

# Is a Team-based Learning Approach to Anatomy Teaching Superior to Didactic Lecturing?

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## هل نهج طريقة التعلم القائم على الفريق لعلم التشريح أفضل من إلقاء المحاضرات التعليمية؟

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**ABSTRACT: Objectives:** Team-based learning (TBL) is used in the medical field to implement interactive learning in small groups. The learning of anatomy and its subsequent application requires the students to recall a great deal of factual content. The aims of this study were to evaluate the students' satisfaction, engagement and knowledge gain in anatomy through the medium of TBL in comparison to the traditional lecture method. **Methods:** This study, carried out from February to June 2012, included 30 physical therapy students of the Shiraz University of Medical Science, School of Rehabilitation Sciences. Classic TBL techniques were modified to cover lower limb anatomy topics in the first year of the physical therapy curriculum. Anatomy lectures were replaced with TBL, which required the preparation of assigned content, specific discussion topics, an individual self-assessment test (IRAT) and the analysis of discussion topics. The teams then subsequently retook the assessment test as a group (GRAT). The first eight weeks of the curriculum were taught using traditional didactic lecturing, while during the second eight weeks the modified TBL method was used. The students evaluated these sessions through a questionnaire. The impact of TBL on student engagement and educational achievement was determined using numerical data, including the IRAT, GRAT and final examination scores. **Results:** Students had a higher satisfaction rate with the TBL teaching according to the Likert scale. Additionally, higher scores were obtained in the TBL-based final examination in comparison to the lecture-based midterm exam. **Conclusion:** The students' responses showed that the TBL technique could be used alone or in conjunction with traditional didactic lecturing in order to teach anatomy more effectively.

**Keywords:** Learning; Anatomy; Physical Therapy Specialty; Education; Curriculum.

**المخلص: الهدف:** تستخدم طريقة التعلم القائم على الفريق في المجال الطبي لتطبيق التعليم التفاعلي في المجموعات الصغيرة. يحتاج تعلم التشريح وتطبيقاته إلى حفظ وتذكر قدر هائل من الحقائق العلمية. هدفت الدراسة إلى تقييم مدى تحصيل الطالب المعرفي لعلم التشريح بطريقة التعلم القائم على الفريق بالمقارنة مع طريقة إلقاء المحاضرات العلمية التقليدية. **الطريقة:** أجريت الدراسة خلال الفترة من فبراير إلى يونيو 2012 في جامعة Shiraz (إيران). تم تعديل طريقة التعلم القائم على الفريق التقليدية لتستخدم في تدريس تشريح الطرف السفلي لثلاثين من طلاب السنة الأولى في كلية العلاج الطبيعي. تم استبدال محاضرات التشريح التقليدية بطريقة التعلم القائم على الفريق والتي تتطلب التحضير المسبق للمحتوي التدريسي والعناوين موضع النقاش واختبار التقييم الفردي وتحليل مواضيع النقاش. بعد ذلك تم اختبار الفريق للجاهزية. تم تدريس الثمانية أسابيع الأولى بطريقة المحاضرات التقليدية بينما استخدمت طريقة التعلم القائم على الفريق في فترة الثمانية أسابيع التالية. تم تحديد تأثير طريقة التعلم القائم على الفريق على مشاركة الطلاب وتحصيلهم المعرفي باستخدام النتائج الرقمية لاختباري التقييم الفردي وتقييم الفريق بالإضافة إلى نتائج الإختبار النهائي. قام الطلاب بتقييم جلسات الدراسة بطريقة التعلم القائم على الفريق عن طريق استبيان. النتائج: أظهر مقياس ليكرت نتائج أعلى لمعدل رضا الطلاب عن طريقة التعلم القائم على الفريق. وبالإضافة إلى ذلك كانت نتائج الطلاب في الإمتحان النهائي المبني على طريقة التعلم القائم على الفريق أفضل من تلك التي حصل عليها الطلاب في امتحان منتصف الفصل الدراسي. الخلاصة: أظهرت استجابات الطلاب أنه من الممكن تطبيق طريقة التعلم القائم على الفريق إما وحدها أو بالإضافة إلى المحاضرات التقليدية لتدريس علم التشريح بطريقة أكثر فاعلية.

**مفتاح الكلمات:** التعلم؛ علم التشريح؛ تخصص العلاج الطبيعي؛ التعليم؛ المناهج.

### ADVANCES IN KNOWLEDGE

- Team-based learning (TBL) can be applied successfully with students in physical therapy education.
- TBL can trigger active participation of students in learning anatomy.

### APPLICATION TO PATIENT CARE

- Advances in medical education will indirectly improve patient care.
- The social skills required for working effectively in teams and collaborating are essential for good patient treatment and care. This can be experienced by students at a very early stage in their careers, thus making them ready for future teamwork.

