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RESEARCH ARTICLE

Physical therapy students' perceptions of team-based learning in gross anatomy using the Team-Based Learning Student Assessment Instrument

Beven Livingston[1]*, Mary Lundy[1], Shana Harrington[1,2]

[1]Department of Clinical and Applied Movement Sciences, University of North Florida, Jacksonville, FL, USA; [2]Department of Physical Therapy, University of Florida, College of Public Health & Health Professions, Gainesville, FL, USA

Abstract

Purpose: The objective of this study was to assess physical therapy student perceptions of team-based learning (TBL) in a graduate level gross anatomy course using the TBL Student Assessment Instrument (TBL-SAI). **Methods:** The TBL-SAI was administered to 85 doctor of physical therapy (DPT) students, comprising three cohorts (classes of 2013, 2014, and 2015), who successfully completed a gross anatomy course where TBL was implemented. The TBL-SAI surveys 33 items, each rated from one (strongly disagree) to five (strongly agree) and measures three subscales: students' perceptions of accountability, preference for lecture or TBL, and student satisfaction. **Results:** The means for each subscale and the total TBL-SAI score for each cohort fell above the neutral score. The 2015 group (mean, 37.97; 95% confidence interval [CI], 35.67 to 40.26) reported significantly higher satisfaction than that of the 2013 group (mean, 32.71; 95% CI, 30.31 to 35.05) and the 2014 group (mean, 33.11; 95% CI, 30.69 to 35.53). The 2015 group (mean, 125.3; 95% CI, 120.6 to 130.3) also had a significantly higher total score than that of the 2013 group (mean, 115.6; 95% CI, 110.5 to 120.5). **Conclusion:** The physical therapy students reported an overall positive experience in using TBL to learn gross anatomy in terms of accountability, preference for learning mode, and satisfaction. This positive experience with TBL was accompanied by their successful academic performance. Given the traits and learning preferences in this generation of graduate students, TBL could be a teaching method that is received positively elsewhere and results in successful academic performance and learning.

Key Words: *Anatomy; Education; Perception; Team-based learning; Questionnaire*

INTRODUCTION

Team-based learning (TBL) is a well-defined, student-centered instructional strategy developed by Dr. Larry Michaelsen [1] that purportedly engages students in active learning and critical thinking. Students in TBL courses come prepared with information learned from completing clearly communicated, pre-class assignments to solve real world problems in permanent, predetermined work teams [1]. Through regular assessments, both as individuals and as a team, students are given frequent, immediate feedback on the quality of their performance [1]. Many studies have reported improved problem solving abilities and increased knowledge retention that have resulted in better performance outcomes when using TBL in healthcare education [2-6]. TBL is an engaging, collaborative, participatory, and relevant teaching strategy, and despite the lack of quantitative evidence surrounding student perceptions of TBL, numerous institutions, such as Wright State University School of Medicine, New Jersey Medical School, and Baylor College of Medicine, have implemented TBL in their gross anatomy courses [7].

Many factors are important for successful learning outcomes in higher education. One of the most important factors is

*Corresponding email: b.livingston@unf.edu

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matching the learning preferences of students with the instructional design and strategies used by educators [8]. According to the Strauss-Howe Generational Theory, each generational cohort has unique traits that are shaped by life experiences and that strongly influence learning preferences [9]. Many individuals born between 1981 and 1993 are now enrolled in graduate education programs in the United States [9], including physical therapy. This generational cohort of students is commonly described as the "Millennial Generation" and is the second largest generation in American history [10]. Millennials are described as ambitious, stressed, inclusive, confident, and optimistic with a capacity for high-level cooperative work [9], and these generational traits influence their learning preferences [11]. According to educational researchers, Millennials prefer engaging, collaborative, learner-centered experiences with clear directions, expectations, and real-life applications [8]. Therefore, they expect instructors to facilitate learning and provide immediate feedback. Because of their unique generational traits and learning preferences, Millennials present new challenges to educators such as utilizing a variety of engaging, participatory, and relevant teaching strategies.

Given the described traits and learning preferences of Millennials, TBL provides experiences well suited for successful academic performance. Based on empirical analysis, adoption of this innovative, instructional methodology by graduate education programs can be expected to result in high student performance and increased satisfaction towards TBL. When graduate students enrolled in professional programs were asked to compare TBL to traditional didactic lectures, the students reported feeling more engaged, resulting in a more enjoyable learning experience in TBL than traditional lectures [12,13]. Additionally, students, who reported feeling more engaged, have responded positively towards TBL when asked to compare TBL to traditional lectures after learning course content [5,14]. However, a standardized method of assessing the influence of TBL has yet to be determined. Until recently, researchers and academicians who aimed to assess the impact of TBL on students had to create their own open-ended surveys using behavioral and observational scales or instruments to assess traits such as ability to work in a team [5,15,16]. The lack of a standardized assessment instrument, specifically designed to measure student perceptions in the key concept areas of TBL, was making evidence-based decision-making surrounding the continued utilization or adoption of TBL in curricula challenging. Prompted by her interest in innovative teaching strategies in nursing, Mennenga [17] developed the Team-Based Learning Student Assessment Instrument (TBL-SAI), a valid and reliable assessment tool that evaluates student perceptions of accountability, preference for learning, and satisfaction in TBL. The purpose of this study was to explore the attitudes and perceptions of doctor of physical therapy (DPT) students toward TBL in a gross anatomy course using the TBL-SAI.

