year students completing internal medicine clerkship.	Team emotional intelligence increased significantly pre to post clerkship for awareness of own emotions, recognising emotions in others, and ability to manage other's emotions while there was no change for ability to control own emotions.
Hrynchak & Batty, 2012	Canada	Discussion article.	Show how TBL follows the constructivists learning theory and review of the effectiveness of TBL in healthcare education.	Healthcare education.	TBL is solidly grounded in the constructivists theory and is a promising method to strengthen healthcare education.
Inuwa et al., 2012	Oman	Computer based evaluation.	Determine if TBL could be used to improve student attendance at lectures and to determine how TBL affects student performance.	Medical School Introductory course.	Class attendance was improved with the use of TBL and creating appropriate reading assignments and learning objectives to replace lectures, were critical in focusing students preparation. The students performance in IRAT whole class mean was significantly higher than that of the in-course test score.

Parmelee et al., 2012	USA and Singapore	AMEE Guide No. 65.	Clarify what TBL is and is not and entice those are still lecturing to consider TBL. Further, to generate innovative ideas for collaborative scholarship.	Medical education.	TBL is an excellent fit with medical education and it holds learners accountable for their preparation for class and in-class engagement. It also requires learners to apply knowledge to solve authentic problems.
Parmele & Hudes, 2012	USA	Not applicable.	Explain the importance and relevance of TBL in healthcare education and support its inclusion in teaching.	Healthcare education.	TBL is an instructional strategy that provides learners with opportunities to master course content and apply concepts to real problems and it can be used at all levels of training.
Khogali, 2013	UK	AMEE Guide supplement.	Review the use of TBL in the UK.	Medical and Health Sciences education.	TBL has a potential to bring benefits to students and educational institutions by enhancing the opportunities for active adult learning. The effectiveness of TBL can only be studied if it is used within the UK context.
Hosseini, 2014	Iran	Quantitative.	Comparing possible effects of Competitive TBL (CBTL) vis-à-vis Group Investigation (GI) method of Cooperative Learning (CL) on the language proficiency.	English language teaching.	CTBL was shown to be more effective in terms of its effect on improving language proficiency. It was also shown that within the CTBL group, all participants felt accountable for their own learning and that of the teammates as well. CBTL also provided the team members with the need for perseverance, collaboration, and joint activity.
Jafari, 2014	Iran	Quantitative.	Comparing conventional lecture to TBL.	UG neurology students.	There was more success and student satisfaction from TBL. TBL could be effectively introduced to improve levels of education and student learning.
Leisey, et al., 2014	USA	Quantitative (pre and post surveys).	Exploration of the efficacy of TBL in increasing student engagement.	Chemistry, Finance, Geography, Political Science, and Social Work students.	TBL may increase students' metacognition due to increased student engagement and higher likelihood of analysis and discussion within teams. Increased perceived self-efficacy by students due to an increase in their ability to participate in team's discussion and analysis.
McMullen et al., 2014	UK	Quantitative with the use of the questionnaire to evaluate the students' experience.	Report on the experience of the implementation of TBL.	Psychiatry resident students.	Students reported that TBL improved their knowledge and clinical skills. The students reported that they found it difficult to complete the prereading due to professional and personal demands on their time. It was highlighted that it is important to involve a TBL expert when implementing TBL.

Nyindo et al., 2014	Tanzania	Quantitative.	Assessing students' perceptions of TBL following the piloting of TBL.	Ectoparasites module.	Student perceptions of TBL were very positive while their final exam grades showed improvement. However, the improvement could not be attributed to TBL implementation alone.
Park, et al., 2014	USA	Quantitative.	Evaluating whether TBL environment facilitated the competency in caries detection and activity assessment.	Third year Dental students.	TBL methods facilitated correct assessment of caries detection and activity albeit to a limited degree. Teams performed better compared to the individual students. TBL learning environment can facilitate competency of dental students in carries detection and activity assessment.
Bawazir & Binkroom, 2015	Yemen	Mixed-methods - pilot descriptive cross-sectional study using a questionnaire with open ended questions.	Perceptions and attitudes regarding TBL.	Paediatric clerkship students.	Students perceptions and attitudes toward TBL were generally positive. Some aspects of TBL must be re-examined and remedied to improve its effectiveness.
Epstein, 2015	USA	Mixed methods with the use of a questionnaire with open ended questions.	Investigate the educational outcomes and students' perceptions of TBL.	Communication disorders graduation course.	TBL provides student teams with opportunities to apply course content in problem-solving activities followed by immediate feedback.
Harde, 2015	Canada	Case study/essay.	Discuss the practice of using TBL and ways in which a TBL approach to teaching women's environmental literature encourages collaborative learning among students.	Environmental literature classroom	TBL is an effective approach to teaching but it is labor intensive during the initial implementation. TBL can be used to drive the investigations of teaching and learning issues.
Huggins & Stamatel, 2015	USA	Quantitative exploratory analysis.	Comparing lecture and TBL for teaching content and developing skills.	Sociology course.	No difference between the two groups but TBL students improved their oral communication and creative thinking skills, they also reported getting to know their educators and classmates better.
Miller et al., 2015	USA	Mixed-method – quantitative questionnaire with open ended questions.	Use of a revised, low-stress TBL format to improve students' experience.	School of Medicine (Medical Physiology and Dental Physiology) first year students.	Students in the revised TBL format reported higher effectiveness of the learning format, lower stress levels and higher levels of perceived fairness.