**T**EAM-BASED LEARNING (TBL) WAS A TERM first popularised by Michaelsen to describe an educational strategy that he developed for use in academic teaching. TBL is a teacher-directed method that promotes the application of knowledge using small groups in a class. The method increases learner engagement, promotes active learning and is reported as enjoyable by learners.<sup>1-3</sup>

TBL is increasingly being used in medical education.<sup>2,3</sup> The objective of TBL is to go beyond the simple coverage of content and to focus on ensuring that the students practise using course concepts to solve problems. In other words, TBL can be defined as an instructional strategy that is based on techniques for developing high-performance learning teams and that can enhance the quality of student/trainee learning in almost any course.

TBL promotes active learning within a group of students for three reasons. First, group work is central to exposing students to and improving their ability to apply course content. Second, the greater part of class time is used for this group work. Third, TBL involves multiple group tasks that are designed to improve learning and promote the development of self-managed learning groups.

Students involved in TBL learn content in three phases. In phase one, the students complete assignments, such as textbook reference readings, outside of the classroom. The students are responsible for the completion of these assignments. In phase two, student groups meet, as well as taking readiness assurance tests (RATs), first individually (IRAT) and then in assigned small groups (GRAT). In the third phase, the students in the assigned teams consult to solve complex problems, triggering active participation and learning.<sup>4,5</sup>

The benefits of TBL include maximising student engagement, improving teamwork, developing communication skills, enhancing problem-solving skills and promoting knowledge outcomes.<sup>5-9</sup> There are limited studies comparing TBL to other educational methods. These studies are also varied in their methodology as well as their choice of subjects. Despite this, the studies have demonstrated higher engagement and enjoyment among TBL participants. Nevertheless, there are controversial data on whether TBL improves knowledge outcomes compared to other educational techniques.<sup>6,10-12</sup>

Human anatomy is a basic science course in any

physical therapy curriculum. Anatomy teaching has recently seen the introduction of several controversial changes. These include a reduction in course hours, the integration of preclinical and clinical courses, the abolition of cadaver dissection, the introduction of new educational methods, a change in students' learning objectives and a decreased supply and demand for gross anatomy dissectors and instructors.<sup>13</sup> The teaching of anatomy using TBL has received much attention in recent years.<sup>14-16</sup> As an understanding of anatomy is fundamental to the understanding of other subjects in the physical therapy curriculum, especially the anatomy of the limbs and the vertebral column, it has to be learned effectively. In limb anatomy, the anatomy of related bones, muscles, and nerves are taught together. This gives a holistic understanding of the upper and lower limbs of the body and the mutual relationship of the limb structures.<sup>17</sup> The hypothesis of this study was that TBL would be effective for teaching limb anatomy; this would be tested on undergraduate physical therapy students by comparing TBL to a traditional lecture course, measuring knowledge and the students' satisfaction with the outcomes.

## Methods

This study was conducted at the School of Rehabilitation Sciences, Shiraz University of Medical Science, Iran, from February to June 2012. The participants were first-year physical therapy students who voluntarily took part in the study. All the procedures were performed under the supervision of the Ethics Committee of Shiraz University of Medical Sciences, Shiraz, Iran.

The lower limb anatomy instruction programme began in the second semester of the first academic year. Lower limb anatomy serves as the basic anatomy course of the curriculum. In February 2012, 30 students were enrolled in the course. The class met once a week for two hours and the students participated in all class sessions for 16 weeks. The course was divided into six parts: bones, joints, gluteal region, thigh, leg and foot. The same students were taught using traditional lectures and TBL in the first and second eight-week periods of the semester, respectively. Information regarding the dates of the midterm and final examinations, study guides, and textbook references were offered

to the students at the beginning of the term. It should be noted that approximately half of the course time was spent in the laboratory. The final examination covered only the last eight weeks of content.

In the first eight weeks of the semester, the traditional lecture-based method for teaching lower limb anatomy was used; this included eight hours of teaching and eight hours of laboratory dissection. The students (both male and female) were assigned to two laboratory groups receiving the usual traditional lectures by the faculty members. The most widely used method for theoretical classes are traditional lectures, which are a direct technique to encourage the students' motivation and intellectual stimulation. All of the important material related to the lectures on lower limb anatomy, including pure anatomy and clinical problems, were explained to the students. The students were asked to answer five short-answer questions related to the lecture before the beginning of the lecture and at the end of the class (pre- and post-tests). Later, in the mid-term examination, they had to answer 30 multiple choice questions (MCQs) on lower limb anatomy.