METHODS

Research design

This cross-sectional study used the TBL-SAI to examine the perceptions of DPT students toward implementation of TBL in a gross anatomy course.

Participants

All 85 DPT students who had completed the first semester gross anatomy course at the University of North Florida (UNF) were eligible to participate in this study. A total of 85 DPT students participated in this study. The TBL-SAI questionnaire was administered to the DPT class of 2015 (n = 30), class of 2014 (n = 27), and class of 2013 (n = 28) in December 2012.

Ethical considerations

The Institutional Review Board at UNF approved this study. Prior to participation, all students consented to the use of their anonymous responses. No student names were associated with any of the surveys, and all research materials were handled exclusively by the authors of this study.

Mixed lecture/TBL implementation

The gross anatomy course in the DPT program at UNF is a six-credit-hour course conducted during the first semester (15 weeks) of a three-year curriculum. The gross anatomy course is divided into three units: general systems and upper extremities (five weeks); head, neck, back, thorax, and abdomen (five weeks); and pelvis, perineum, and lower extremities (five weeks). The students' overall grades were determined by a cumulative score of four written exams (three unit exams and one final cumulative exam, 400 points), four laboratory exams (three unit exams and one final cumulative exam, 200 points), individual readiness assurance tests (10-100 points), team readiness assurance tests (10-50 points), and application exercises (10-50 points) for a maximum of 800 possible points. The students were assigned to a team of five or six fellow students with an emphasis on mixed gender teams, and the students' undergraduate anatomy and physiology grades were considered to attempt to distribute ability equally. On the first day of class, the teams were assigned and introduced to their cadaver. The students remained with the same team throughout the semester. The mixed lecture/TBL format is similar to the traditional TBL design, introduced by Michaelsen [1], consisting of three phases as represented in Fig. 1. Although including lectures in a TBL format is not typical, the TBL-SAI has a subscale that assesses the student's preference for traditional lectures or

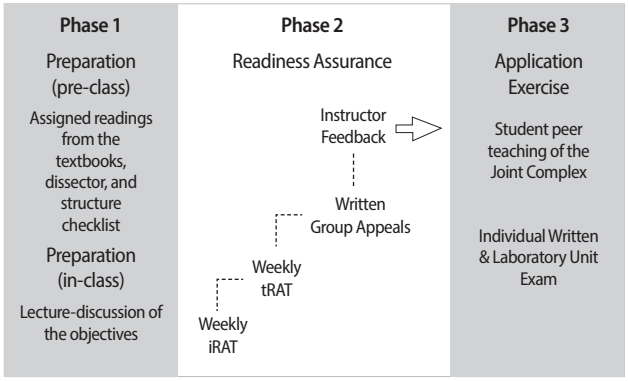

Fig. 1. Mixed team-based learning/lecture phases. iRAT, individual readiness assurance test; tRAT, team readiness assurance test.

TBL activities. Therefore, a lecture component is required, so students can compare these two learning modes. Including lectures also enables the potential to compare our results to the typical coursework of graduate level anatomy students.

There were three phases in the implementation of the mixed lecture/TBL format. In phase I, pre-class preparation, the faculty assigned readings from the required textbook *Clinically Oriented Anatomy* [18]. The faculty created learning modules for Monday and Wednesday's lecture discussions (approximately 90 min/day), followed by team dissections (approximately 2.5 hr/day) that focused on a specific learning objective from the pre-class assignments. These modules require the integration of additional course materials including content from the *Atlas of Human Anatomy* [19] *Finley's Interactive Cadaveric Dissection Guide* [20], and an anatomical structure checklist [21]. A member of the faculty identified the instructional objectives and partitioned the course content into units. At the beginning of the week, the students used available resources, both required and self-obtained, to discuss and learn the objectives. In phase 2, readiness assurance, each student completed ten questions (ten points) of the multiple-choice individual readiness assurance test (RAT) weekly [1]. Following the individual RAT, teams completed a team RAT [1], which was sometimes administered in the cadaver laboratory. The RATs were administered every Friday before the application exercise, which was also administered every Friday, and lasted for three hours, the same amount of time that was dedicated during lecture-discussion on Mondays and Wednesdays. In phase 3, application of the concepts, students engaged in peer-teaching and case discussions centered on the specific joint complex within the region of the body being learned. This component took place in the classroom on tables that were set up to facilitate inter- and intra-team discussions. Application exercises followed "the 4 *S*'s" according to Michaelsen [1]: (1) each team worked on the *same* problem,(2) the problem was clinically *significant*, (3) each team made *specific choices*, (4) the team answered each question related to the application exercise *simultaneously*.