Peterson & Carrico, 2015	USA	Quantitative.	To determine the suitability of TBL for the implementation of coarse goals and teaching of scientific skills.	Laboratory exercise in behavioural genetics.	Students performed significantly higher on the team RAT, in comparison to the individual portion. TBL was found to be a successful tool in encouraging the development of scientific skills in the laboratory.
Roh et al., 2015	Republic of Korea	Quantitative – descriptive survey design.	To assess the perception, expected competence, and satisfaction of learners in a TBL program.	Nursing student enrolled in a medical-surgical nursing course.	TBL was found to be an effective instructional strategy, with beneficial impact on expected competence and overall satisfaction. The students generally had a positive experience of TBL.
Timmerman & Morris, 2015	USA	Review.	The need for help in designing effective exercises.	Business.	TBL presents teams of students with complex problems rooted in real world situations. TBL is being accepted as a good fit for business courses. Four broad categories or sources for creating effective exercises were identified as: new items, existing cases, custom episodes, and simulations.
Yuretich & Kanner, 2015	USA	Mixed methods.	Evaluation of the effects of TBL on student learning and achievement.	Oceanography course.	Attendance during class sessions increased measurably. TBL allowed instructors to read and assess the student investigations after each class which addressed misconceptions or unresolved issues. Students satisfaction with regards to feedback and assessment improved noticeably. The effectiveness of TBL in promoting high-order learning was uncertain.
Emke, et al., 2016	USA	Quantitative using quasi-experimental design.	Comparing TBL vs traditional curriculum on long term retention of knowledge.	Undergraduate medical education pre-clinical paediatric course.	Incorporating TBL into pre-clinical paediatrics led to large gains in knowledge over the short term but these gains did not persist.
Huang et al., 2016	China	Quantitative.	Examine the impact of modified TBL and assess the student evaluations of TBL.	Ophthalmology clerkship.	Modified TBL application improved students' performance and increased students' engagement and satisfaction.
Pogge, 2016	USA	Quantitative and qualitative using the questionnaire with open ended questions.	Evaluation of knowledge gained, attitude changes towards interprofessional education, and overall satisfaction with the course.	Doctor of Pharmacy and Doctor of Osteopathic medicine students.	Most of the students responded favourably to TBL. TBL can enhance interprofessional education because of the benefits that enhance communication and teamwork skills.

Zgheib et al., 2016	Lebanon	Quantitative.	Explore if TBL improves students' teamwork skills, communication skills, professionalism and personal development over long term and how do students evaluate TBL.	Medical students (years 1 and 2).	TBL improves medical students' team dynamics and their perceived self-learning, problem solving and communication skills, professionalism, and personal development. Due to the crowded curriculum, the students preferred to have TBL as an adjunct to lectures.
Alvarez-Bell et al., 2017	USA	Quantitative through an online survey.	Examination of which aspects of student engagement, and TBL best predicted student perceptions of learning.	Chemistry course students.	TBL encourages collaboration within each learning team and between different teams. Most students indicated that the TBL approach was beneficial to their learning needs, thus developing a positive view of the learning environment. The interests demonstrated by the instructor in TBL positively relates to students' perceived learning outcomes.
Du & Yang, 2017	China	Quantitative.	Piloting of TBL format of teaching.	Medical students.	TBL taught students demonstrated better academic performance and spent more time studying. TBL also inspired teachers' desire to lead discussions and administer quizzes.
Walker & Zheng, 2017	Singapore	Mixed-methods case study.	Experience of teachers about learning through TBL.	Teacher education.	Teachers generally perceived TBL to be a positive experience and provided some suggestion for future improvement. The quality of scores through TBL was high with team scores significantly higher than individual scores.
Tahira, et al., 2018	Pakistan	Comparative cross-sectional study.	Comparing effectiveness of lecture based learning and modified TBL in achieving cognitive skills.	Resident doctors (house officers and postgraduate residents).	Modified TBL significantly improved performance in early cognitive domains and did not achieve the same in advanced cognitive domains.

through postgraduate specialised training, RTs training is offered at undergraduate level thus the learners are comparably younger and less experienced. This makes it important to ensure that learners are well prepared to encounter the complex and demanding real-world radiation oncology practice before being exposed to this environment through clinical placements.