In the second eight-week period, students were again instructed through eight hours of teaching and eight hours of laboratory dissection. One week prior to the first modified TBL session, 30 undergraduate physical therapy students (both male and female) were randomly assigned to five groups ( $n = 6$ ) for both the theoretical lectures and laboratory practice. One week before the class, all of the students were given a student guide explaining the learning objectives and textbook readings. Before the beginning of the class, the preparatory material was individually studied and the modified TBL procedure was explained to the students.<sup>2,17</sup>

The students were required to complete five short-answer questions related to the lecture on lower limb anatomy in five mins before the beginning of the class (pre-test). The questions on the individual readiness assurance test (IRAT) assessed whether the students understood and could apply the important concepts of basic limb anatomy to the practice of physiotherapy. The answers were recorded on paper and considered for later grading. Immediately after the IRAT, the pre-assigned teams of five students re-evaluated the same IRAT quiz within 15 mins, coming to a group consensus regarding the answers (post-test). This was the group readiness assurance test (GRAT). The team

questions were reviewed by having the teams show their answers simultaneously. If the team answers did not agree, the problem was addressed by asking the teams to defend their answers (RAT question/discussion); this discussion phase was scheduled for 15 mins. The whole procedure filled the first hour of the class.<sup>2,17</sup>

The student groups were asked to study readings, copies of their textbooks, the standard atlas of anatomy and PowerPoint presentations (Microsoft PowerPoint 2010, Microsoft Corporation, Redmond, Washington, USA) in order to encourage an active learning process and higher-order learning, which included discussions, problem-solving and clinical anatomy studies. The instructor was responsible for planning the sessions, preparing the material and evaluating the sessions. The instructor also presented a PowerPoint presentation about each topic to clear any doubts that emerged during the discussion. Once the instructor felt that the students had mastered the main concepts of the RAT, the class would proceed to an application exercise. In this exercise, student teams worked on two questions that provided opportunities to apply their theoretical knowledge to complex real-world problems. The questions in the exercises were designed to be more challenging than the RAT questions, requiring problem-solving skills beyond the simple recall of theoretical knowledge, such as these found in actual limb anatomy cases.<sup>2,17</sup>

One of the objectives of the study was to determine if student satisfaction was greater using the TBL method or traditional lecturing. After the students had completed the TBL and lecture sessions, they were asked to fill out a Likert-scale six-item questionnaire, which included five options of *strongly agree*, *agree*, *neutral*, *disagree* and *strongly disagree*, in order to evaluate their levels of satisfaction with each session. This questionnaire was designed specifically to compare the TBL sessions to the traditional lecture-based classes on important key aspects of learning. The number of students responding to each item was noted and the mean value for each item was calculated. Students' suggestions were also elicited.

The secondary objective of the study was to evaluate knowledge gain, which was assessed by an improvement in the students' scores at pre-test and post-test (using the individual and group RATs). The third objective was determining the

impact of TBL sessions or lectures on student engagement. The educational achievements were evaluated based on the results of the midterm and final examinations. In the pre- and post-tests (IRAT and GRAT, respectively), as well as the midterm and final examinations, the students were scored for correct answers; however, they got full marks for the best answer in the application exercise. The pre-test scores were compared to the post-test scores, and the midterm examination results after the lecture sessions were compared to the final examination scores after TBL sessions, in order to evaluate the effectiveness of TBL in comparison to lecturing.<sup>2,17</sup>

The data were shown as mean  $\pm$  standard deviation (SD) and analysed by the application of a paired sample t-test and an independent sample t-test. Significance was defined as  $P < 0.05$ . The difficulty of the examinations was tested using statistical approaches.

## Results

The results of the paired sample t-test revealed a statistically significant increase in knowledge gain between the students' pre-test and post-test scores in both the traditional lectures and the TBL groups [Table 1]. The maximum score was 5 and the mean pre-test scores were low in both groups. A statistically significant difference was observed between the scores of the lecture-based midterm examination and those of the TBL-based final examination ( $P < 0.01$ ) [Table 1]. The maximum score was 8 and the scores of the TBL-based examination were higher than those of the lecture-based examination [Table 1]. Statistical analysis showed that the midterm and final examinations were of equal difficulty. The post-test

**Table 1:** Pre-test, post-test, midterm and final examination scores for the lecture and team-based learning groups

Group	Mean scores (SD)		Examinations
	Pre-test	Post-test	
Lecture	1.5 (1.0)	2.2 (1.20)*	6.0 (1.3)
TBL	1.5 (1.0)	2.6 (1.20)*	6.5 (1.0)**

SD = standard deviation; TBL = team-based learning.

\* $P < 0.01$ , (post-test versus pre-test scores), (post-test of TBL versus post-test of the lecture).

\*\* $P < 0.01$ , final (TBL) versus midterm (lecture) examination scores.