Study instrument

The TBL-SAI developed by Mennenga [17] has been shown to be a valid and reliable assessment tool specifically designed to evaluate student perceptions of TBL. A panel of four TBL experts determined the content validity of the initial 39-item instrument based on a content validity index of 0.89 [17]. Internal consistency assessments were performed on each of the three subscales accountability, preference for lecture or TBL, and student satisfaction as well as the total scale and a Cronbach α of 0.782, 0.893, 0.942, and 0.941 were calculated, respectively [17]. The current TBL-SAI is a 33-item instrument that uses a Likert scale. Each item is scored on a scale from one to five (1, strongly disagree; 2, disagree; 3, neither disagree or agree (neutral); 4, agree; 5, strongly agree) and can be viewed in Appendix 1. The scale allows for neutrality rather than forcing students to disagree or agree. The TBL-SAI is composed of three subscales: (1) Accountability, composed of eight items where scores range from 8-40; (2) Preference for lecture or TBL, containing 16 items where scores range from 16-80; and (3) Student satisfaction, comprising nine items where scores range from 9-45 [17]. The total scores of the TBL-SAI ranges from 33-165. Neutral scores defined by Mennenga [17] are as follows: accountability, 24; preference for lecture or TBL, 48; student satisfaction, 27; and total score, 99. Positive attitudes or experiences are classified as scores that fall above all neutral scores.

Statistical analysis

For each DPT cohort (2013, 2014, and 2015), the mean ± SD for each subscale and total score were calculated. One-way analysis of variance (ANOVA) and Tukey post hoc comparisons were conducted to evaluate differences between the three DPT cohorts for each of the three subscales and the total score. IBM SPSS ver. 21.0 (IBM Co., Armonk, NY, USA) was used to analyze the data, and statistical significance was set at 0.05.

RESULTS

The demographics of the 85 DPT students who participated in this study are shown in Table 1. The means, standard deviations, and histograms for each subscale and for the total score are depicted for each cohort (Figs. 2-5). For all cohorts, the means of the subscale and total score were above the neutral score established by Mennenga [17]. The one-way ANOVA revealed a significant difference among the three groups for the student satisfaction subscale ($F_{2,84} = 6.307$, $P = 0.003$) and for the TBL-SAI total score ($F_{2,84} = 4.066$; $P = 0.021$). Tukey post

hoc comparisons of the three cohorts indicate that the 2015 cohort (mean, 37.97; 95% confidence interval [CI], 35.67 to 40.26) reported significantly higher levels of satisfaction than the 2013 cohort (mean, 32.71; 95% CI, 30.31 to 35.05) and the 2014 cohort (mean, 33.11; 95% CI, 30.69 to 35.53). In addition, the 2015 cohort (mean, 125.3; 95% CI, 120.6 to 130.3) had a significantly higher TBL-SAI total score than the 2013 cohort (mean, 115.6; 95% CI, 110.5 to 120.5); however, none of the other comparisons were statistically significant (Table 2).

Table 1. Physical therapy student demographics who participated in assessment study after team-based learning (TBL) in a graduate level gross anatomy course using the TBL Student Assessment Instrument (TBL-SAI)

Variable	DPT 2013 (n = 28)	DPT 2014 (n = 27)	DPT 2015 (n = 30)
Age (yr)	26.3 ± 1.71	27.6 ± 5.91	26.0 ± 3.52
Gender (female:male)	17:11	18:9	16:14
Average overall points (800 points)	736.27 ± 50.99	705.05 ± 54.36	722.33 ± 45.60
Average grade	A-	B+	A-

DPT, doctor of physical therapy.

DISCUSSION

Eighty-five DPT students reported positive attitudes (several points above the neutral score) on all of the TBL-SAI subscales and for the total TBL-SAI score while achieving an above average grade in gross anatomy (A-, B+, and A- for the 2013, 2014, and 2015 cohorts, respectively) . Differences existed between cohorts for the satisfaction subscale and total score. The most recent DPT cohort (2015) reported the highest level of student satisfaction. Additionally, the 2015 DPT cohort had a higher total score than that of the 2013 cohort.

