

# Using practical-based team-based learning (PTBL) as a tool for providing an immediate feedback to the students during Anatomy Education

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## SUMMARY

Team-based learning (TBL) is a student-centered learning strategy, which has been confirmed in medical education to enhance learning. Nevertheless, it has not been implemented during practical anatomy learning that challenges the spatial perception of the learned material in contrast to other disciplines. This study aims to present a novel intervention in using practical-based team-based learning (PTBL) in anatomy and its impact as a tool for providing immediate feedback. It also determines students' perceptions of the PTBL and the effect of the given feedback on anatomy learning. The students were subjected to a formative objective structured practical examination (OSPE) in two successive formats: individual readiness assurance test (iRAT) and team readiness assurance test (tRAT). In the iRAT, individual students rotated around the practical stations in the form of a steeplechase examination. For the subsequent tRAT, groups of 5 students rotated around the same practical stations. The session was concluded by discussing the practical stations with the tutor and immediate feedback about the students' performance was provided along with an explanation of the reasoning behind judgments and practical assessment criteria. Students' perception

(N=90) was measured through a self-administered questionnaire and a comparison of test scores. There was a significant rise in the average final summative OSPE scores of the students ( $p$ -value=0.029) comparing their results to the previous semester in which PTBL was not implemented, concluding that PTBL is a valuable pedagogical instrument that can be employed as an effective method for providing immediate feedback during anatomy education.

**Key-words:** Anatomy practical – TBL – Active learning – Action learning – Peer teaching

## INTRODUCTION

In recent decades, basic science education in medicine has shifted from traditional discipline-based courses to integrated systems-based courses in the preclinical curriculum (Drake, 2014; Bock et al., 2019). Human anatomy is considered the cornerstone of medical education. Traditionally, cadaver dissections and didactic lectures were the means for teaching anatomy. Nowadays, and in view of curricular changes, traditional teaching methods are gradually giving way to new strategies. There is a tendency to move away from "passive" learning, which lectures represent, and to introduce new systems which actively engage students (Vankova, 2012; Woodcock et al., 2019). The active engagement of the learner in the learn-

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ing process can mean engagement with others, as in interactive activities, or engagement with the material, as in reading, writing, formulating questions and responses to questions. Most educators agree that active learning is key to effective education (Marcos et al., 2004; Jabbar et al., 2017).

People learn in different ways and being able to interact is more important to some than to others. Research has shown that interaction with colleagues is important to enhance critical thinking, and it is an essential aspect of adopting new information into practice (Lloyd et al., 2018). Looking at the learning objectives of Bloom's taxonomy we will notice that most anatomy education objectives are located in the lower three levels: remembering (knowledge), understanding (comprehension) and application (Bloom et al., 1956; Anderson et al., 2001; Hulme et al., 2019). Even with modern methods of teaching, students still require to memorize gross anatomical structures and their three-dimensional relationships. Thus, active learning methods would better fit in supplementing anatomy teaching modules rather than completely replacing traditional cadaveric demonstration. To achieve this goal, active learning in anatomy should be planned so that the appropriate technique is chosen within a physical setup and during the time allocated. Active learning is student-centered; and the instructor's role should not be confined to an information provider, but should be rather like a facilitator who creates an interactive and collaborative environment (McCoy et al., 2018).

Team-based learning (TBL) is a student-centered learning strategy which has been adopted in medical education to enhance active learning in small groups (Jabbar et al., 2017; Jaime et al., 2018; Burgess et al., 2018). Nevertheless, there remains controversy over the effectiveness of TBL in anatomy education where TBL falls short in adapting to practical teaching that requires spatial comprehension of the learned material in contrast to other disciplines. Consequently, an intervention was introduced to incorporate practical objectives.

This study aims to present a novel intervention in using practical-based team-based learning (PTBL) in anatomy and to evaluate its impact as a tool for providing immediate feedback. It also determined students' perceptions towards PTBL and the effectiveness of the given feedback on anatomy learning.