Further to its feature of emphasis on authentic learning experiences, TBL is an active learning approach whereby learners actively participate in the learning process as opposed to passively receiving information from a teacher. [8,13,16,22,24,26] Active learning approaches such as TBL overcome passiveness by prioritising learner interaction and engagement to create a multidirectional information flow

between a teacher, learners, and their peers.[23,24,27] Further, TBL recognises learner agency. This is the capability of individual human beings to make choices and act on these choices in a way that makes a difference in their lives,[28] which allows learning through activities that are meaningful and relevant to learners, while accommodating their interests and self-initiated learning.[29] In addition to the theoretical underpinnings, we found that some important features and principles of TBL that may be useful in RT education lie in how this learning approach is structured and the process it follows to facilitate learning. These are discussed below.

• TBL structure and process

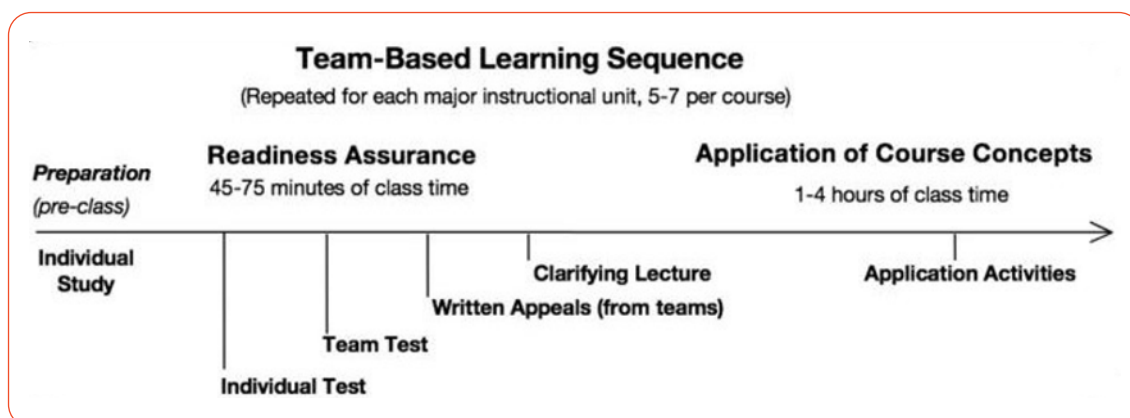Although the number of phases used to describe the TBL

Figure 2. TBL sequences.

structure and process vary, these can be grouped into three main phases: i) preparation, ii) readiness assurance, and iii) team application. Each phase has different activities, and the phases can either take place within one session or over several sessions. Figure 2 (TBL sequence)[30] schematically demonstrates how these phases unfold.

Phase 1: preparation

Phase 1 comprises exercise/assignment design, team formation, and advance preparation.[8,16,31,32-34] Exercises that will encourage individuals to be accountable and promote both physical proximity and high levels of interaction within the team during team discussion are designed to enhance learning.[24] In the process of designing these exercises, a teacher:identifies the designed outcomes or objectives; determines the acceptable achievement evidence; and only then designs the application, feedback, and assessment exercises to achieve the outcomes.[24,34-35]

A teacher carefully allocates teams at the beginning of the course, while ensuring that the newly formed teams have a balanced distribution of skills, experience, content knowledge, and social and cultural diversities.[8,12,15-17,24,32-34,36-38] Exposing learners to working in such diverse and heterogenous teams may be useful in RT education because both as students and as qualified professionals, RTs are expected to work with and within diversity. For example, as students (some as young as 18 years old) they are expected to work with a team of postgraduate qualified specialists; some of them old enough to be their parents and grandparents. This kind of multigenerational team environment presents some complex social and cultural challenges, and perhaps training students to work with culturally and socially diverse teams may be helpful in preparing them for such complexities. The key in the formation of teams is to ensure that they have sufficient intellectual resources while establishing that the team members will engage and interact with each other in productive ways.[39]

The preparation phase also requires learners to prepare themselves in advance by learning basic course content through the prescribed learning resources.[12,13,21,27,31,33-34,40] The learning resources must be studied according to the teacher-defined objectives provided for that particular session.[23,37,40,41] A learner's initial study of course content out of class allows for class time to be spent on the application and evaluation of concepts.[16,18] After mastering the basic course content, learners should be ready to start with phase 2 of TBL which comprises in-class activities only.