The accountability subscale assesses a student's preparation for class and their readiness to contribute to their team [17]. Based on a neutral score of 24, the scores of all three cohorts ranged from 31.5 to 33.0 out of 40; therefore, a high level of accountability (19%-22% higher than the neutral score) with team-based learning was found [17]. These results suggest that accountability may be a valued component of the TBL pedagogy for DPT students studying gross anatomy. Student satisfaction refers to positive feelings and attitudes toward a course format (TBL or traditional lectures) [17]. With a neutral score

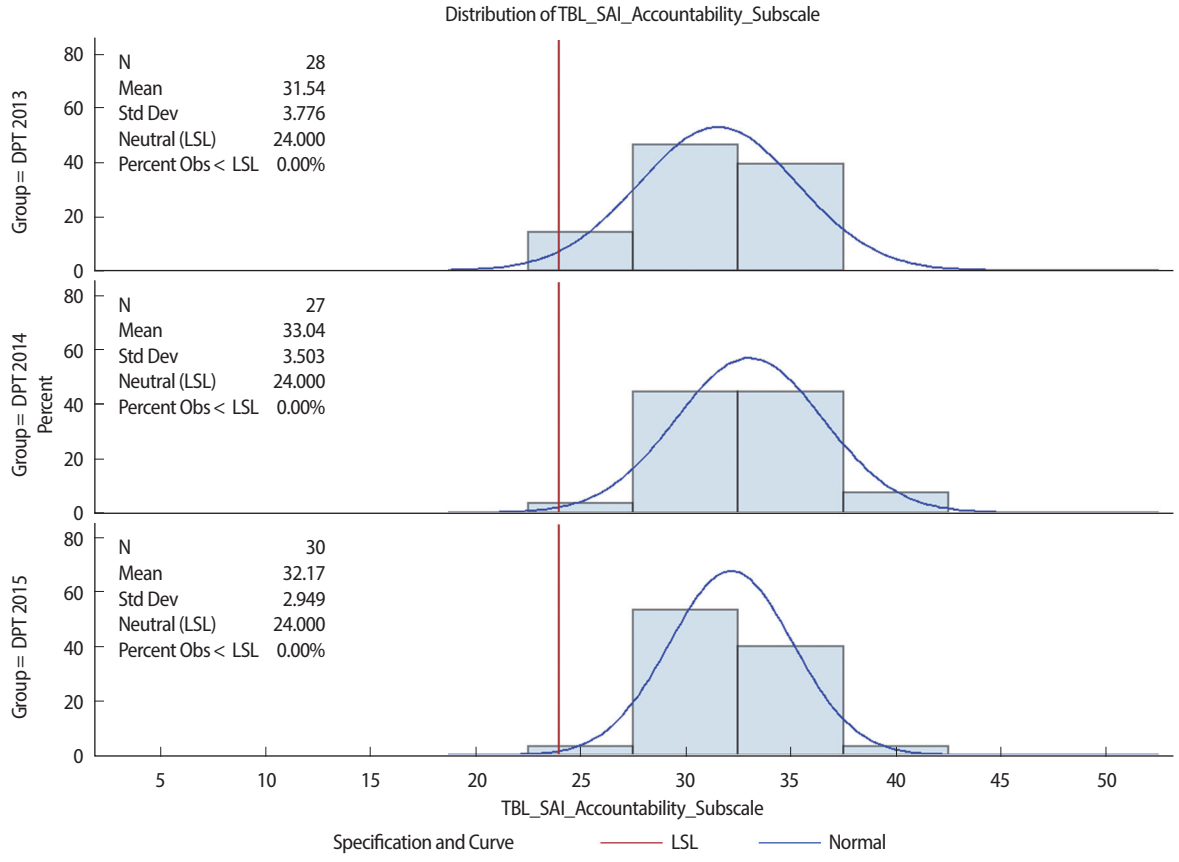

Fig. 2. Accountability subscale. TBL-SAI, Team-Based Learning Student Assessment Instrument; DPT, doctor of physical therapy; Std Dev, standard deviation; Obs, observation; LSL, neutral response score.