## METHODS

This research was granted ethical clearance from the University of Sharjah Research Ethics Committee. The study included second-year medical students at the College of Medicine, University of Sharjah, UAE. A Problem-Based Learning (PBL) curriculum that is body-system-oriented and distinguished by a significant degree of integration between disciplines is being used. During the anat-

my lab sessions, students spend time with cadaveric prosections, plastic specimens and plastinated models. Practical assessment is in the form of objective-structured practical examination (OSPE) at the end of each semester. The individual students rotate around the practical stations in the form of a steeplechase examination. During the first semester of the year, and before the final summative exams, the students went through a formative OSPE as a preparation for them to understand the practical aspects of anatomical knowledge. During the second semester of the year, the same cohort of the students were introduced to the PTBL, where the students were subjected to the formative OSPE in two successive formats; the individual readiness assurance test (iRAT) and the team readiness assurance test (tRAT). In the iRAT, the individual students rotated around the practical stations. For the subsequent tRAT, groups of 5 students rotated around the same practical stations in the same format where they discussed their answers together and came up with one single answer sheet for each group. The session was concluded by discussing the answers by the tutor through projection of photographs of the stations in the classroom, and during that an immediate feedback about the students' performance was provided. Amid the feedback period, the practical objectives were adequately highlighted by the faculty member, and the reasoning behind judgments was analyzed with complete clarification of the students' inquiries. Next, a self-administered questionnaire was utilized to assess the students' perception about the PTBL session.

At the end of each semester, the students went through the end of semester examination where OSPE and multiple-choice question (MCQ) format examinations. The MCQ exam includes all the subjects studied during the semester.

A total of 90 students completed the self-administered questionnaire and reported their perception of the practical-based TBL session effectiveness. The questionnaire comprised of 18 items and the participants were asked to express their level of agreement or disagreement with each statement using a 5-point Likert scale (1-Strongly disagree, 2-Disagree, 3-Uncertain, 4-Agree, 5-Strongly agree).

The scores of the students in the first semester (Semester 1 Formative OSPE, Semester 1 summative OSPE and Semester 1 final MCQ Exam) were then compared to their marks in the subsequent semester (Semester 2 iRAT, Semester 2 tRAT, Semester 2 summative OSPE and Semester 2 final MCQ Exam) to delineate a quantitative measure of the impact of the practical-based TBL session.

The data was analyzed using the Statistical Package for the Social Sciences (SPSS) software version 22 for analysis. Descriptive statistics were used to portray the results of the questionnaire and

the paired samples t-test was used to compare the average marks between the first and second semesters. A p-value of 0.05 was considered to be statistically significant.

## RESULTS

The majority of the students mentioned that they enjoyed PTBL setup, with a mean rating of 3.90. (Table 1) The results also demonstrated that the

**Table 1.** Responses of the students to the items on the questionnaire. The responses are recorded on a Likert scale and the percentage of students choosing each response are shown. The mean rating for the responses on the Likert scale with the standard error of the mean (SEM) are also illustrated

	1-Strongly Disagree	2- Disagree	3- Uncertain	4- Agree	5- Strongly Agree	Mean rating	SEM
I enjoyed the PTBL session	3%	6%	19%	42%	30%	3.90	(0.106)
PTBL stimulated motivation to attend	1%	3%	10%	38%	48%	4.28	(0.091)
PTBL provides environment for inter & intra group discussion	5%	11%	12%	41%	31%	3.83	(0.119)
PTBL provided opportunity to improve my knowledge from peers	3%	5%	13%	49%	30%	3.98	(0.101)
PTBL highlighted the areas of my weakness	0%	4%	7%	29%	60%	4.44	(0.085)
PTBL provides a venue for a weaker student to cover learning objectives	5%	7%	13%	42%	33%	3.93	(0.113)
PTBL helped me to understand cross-sectional anatomy questions	1%	3%	20%	47%	29%	3.99	(0.090)
PTBL helped me to understand radiological anatomy questions	3%	8%	18%	38%	33%	3.90	(0.112)
PTBL helped me to understand histology questions	1%	6%	7%	42%	44%	4.23	(0.094)
PTBL helped me to understand embryology questions	9%	14%	21%	30%	26%	3.49	(0.133)
PTBL improved the exam self confidence	12%	12%	18%	21%	37%	3.58	(0.148)
My colleagues distracted me during the PTBL	49%	30%	13%	5%	3%	1.83	(0.110)
PTBL can be used as an alternative to using MCQs in anatomy	5%	14%	16%	37%	28%	3.67	(0.125)
The feedback given after PTBL has helped me to identify my strengths and weaknesses	0%	10%	21%	45%	24%	3.83	(0.096)
The faculty has provided me with specific advice on how to improve my performance	3%	12%	27%	33%	25%	3.63	(0.114)
The feedback given after PTBL clarified the reasoning behind judgments	3%	18%	23%	31%	25%	3.56	(0.120)
The feedback given after the PTBL improved my understanding	3%	5%	21%	45%	26%	4.13	(0.161)
PTBL feedback helped me to utilize the course concepts in thinking and problem solving	2%	14%	21%	42%	21%	3.67	(0.108)