Phase 2: readiness assurance

In this phase, learners' knowledge of course content and level of preparation are measured by means of two tests: the individual readiness assurance test (IRAT), and the team assurance test (TRAT).[13,21] The IRAT is usually a closed book 10-15 multiple-choice questions (MCQ) test and is taken individually. This is immediately followed by the TRAT, which is the same test but now written in teams. The IRAT aims to assess the respective learners' preparedness, while the TRAT assesses their team's preparedness. Moreover, the scores from the IRAT and the TRAT are used to evaluate the effects of collaboration on individual work. Following these two tests, learners receive immediate feedback, and their teacher clarifies any misconceptions. In addition to testing content knowledge, the two tests aim to motivate learners to come to class prepared, which is essential for success in active learning approaches such as TBL.[16,19] Moreover, the IRAT promotes accountability in individual team members,[18,41] an important principle in TBL.

Phase 3: team application

This phase involves discussions and application of course concepts in the teams,[21] including both intra-team and inter-team discussions. This is the centrepiece of this teaching approach.[31,36] Team application exercises (AEs) are used to facilitate the discussions with emphasis on the application of content knowledge. The aim of AE is to encourage learners to work together towards solving a common problem.[12,13,24] All teams work on the same problem at the same time and present their answers for discussion. Unlike other forms of group work, in TBL team collaboration is executed in the classroom, in the presence of a teacher and peers.[24,42] This avoids the problems that often arise when learners must meet in their own time due to conflicting schedules.[19]

• The impact of TBL on academic outcomes

Improved academic outcomes have been reported with TBL.[16,20-22,37,43-45] Moreover, Jafari[21] found the degree of improvement to be higher in academically low-performing learners than in academically high-performing learners. This observation is also made by Bahramifarid et al.,[31] Chung et al.,[46] Du and Yang,[43] Harde,[47] Hosseini,[20] Huang et al.,[37] Miller et al.,[13] Shankar & Roopar,[32] Park et al.,[48] and Parmelee and Hudes.[25] Improved academic outcomes for academically low-performing learners could be a motivating factor for them to participate in learning while being afforded the opportunity to achieve their desired performance.[49] This is realised because small groups enhance individual accountability and collaborative behaviours.[49]

Some studies[12,16,37,41,46] found that the TRAT scores were significantly higher than the IRAT scores. This could be attributed to the discussion of questions within the group, which is a form of interactive learning that fosters the exchange of knowledge.[16] Moreover, the structure of TBL means that academically high-performing learners do not have to worry about doing all the work, for fear of low-performing learners negatively affecting their grades.[34]

In addition to knowledge application and problem-solving skills, TBL has been found to enhance communication, teamwork, and interpersonal skills.[15,16,24,25,40,45,50,51] Moreover, TBL has been found to be effective in teaching inter-professional courses. In addition to this, by intentionally forming diverse teams and facilitating them to effectively work together, TBL prepares learners for their future inter-professional work.[34]

• The impact of TBL on learners

We believe that the process is as important as the outcomes. Thus having discussed TBL's impact on academic outcomes, in this section we turn our attention to the process (i.e., the journey to the outcomes), particularly focusing on learners, and their experiences and resulting behaviours.

TBL impact on stress and development of empathic skills

Despite its success in terms of academic outcomes, there seems to be a lack of agreement in the literature regarding TBL-related stress on learners. Miller et al.[13] and de Amorim et al.[52] report higher learner stress associated with TBL, which can contribute to a reduction in empathy. However, Borges et al.[50] in their study found that TBL, as an adjunct to traditional internal medicine programme, can result in the development and growth of empathetic skills and emotional intelligence, which may lead to improved HCP-patient relationships and better care. The possible contributing factor to the reported stress is the number of readings teachers prescribe for preparation. This makes some learners feel that TBL comes with an increased workload compared to traditional lecturing.[27,35] McMullen et al.[35] suggest that teachers should not give excessive pre-session material and/or try allocating protected time to curb the feeling of increased workload.