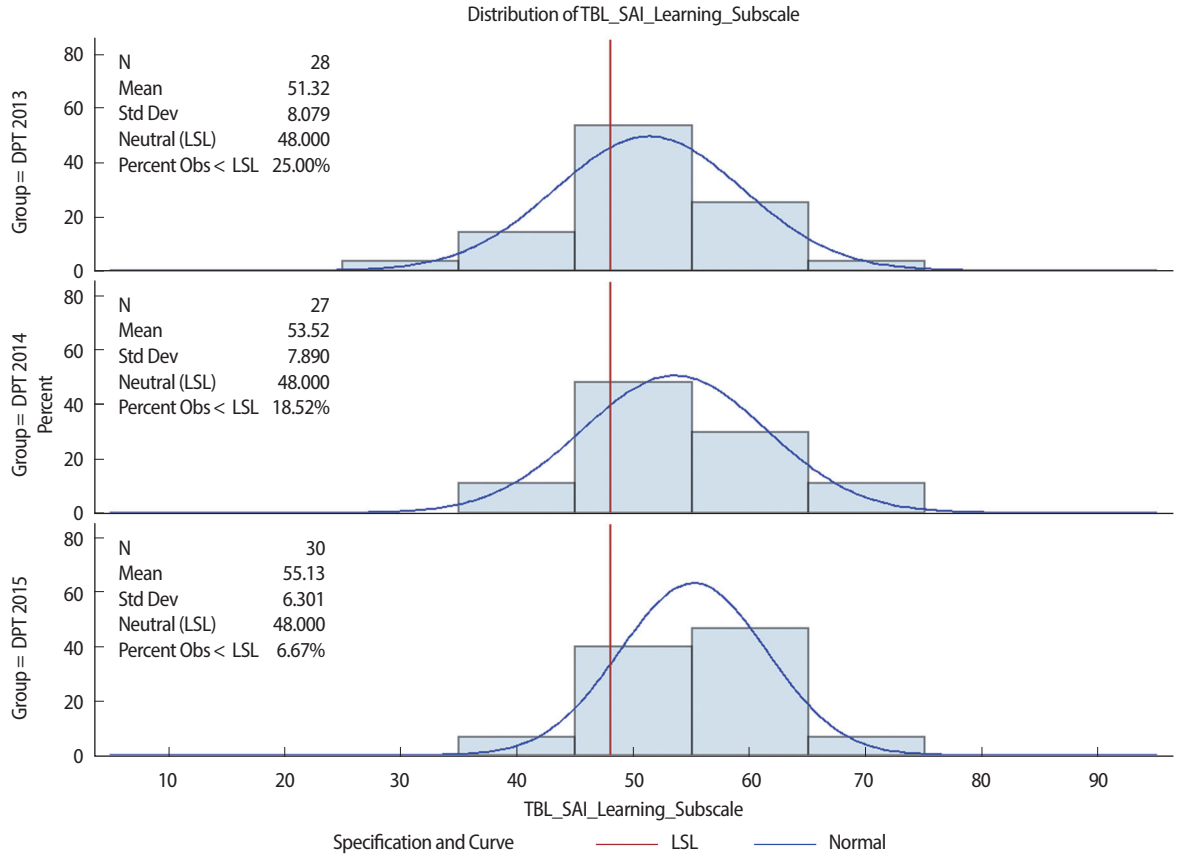

Fig. 3. Preference for lecture or team-based learning subscale. TBL-SAI, Team-Based Learning Student Assessment Instrument; DPT, doctor of physical therapy; Std Dev, standard deviation; Obs, observation; LSL, neutral response score.

of 27 for level of satisfaction, all three cohorts also had high levels of satisfaction with scores ranging from 32.7 to 38.0 out of 45 (13%-24% above the neutral score); thus, our DPT students felt satisfied with the implementation of a TBL strategy in gross anatomy. When we tested for the students' preference for lectures or TBL, we considered the students' ability to recall material and pay attention in lectures versus TBL. All three cohorts scored above the neutral score of 48 (range, 51.3 to 55.1 out of 80). This indicates that students had a slight preference (4%-9% above the neutral score) for TBL.

A recent study published by Mennenga [17] also revealed a similar slight preference for TBL versus lectures using the TBL-SAI. In Mennenga's study [17], 396 undergraduate nursing students in a BSN program were enrolled in a variety of courses that implemented TBL. Although our findings are similar, direct comparisons with our study are difficult because an earlier version of the TBL-SAI was used and sample sizes differed. Although the names of the subscales are the same in both versions of the TBL-SAI, the only subscale that remained the same was the Preference for Lecture or Team-Based Learning subscale[17]. When we compare results for this subscale only, the total population of DPT students scored higher (mean, 53.4 ± 7.51) than the nursing students (mean, 49.5 ± 11.29). In addition, the means of the DPT and nursing students are higher (2% and 7%, respectively) than the neutral score of 48 based on Mennenga's definition [17]; therefore, both groups of students preferred TBL.