**Table 2:** Student satisfaction of the lecture and team-based learning groups using a five-point Likert scale

Questions	Satisfaction Mean (SD)	
	Lecture	TBL
1. I found that this learning style helped me understand anatomical concepts.	2.9 (0.7)	3.4 (0.6)*
2. I found that this style of learning encouraged clinical anatomy problem-solving.	3.0 (0.7)	3.5 (0.5)*
3. I found that this type of learning encouraged questions, discussions and interactions.	2.9 (0.9)	3.4 (0.7)*
4. I found that this type of learning forced me to study more consistently.	3.0 (0.8)	3.4 (0.7)*
5. I found that this learning style improved my problem-solving skills.	2.8 (1.0)	3.4 (0.7)*

SD = standard deviation; TBL = team-based learning.

\* $P < 0.05$ , lecture-based versus TBL.

results of the TBL group also showed a significant difference in comparison with the post-test results of the lecture-based learning group.

The difference in mean satisfaction rating was statistically significant in the TBL group [Table 2]. The students in the TBL group reported higher scores on the five-point Likert scale.

## Discussion

This study was the first one to evaluate the effectiveness of TBL for teaching lower limb anatomy education to first-year physical therapy students. A unique application of the TBL curriculum was used, which is also utilised in other physical therapy specialties. One of the findings of this study was that there was increased student satisfaction with TBL compared to the traditional lecture-based method of teaching. Regardless of when the students had participated in the study, they all displayed low pre-test and lecture examination scores. These low pre-test and lecture examination scores may reflect the students' lack of acquaintance with the anatomy curriculum. In this study, knowledge gain was assessed using the post-test and TBL examination scores, and a significant difference was found between the lecture-based and TBL groups regarding score improvement.

This finding agrees with previous studies which reported on the effectiveness of the TBL method in medical sciences education.<sup>18,19</sup> Educational experiences using the TBL format were also compared with other methods.<sup>20,21</sup> For example, Mody *et al.* compared TBL with the lecture-based method and showed that TBL can be used as a novel approach for medical students' education in family planning.<sup>2</sup> This is in agreement with our work. Moreover, Tan *et al.* compared TBL with passive learning and reported that TBL is an effective technique for improving knowledge in undergraduate clinical neurology education.<sup>20</sup> In this study, the post-test scores were significantly higher than the pre-test scores. By working together in highly prepared and structured settings, the students performed better as a group. This result is consistent with those of Chung *et al.* and Nieder *et al.*<sup>17,19</sup>

A similar study by Vasan *et al.* compared TBL and traditional lectures with anatomy curricula.<sup>12</sup> The results of that study also revealed a significantly greater improvement in knowledge gain in the TBL group compared to the lecture group. Vasan *et al.* reported that the subjects' scores in the TBL-based anatomy courses were higher than those of lecture-based anatomy courses. Moreover, our results agree with those of another study demonstrating that knowledge is retained better after TBL.<sup>17</sup> Nevertheless, a study by Haidet *et al.* did not find any significant difference between TBL and lecturing regarding knowledge gain outcomes, possibly due to a lack of follow-up or because of learner heterogeneity.<sup>6</sup>

This study had some limitations. It is possible that the students may have performed better on the final examination because of their having been in the course for a longer period of time. However, the students were nevertheless more satisfied with the TBL method [Table 2].

One of the greatest advantages of TBL is also one of its limitations; as TBL shifts the focus of instruction from learning about concepts and ideas to learning how to apply them in a meaningful way, this necessarily means that the method relies more upon the instructor. The instructor must be ready and willing to reward students for individual and pre-emptive study and provide them with the opportunity to learn how to use basic content in a meaningful and applicative way. Encouraging the

students to undertake study before the class was the main problem in the present study. Another limitation of the present TBL study was the limited tendency of some students to participate in group work.

Thus, if the instructor's primary focus was on simply covering the curriculum content and consequently failing to utilise the necessary application-focused assignments, students would therefore be less likely to invest their time and energy in carrying out additional pre-class study.

Another limitation of the present study was the evaluation of the methods over such a short period of time. One semester may be inadequate to evaluate all aspects of the TBL method in comparison to traditional lecturing. An additional limitation was the uncontrolled interventions regarding the reading guidance during the lecture-based tests. Unlike TBL, where students were given a reading guide, no reading guidance was given with the lecture group. Therefore, this aspect should be controlled in future studies. Furthermore, another aspect of evaluating TBL is considering the peer evaluation of the students; the current study did not take into account peer evaluation in the modified TBL group.

## Conclusion

The present study demonstrates that TBL can be applied to cover lower limb anatomy topics in a physical therapy curriculum. According to the current study's results, this method results in an improved knowledge gain and higher satisfaction ratings for the students. The students obtained improved results in their final examination, undertaken after TBL, in comparison to their midterm examination, undertaken after lecture-based learning. By utilising TBL, anatomy students can learn to collaborate and work effectively in teams at a very early stage in their careers.

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