**Table 2.** Results of the tests in both semesters. The mean scores for each test are recorded in the table along with the standard error of the mean (SEM). The paired sample t-test was used to compare the marks of the students between the two semesters and the p-values are presented \*significant

Semester 1			Semester 2			P value
	Average score (%)	SEM		Average score (%)	SEM	p-value
<b>Formative OSPE</b>	69.2	(1.768)	<b>iRAT</b>	65.3	(1.594)	0.141
			<b>tRAT</b>	90.0	(1.112)	
<b>Summative Final OSPE</b>	78.1	(1.499)	<b>Summative Final OSPE</b>	80.7	(1.296)	0.029*
<b>Final MCQ Exam</b>	77.0	(1.056)	<b>Final MCQ Exam</b>	77.5	(1.064)	0.252

interactive new method stimulated the students' motivation to attend the session (mean rating of 4.28). Furthermore, 72% of the students reported that the PTBL arrangement offered an environment that promoted interaction and discussion both within the members of each team (intra-group discussion) and between the various teams in the classroom (inter-group discussion). This interaction was effective, as the students reported that PTBL helped them to improve their knowledge from their peers (mean rating of 3.98), aided them in identifying the areas of their weaknesses (mean rating of 4.44) and facilitated the weaker student to cover the learning objectives as well (mean rating of 3.93). The benefits of the PTBL are further highlighted with the results showing that it assisted the students to understand the questions related to cross-sectional anatomy (mean rating of 3.99), radiological anatomy (mean rating of 3.90), histology (mean rating of 4.23) and embryology (mean rating of 3.49). While only eight percent of the students mentioned that they were distracted by their colleagues during the PTBL sessions, seventy-nine percent disagreed with that statement. Additionally, 58% reported that the setup of the PTBL session improved their self-confidence for the exam. Also, sixty five percent of the students supported the use of the PTBL layout as an alternative to using MCQs format tests for anatomy.

The results also demonstrated a positive response towards the immediate feedback given after the tRAT session, where the students valued the faculty feedback as helpful in improving their performance (mean rating of 3.63) and pinpointing their strengths and weaknesses (mean rating of 3.83). The majority of students agreed with the statement that the immediate feedback improved their understanding (mean rating of 4.13). Another advantage of the feedback was that according to fifty-six percent of the students, it clarified the reasoning behind judgments when solving the anatomy OSPE questions. The PTBL feedback was further reported to assist the students in utilizing the course concepts in thinking and problem solving with a mean rating of 3.67.

Regarding the quantitative measure of the impact

of the PTBL session, the scores for the assessments in the first semester were compared with those of the second semester (Table 2). A significant rise in the final OSPE scores (p-value=0.029) has been detected between the first and the second semesters final OSPEs, where semester 1 OSPE average score was 78.1%, which increased significantly to 80.7% for the Semester 2 OSPE. However, no significant difference was detected in the MCQ exams results between the first and second semesters where the assessments included all subjects within the basic sciences (p-value=0.252).

The average marks of the formative test (individual based assessment) were 69.2% and 65.3% within the first and second semesters respectively, which shows an insignificant decline of 3.9% in the scores (p-value=0.141). However, the role of the TBL comes to light with the tRAT, where compared to the iRAT a dramatic upsurge of 24.7% in the average marks was observed with the tRAT scores.

## DISCUSSION

The process of curriculum reform and the incorporation of new pedagogical resources have transformed anatomy education. TBL is a student-centered learning strategy that empowers student engagement and active learning. Active engagement of students ensures a pleasant and enjoyable venue that would consolidate student motivation (Nieder et al., 2005; Jabbar et al., 2017). The students in this study showcased their enjoyment of the PTBL sessions and its role in encouraging them.