Different theories exist that attempt to explain the slight preference for TBL versus traditional lectures. First, the introduction of a new learning strategy in the first semester of graduate school deviates from the traditional teacher-centered lecture format that students typically experience [22]. Secondly, in our study, the questionnaire was administered at the end of the fall 2012 semester, and all three cohorts were at different points in our curriculum. Therefore, the 2013 and 2014 DPT cohorts may not have remembered the TBL strategies as well as the 2015 DPT cohort who had just completed the gross anatomy course or have experienced TBL as recently. Finally, the 2015 DPT cohort, with the highest preference for TBL, had the greatest percentage of Millennial students. Emerging evidence indicates that generational differences influence learning [8,9,11]; Millennials prefer collaborative, learner-centered, ex-

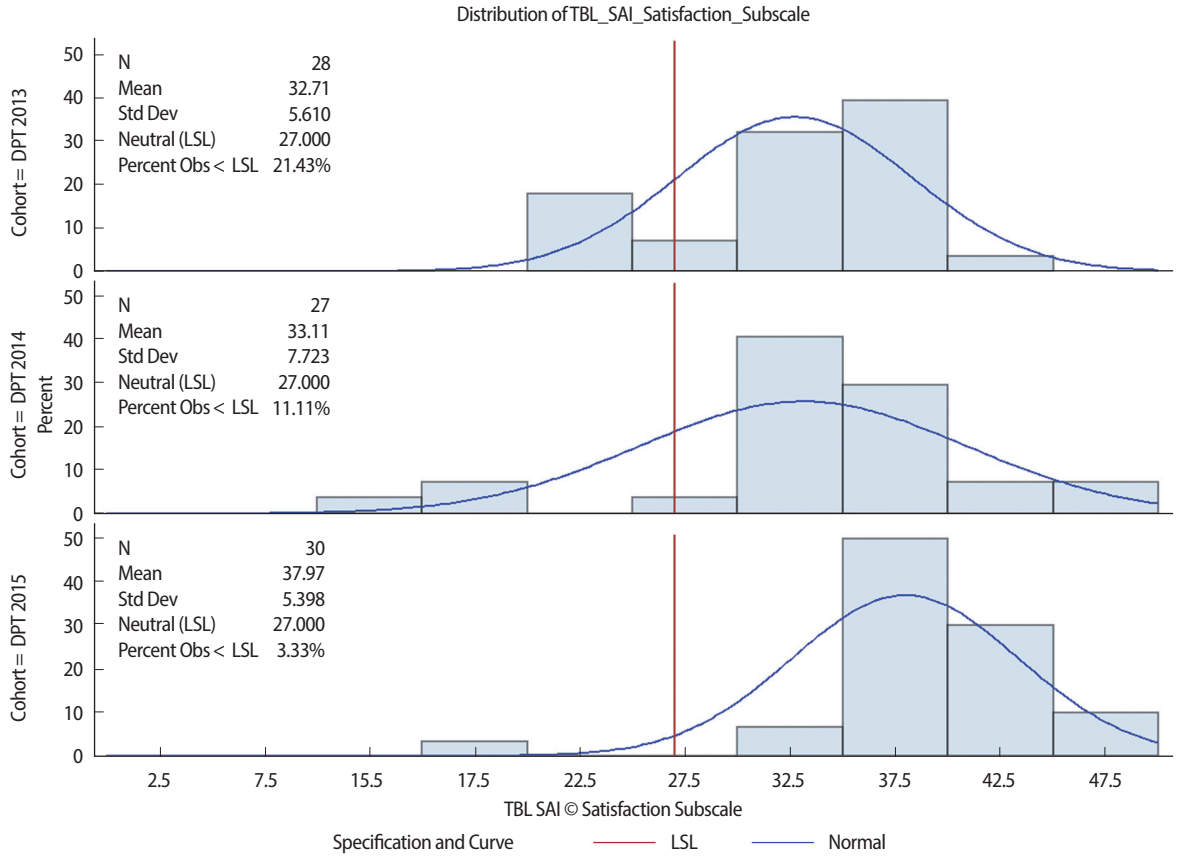

Fig. 4. Student satisfaction subscale. TBL-SAI, Team-Based Learning Student Assessment Instrument; DPT, doctor of physical therapy; Std Dev, standard deviation; Obs, observation; LSL, neutral response score.

periences with clear directions and real-life applications [8].

The direct relationship among student engagement, positive learning outcomes, and student satisfaction has long been established [23]. The more students are engaged in the learning process, the higher the rate of course material retention and degree completion [24]. The learning preferences of the Millennial Generation have been well discussed in the educational literature [11]. Four key preferences have been identified: (1) a desire for active learning, (2) authentic application of course material, (3) working in a diverse team to collaboratively solve problems, and (4) both giving and receiving immediate performance feedback [8]. The TBL instructional strategy described by Michaelsen provides learning opportunities using all four of these preferred learning keys [1]. Despite this reported shift in learning preferences, minimal effort has been made in examining the recommended changes in instructional methods for the Millennial Generation concerning academic or student attitude outcomes. This study is unique in that it examines Millennial student attitudes using a validated instrument (the TBL-SAI) towards an instructional method targeted to their preferences—TBL.

