



Investigating the applications of team-based learning in medical education

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ABSTRACT

The purpose of this study is to perform a review to account for currently published studies on team-based learning (TBL) in medical education by accredited researchers. In doing so, our two goals included seeking information and critical appraisal. First, the literature was scanned by means of manual and computerized methods to identify pertinent documents. Selected works were then critically appraised to identify the most prevalent themes in the applications and effects of TBL in medical education. After considerable data reduction strategies, six major themes are discussed; 1) experimental TBL approaches; 2) student experiences and perceptions of TBL; 3) student examination performance; 4) faculty impressions; 5) peer evaluations in TBL; 6) TBL in gross anatomy. Although TBL is just beginning to be implemented in medicine, usage of this teaching method is thriving. Students and faculty appear to view TBL favourably and to be highly satisfied with it.

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Introduction

TBL is an innovative teaching method developed by Michaelsen (1) for small-group learning in large classes (2). It relies on dividing the class into groups of five to seven members that, in time, function as a team. TBL consists of three phases: 1) pre-class preparation, 2) readiness assurance, and 3) application of course concepts (3). In phase 1, learners study independently outside of class to master identified objectives. In phase two, each person takes an individual, multiple-choice readiness assessment test (IRAT) to ensure mastery of phase one material. Next, each team re-takes this same test, now called a group readiness assessment test (GRAT), and their consensus answers are posted and immediately scored. In phase three, teams complete in-class assignments, called group application problems (GAP), that promote the use of phase-one and two- knowledge, collaboration, and identification of learning deficiencies and misconceptions. All groups then share their answers with the entire class for comparison and feedback. This process appears to stimulate energetic total-class discussion in which groups' debate and defend their answers. The instructor's role is to facilitate and assist with consolidate learning. In addition, peer evaluations are an important part of TBL student assessment (1).

Method

The authors began this review by performing a variety of keyword searches on a multitude of search engines (e.g., Google, Google Scholar, PubMed and Eric). Search constructs included "team-based learning," "team-based learning + medicine," "team-based learning medical school," and "team-based learning + anatomy." Several additional articles and abstracts were retrieved from searches of Team-Based Learning and TBL Collaborative websites.

Upon delving into the literature, the authors retrieved a total of 75 studies closely related to the subject of TBL in medical school and anatomy. These studies included journal articles, abstracts, PowerPoint presentations, and minutes

from meetings and conferences about TBL. From these 75 studies, specific articles, whose topics addressed the following criteria, were selected for inclusion in this review:

- TBL and its use, implementation, and effects;
- TBL in medicine and the medical curriculum, preferably in pre-clerkship but also in clerkship;
- TBL in anatomy

Articles published in foreign medical journals, articles related to undergraduate science courses, nursing, residency, or graduate studies, articles that describe validation instruments or new technologies used in TBL, and articles discussing small-group teaching methods that differed from TBL were generally omitted. Throughout the search, the main investigators were kept up-to-date on the findings via electronic mail.

Analysis

After these studies were selected, they were organized into 11 major thematic domains. Thematic names were assigned to each of the categories are as follows: 1) experimental TBL approaches; 2) student experiences and perceptions of TBL; 3) student examination performance; 4) faculty impressions; 5) peer evaluations in TBL; 6) TBL effects among healthcare professionals; 7) factors influencing the implementation of TBL; 8) specifics of TBL use; 9) the rapid spread of TBL in the medical curriculum; 10) the use of modified TBL; and 11) TBL in anatomy. Several of these themes produced a rather limited number of articles; consequently, the authors engaged in a reduction process to report on the major themes based on the frequency and quantity of data. The resultant six themes are discussed in the following section.

Result

Theme 1: Experimental TBL approaches

In medicine, TBL has been introduced in pre-clerkship and clerkship curricula. In pre-clerkship, TBL has been used in a first-year

intensive course (4), as a component of PBL (5), in microscopic anatomy (6), and in pathology (7, 8). Within 18 months of grant funding, TBL was implemented in over 40 courses at ten American medical institutions (9, 10). As for clerkship, TBL has been incorporated into psychiatry (4, 11) and internal medicine (12). TBL has also been tried in residency in internal medicine (13) and paediatric oncology (14) as well as among various healthcare professionals (15).

Theme 2: Student experiences and perceptions of TBL

Most students have come to regard TBL as a more engaging, effective, and enjoyable teaching method than the conventional didactic approach in medical schools (11, 16). One study reports that, among 97 students of a first-year medical class who were randomly assigned to 18 teams, 83% of students agreed or strongly agreed that TBL promotes their learning in gross anatomy and embryology (17). The most frequent finding has been a high level of student engagement and satisfaction in courses implementing TBL (9), including medical physiology (18), medical ethics (16), pathology (8), gross anatomy (19), psychiatry clerkship (11), internal medicine clerkship (12), and internal medicine residency (13). Although, based on focus group data, many students initially devalued TBL during a seven-week course in evidence-based medicine for a class of 168 second-year medical students, they were actually found to be highly engaged in class based on observation data (20). Students tend to assess teamwork and peer contribution more favourably in courses that implement TBL (9), such as pathology (21), gross anatomy and embryology (22), microscopic anatomy (6), and psychiatry clerkship (11). In medical gross anatomy, students view TBL favourably irrespective of their grades, although high-performing students view it more positively than low-performing students (23).

Theme 3: Student examination performance

In pathology (7), medical ethics (16), and gross anatomy and embryology (17), students in the lowest academic quartile appear upon

examination to have benefited from TBL, while other students performed similarly to before TBL. Among 97 students of a first-year medical class in gross anatomy and embryology, scores from TBL session activities and course examinations were analyzed and compared to previous years' performance, showing that a lower course-failure rate resulted upon implementation of TBL (17).