The construct of empathy is an important aspect of RT education because from early in their studies, RT learners are involved in the care of people living with cancer, a field within which empathy and compassion are vital.[53-54] The development of empathetic skills includes active listening, sharing of feelings, making oneself vulnerable, and being empowered to help while being enabled to understand and relate well to others and having a better sense of belonging.[55] This aligns well with the group notion of TBL that was highlighted earlier: there is a high commitment to the welfare of the team and high levels of trust amongst each other,[42] which require similar skills that are essential in the development of empathy. Further, the use of TBL has been shown to change the behaviour of learners to become more compassionate with enhanced reflective capacity, and the components of the latter (e.g., reflection-on-action and self-appraisal) correlate well with cognitive empathy.[56] However, we acknowledge that TBL alone is not a sufficient instrument to develop the empathetic skills required for RT practice because empathy is a multidimensional construct.[57]

• Learner satisfaction with TBL

In a study comparing conventional lecturing and TBL in terms of learner learning and teaching satisfaction, Jafari[21] found the average level of student satisfaction to be 81.3% from TBL when compared to the traditional lecture-based method. In a different study, Anwar et al.[40] found that 88% of learners prefer TBL over problem based learning (PBL). Good learner satisfaction rates and preference for TBL over other instructional approaches have also been reported by other authors.[16,18,25,27,32,33,35,37,46,58] However, Tahira et al.[41] observed that medical learners did not prefer TBL over other instructional approaches. This observation might be because they did not use TBL in its classical form but modified it for their study. How learners feel about the learning environment is important as it influences their learning.[40] Therefore, good learner satisfaction rates on TBL positively influence learners' learning process.

• TBL impact on class attendance

One of the challenges reported with traditional lecture-based teaching is poor attendance.[27] By making learners accountable to their teams TBL[59] has been found to encourage class attendance.[23,47] Other authors[17,19,32,43] reported improvements in class attendance during the implementation of TBL sessions. In addition, TBL resulted in improvements in punctuality. This was achieved by starting the TBL sessions on time, therefore latecomers would disadvantage themselves as they would have less time to complete the IRATs.[35]

• TBL in developing learner accountability

One of the measures TBL uses to increase learner accountability is peer evaluation.[12,19] Learners are required to qualitatively and quantitatively evaluate each other based on each individual's contributions to the team. Peer feedback is given to individual team members anonymously (learners

only provide their names to their teacher for record-keeping purposes) and forms part of their course grade. This feedback encourages individual introspection in the learning process.[16,26] An increase in learner accountability is not only observed by teachers but some learners attested to this effect themselves.[58] However, not all learners are satisfied with this feature of TBL: some are not comfortable with using graded peer evaluations.[31] Learners' struggle with peer evaluations was observed by Parmelee et al.[38] and Zgheib et al.[45] However, it is important for health professions learners to learn how to effectively evaluate and give constructive feedback to their team members. When properly designed, peer evaluation does not only teach them how to give feedback but also how to receive feedback and use it to improve their own behaviours, including the development of professional competencies such as interpersonal communication, teamwork, and giving constructive feedback.[25,34] These are important skills both in RT education and practice.

LIMITATIONS

The major limitation of this NR is that it did not focus on databases exclusively related to education/learning and teaching. However, the inclusion of the ASP and ERIC databases helped to minimise bias to health sciences publications. Additionally, data used to frame the discussion presented in this paper were collected in 2019. This means that some recently published literature on this topic might be missed. Finally, this study focused on the use of TBL in RT education and did not consider the application of this teaching approach in other radiography disciplines.

CONCLUSION AND RECOMMENDATIONS

This narrative review paper discusses TBL as a potentially suitable and favourable approach to make a positive contribution to RT education. The literature demonstrates that knowledge application is considered TBL's strong point, making it favourable for RT education. Moreover, the knowledge application in TBL is through teamwork. The latter is an important component and fundamental requirement in RT practice. In addition, TBL's ability to equip learners with the necessary skills to apply conceptual knowledge practically, while effectively working in small teams, makes it one of the teaching approaches that has the potential to enhance RT education. However, there is a need for more scholarly investigations to validate the application of TBL in various RT education contexts to augment the review presented in this paper.

The study sought to explore the use of TBL in undergraduate RT education. The discussion suggests that TBL may indeed have some potential for application in undergraduate RT education. Considering this, and considering the study's limitations, we recommend further empirical research into the application of TBL in RT education to generate evidence and inform future teaching in RT education. Future studies can also include the suitability of the use of TBL in other disciplines of radiography.

ACKNOWLEDGMENTS

CONFLICT OF INTEREST

Nil to declare.

AUTHOR CONTRIBUTIONS

OSM conceptualised the study, conducted the data collection and analysis. SM and MO provided substantial intellectual input in the conception of the research idea and revision of the manuscript. All authors approved the final manuscript.

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