Limitations and future recommendations

The limitations in this study include the ability to generalize these results to other less homogenous populations. This study took place at a single university and in one DPT program. Moreover, this study was only carried out during the first semester of a basic science course. Another limitation is the timing of administration of the TBL-SAI. The 2013 and 2014 DPT cohorts were asked to recall information about the TBL two years and one year after completing the gross anatomy course, respectively. Moreover, the 2013 DPT cohort were surveyed only one week after completing the course. Future studies should compare cohort responses from this survey at the same periods that were used in this study, survey additional DPT programs, and include other DPT courses where TBL can be implemented.

In conclusion, DPT students assessed their overall experience with TBL in gross anatomy as very positive in terms of accountability, preference for learning mode, and satisfaction. Given the traits and learning preferences of the Millennials, TBL could provide a positive experience, successful academic performance, and positive learning outcomes in the healthcare professions.

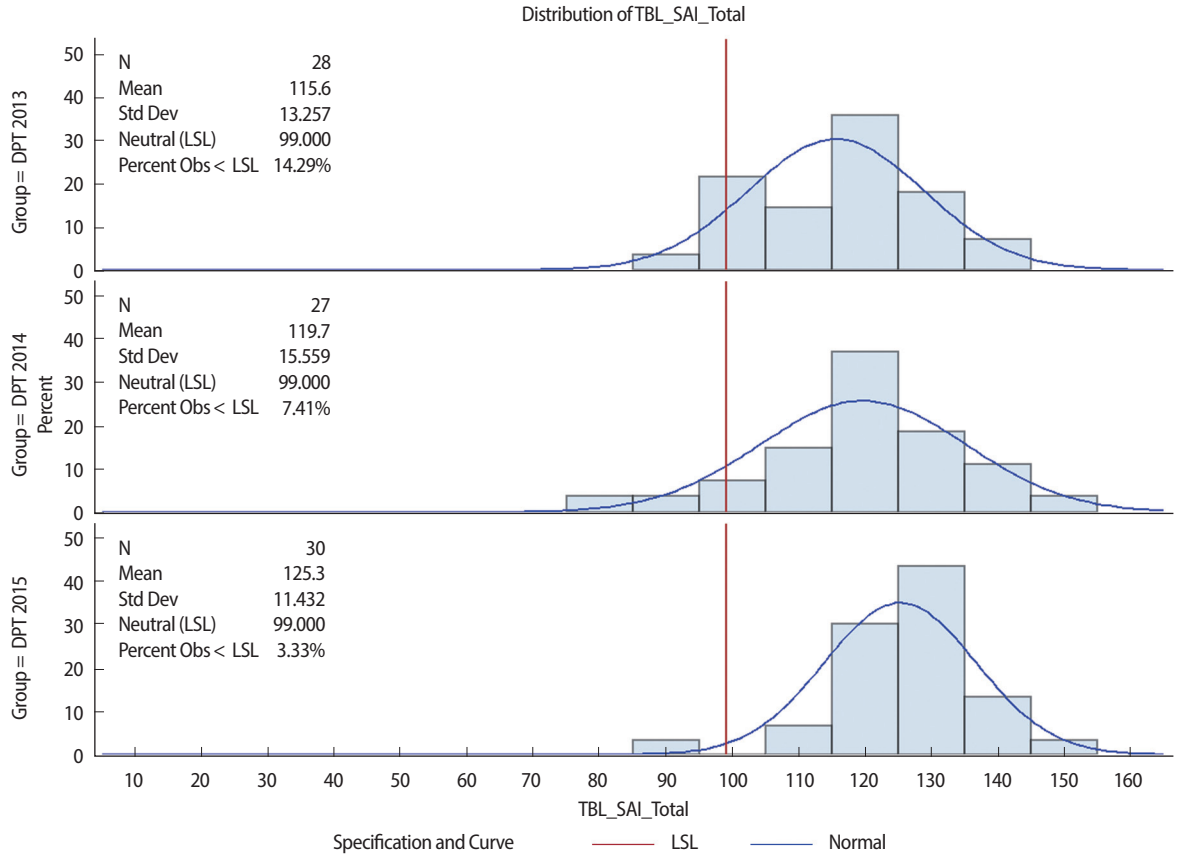

Fig. 5. Total team-based learning student assessment instrument score. TBL-SAI, Team-Based Learning Student Assessment Instrument; DPT, doctor of physical therapy; Std Dev, standard deviation; Obs, observation; LSL, neutral response score.