In evidence-based medicine, student performance is reported to have improved when compared to efforts made under previous teaching techniques (20, 24). In 40 courses implementing TBL in ten different American medical schools, semi structured interviews between the Team Based Learning Collaborative and eleven representative faculty members revealed academic performance evaluated over two years was rated equal to or better than achievements made in response to previous teaching methods (9, 10). In gross anatomy (19, 22, 25) and in a psychiatry clerkship (11), students involved in TBL performed significantly better than on previous exams. In an internal medicine clerkship, however, no statistically significant difference was found with respect to student performance, as reflected via National Board of Medical Examiners (NBME) shelf examination scores, between TBL and non-TBL content (12).

Theme 4: Faculty impressions

After initial pilot studies at one institution, nine other institutions implemented TBL in their curricula based on manifested interest supported by grant funds and these American medical institutions have reported a high degree of satisfaction with TBL among faculty, who tend to have a positive perception of TBL as reported in 30% of 118 responses for 40 courses (9). In pathology (17) and medical gross anatomy (19, 25), the use of TBL reportedly appeals to faculty. Nieder, Parmelee, Stolfi, and Hudes found that faculty of medical gross anatomy and embryology strongly support introducing TBL into classes and favour this method over traditional didactic approaches to pedagogy,

based on feedback collected from three full-time faculty in the form of recorded comments.

Theme 5: Peer evaluations in TBL

Searle, Haidet, Kelly, Schneider, Seidel, and Richards found, as reported by students, peer evaluations to be the most controversial aspect of TBL, based on 118 responses from 40 courses implementing TBL across ten American medical institutions. Similarly, Thompson, Schneider, Haidet, Levine, McMahon, Perkowski, and Richards observed that many students were initially resistant to the idea of adopting a TBL approach, mainly because of the peer evaluation component, as revealed by semistructured interviews between the Team Based Learning Collaborative and eleven representative faculty members discussing the implementation of TBL over two years in those ten institutions.

In medical gross anatomy and embryology, students were reluctant to use a peer evaluation system requiring team members to be assessed independently in comparison to one another as per solicited open-ended comments from 97 students of a first-year medical class (17). Meanwhile, Nieder, Parmelee, Stolfi, and Hudes concluded that student satisfaction with the peer evaluative process begins to decline over time. In part, this decline might be attributed to students' growing concerns about the impact of the graded peer evaluations (9). A few correlation studies, specifically in a psychiatry clerkship (92), medical gross anatomy and embryology (22), and in medical gross anatomy, indicate that peer evaluation scores modestly predict student academic performance.

A small but significant correspondence has been determined between peer evaluations and both IRAT and exam scores in medical gross anatomy and embryology in a first-year medical class of 97 students (17).

Theme 6: TBL in gross anatomy

This review also investigated the extent to which TBL has been adopted in Canadian universities. The University of Ottawa Medical School and

the Queen's University School of Medicine are the only two Canadian institutions that have incorporated TBL in anatomy (27). In the United States, TBL has been implemented in anatomy classes at five institutions. TBL is currently used in the anatomy laboratory at the University of Arizona College Of Medicine and in gross anatomy at the University of Oklahoma Health Sciences Center (9). At the Mayo Medical School, a web-based portal system is utilized in conjunction with TBL in gross anatomy (28). Wright State University School of Medicine makes use of TBL in anatomy on assignments, IRATs, GRATs, and GAPs (20). Since August of 2004, the New Jersey Medical School has eliminated all anatomy lectures and replaced them with modified TBL sessions composed of pre-class readings with assignments related to laboratory dissections, IRATs, discussions, and GRATs, using cadavers, radiographs, skeletons, and other study aids in the lab (19, 22, 23, 25).

Discussion

A thorough review of the TBL literature revealed that employment of this teaching method is rapidly growing, particularly in medicine, as demonstrated by the pioneering efforts being made to integrate TBL into the curricula of medical schools across North America. TBL is continuously piloted in various healthcare courses in pre-clerkship, clerkship, residency, and even among healthcare professionals. A number of the studies cited above determined that students find TBL to be particularly beneficial in the learning process and prefer it to conventional didactic approaches. Not only are students highly engaged and satisfied in class, but they appreciate teamwork and peer contributions to their learning. TBL seems to appeal to students irrespective of their grades, making learning more enjoyable to all involved. As described above, academic performance with TBL has been rated equal to or better than achievements under previous teaching methods.

Failure rates have plummeted, demonstrating students in the lowest academic quartile to have benefited most from TBL, which has, however, also significantly improved other students'

academic performance. Studies indicate a high degree of satisfaction with and support among faculty for using TBL, which clearly increases the chance of its continued use and development. Nevertheless, peer assessment has been controversial among students. Studies have found that students' satisfaction with this evaluation process declines as they become more concerned about, and eventually reluctant to use, graded peer evaluations. Peer evaluations, however, have been shown to be modest predictors of academic performance.

Conclusion

A review of current literature illustrating Team-based learning in the medical education literature resulted in the emergence of 11 key themes. This review suggests that despite some challenges, the TBL approach is poised for success by virtue of faculty buy-in with regard to the pedagogy of the approach to increase student involvement and retention. As well, students who came to the sessions prepared were viewed as more engaged in their learning. Undeniably, future physicians will need to embrace the theory and practice of teamwork.

As we move to more inter-professional work environments a critical element will be to motivate individual contributors to shine in lead roles while simultaneously shaping them into strong team players. A solution taught at many leading business schools includes aligning individual and team performance metrics. That is, as much as possible use the same or similar metrics to evaluate both team and individual performers.

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