Table 2. One-way ANOVA for TBL-SAI subscales and total score

	Class	Mean ± SD	Fvalue	P-value	Tukey post hoc	Tukey post hoc P-value	Partial eta^2	Observed power
Accountability subscale	2013	31.54 ± 3.78	1.360	0.262	2013-2014	0.235	0.032	0.285
	2014	33.04 ± 3.50			2013-2015	0.782		
	2015	32.17 ± 2.95			2014-2015	0.577		
Preference for Lecture lecture or TBLeam-Based Learning S subscale	2013	51.32 ± 8.08	2.204	0.117	2013-2014	0.505	0.051	0.438
	2014	53.52 ± 7.89			2013-2015	0.096		
	2015	55.13 ± 6.30			2014-2015	0.616		
Satisfaction subscale	2013	32.71 ± 5.61	6.307	0.003*	2013-2014	0.965	0.133	0.887
	2014	33.11 ± 7.72			2013-2015	0.006*		
	2015	37.97 ± 5.40			2014-2015	0.013*		
Total TBL-SAI score	2013	115.60 ± 13.28	4.066	0.021*	2013-2014	0.237	0.090	0.708
	2014	119.70 ± 15.56			2013-2015	0.016*		
	2015	125.30 ± 11.43			2014-2015	0.237		

ANOVA, one-way analysis of variance; TBL, team-based learning; TBL-SAI, TBL Student Assessment Instrument.
*P < 0.05.

ORCID: Beven Livingston: http://orcid.org/0000-0001-8747-6519; Mary Lundy: http://orcid.org/0000-0001-8249-3643; Shana Harrington: http://orcid.org/0000-0002-3713-3371

CONFLICT OF INTEREST

No potential conflicts of interest relevant to this article are reported by all authors.

SUPPLEMENTARY MATERIAL

Audio recording of abstract

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Appendix 1. Team-Based Learning Student Assessment Instrument (TBL-SAI)

Accountability Subscale

This subscale assesses student preparation for class and contribution to the team.
The scale for the items is as follows:

1 = Strongly disagree
2 = Disagree
3 = Neither disagree or agree (neutral)
4 = Agree
5 = Strongly agree

1. I spend time studying before class in order to be more prepared.	1	2	3	4	5
2. I feel I have to prepare for this class in order to do well.	1	2	3	4	5
3. I contribute to my team members' learning.	1	2	3	4	5
4. My contribution to the team is not important.	1	2	3	4	5
5. My team members expect me to assist them in their learning.	1	2	3	4	5
6. I am accountable for my team's learning.	1	2	3	4	5
7. I am proud of my ability to assist my team in their learning.	1	2	3	4	5
8. I need to contribute to the team's learning.	1	2	3	4	5

Preference for Lecture or Team-Based Learning Subscale

This subscale assesses student ability to recall material and student attention level in lecture and team-based learning.
The scale for the items is as follows:

1 = Strongly disagree
2 = Disagree
3 = Neither disagree or agree (neutral)
4 = Agree
5 = Strongly agree

1. During traditional lecture, I often find myself thinking of non-related things.	1	2	3	4	5
2. I am easily distracted during traditional lecture.	1	2	3	4	5
3. I am easily distracted during team-based learning activities.	1	2	3	4	5
4. I am more likely to fall asleep during lecture than during classes that use team-based learning activities.	1	2	3	4	5
5. I get bored during team-based learning activities.	1	2	3	4	5
6. I talk about non-related things during team-based learning activities.	1	2	3	4	5
7. I easily remember what I learn when working in a team.	1	2	3	4	5
8. I remember material better when the instructor lectures about it.	1	2	3	4	5
9. Team-based learning activities help me recall past information.	1	2	3	4	5
10. It is easier to study for tests when the instructor has lectured over the material.	1	2	3	4	5
11. I remember information longer when I go over it with team members during the GRATS (group readiness assurance test) used in team-based learning.	1	2	3	4	5
12. I remember material better after the application exercises used in team-based learning.	1	2	3	4	5
13. I can easily remember material from lecture.	1	2	3	4	5
14. After working with my team members, I find it difficult to remember what we talked about during class.	1	2	3	4	5
15. I do better on exams when we used team-based learning to cover the material.	1	2	3	4	5
16. After listening to lecture, I find it difficult to remember what the instructor talked about during class.	1	2	3	4	5

Student Satisfaction Subscale

This subscale assesses student satisfaction with team-based learning.
The scale for the items is as follows:

1 = Strongly disagree
2 = Disagree
3 = Neither disagree or agree (neutral)
4 = Agree
5 = Strongly agree

1. I enjoy team-based learning activities.	1	2	3	4	5
2. I learn better in a team setting.	1	2	3	4	5
3. I think team-based learning activities are an effective approach to learning.	1	2	3	4	5
4. I do not like to work in teams.	1	2	3	4	5
5. Team-based learning activities are fun.	1	2	3	4	5
6. Team-based learning activities are a waste of time.	1	2	3	4	5
7. I think team-based learning helped me improve my grade.	1	2	3	4	5
8. I have a positive attitude towards team-based learning activities.	1	2	3	4	5
9. I have had a good experience with team-based learning.	1	2	3	4	5

Please add any comments you may have about your experience with team-based learning.