Anatomy is a unique subject that demands a high standard of spatial comprehension and therefore a modified PTBL approach would be more suitable. The small-group setting enables interaction and deep discussions between the team members. This has been shown to promote the development of skills required for teamwork and improve student participation (Johansson et al., 2018; Viana et al., 2019). Additionally, previous studies have reported that students find topics to be easier to un-

derstand when discussed among themselves as a group (Jabbar et al., 2017; Yan et al., 2018). The presence of variations in the level of knowledge of the course contents among students is an evident element. In line with that, the small-group discussions would be expected to provide a peer-to-peer learning platform. Indeed, the results of the current study showed that PTBL can fulfill the expectation where students were capable of identifying their weaknesses and boost their knowledge through peer discussions.

An added benefit is that the academically weaker students will get an opportunity to cooperate and intermingle with their colleagues, which could enhance their understanding of the complex concepts. In the current study, the majority of the students (75%) agreed that the PTBL had provided the venue for a weaker student to cover the learning objectives. Studies have reported that incorporation of TBL in the anatomy course increases their performance (Vasan et al., 2008) and peer assisted learning is at least as effective as traditional didactic methods among medical students (Anantharaman et al., 2019).

An adverse effect of the free communication in small groups could be that a student could get distracted and the discussion may tend to deviate from the learning objectives. Our results showed that only 8% of the participants mentioned that they got sidetracked by their colleagues, while 79% refused that they were distracted by the PTBL discussions. This may be due to a bad group member or a slacker. However, an adequate setup and the role of faculty as a moderator could help to prevent this. White et al. stated that distraction usually happens when the students sit with their friends and feel less pressure and embarrassment when criticized by a friendly classmate (White et al., 2014).

An important aspect of the PTBL framework is to provide students with immediate feedback by the faculty to enhance their understanding and clarify their queries. In this research study, students reported a positive response to the effect of immediate feedback on their anatomy learning. Many times, although students may be informed about the correct solutions to a question, they may not fully comprehend the thought process of tackling the problem and deducing the correct result. Therefore, it is imperative to teach students such skills to enhance deeper understanding of practical anatomy. Actually, 71% of the students agreed that immediate feedback improved their understanding and 56% mentioned that it clarified the reasoning behind judgments. Additionally, around two thirds of the students mentioned that the faculty feedback in the PTBL provided them with specific advice on how to improve their performance. The PTBL design houses an excellent opportunity for these crucial factors to be explained to students through the immediate feedback section.

Several authors highlighted the effect of immediate feedback with the correct answers after exams so that incorrect answers do not become 'learned' by the students (Eladi et al., 2018; White et al., 2019). Furthermore, according to 63% of the students, the PTBL allowed them to utilize the course concepts in thinking and problem solving. Literatures have reported that TBL has given students the opportunity to develop higher reasoning skills (Nieder et al., 2005; Oakes et al., 2019), and the students' perceived team-based learning to have aided in nurturing their critical thinking and problem solving skills (De Sam Lazaro and Riley, 2019).

The main output to assess the impact of PTBL would be the results of the end of semester OSPE examinations in the two semesters. Semester 1 OSPE average score was 78.1%, which increased significantly to 80.7% for the Semester 2 OSPE ( $p$ -value=0.029). This significant rise exemplifies the impact of PTBL on enhancing the anatomy education. Moreover, no difference was seen for the MCQ Exams in the first and second semesters where the assessments included all subjects within the basic sciences ( $p$ -value=0.252). Additionally, fifty eight percent of the students mentioned that the PTBL had improved their exam self-confidence, which could be one of the contributing factors leading to the elevated results seen in final semester 2 OSPE. These results further support the role of PTBL as a vital pedagogical tool supplementing the anatomy education.

The formative OSPE in the first semester was compared to the iRAT of the PTBL in the second semester, with no significant differences observed in the average scores. The students obtained much higher scores in the tRAT compared with the iRAT, where a rise in average marks of roughly 25 percent was detected. It can be generally expected to observe an improvement in scores in the group test compared to the individual assessment. Similar results were noted by several authors who compared iRAT with tRAT in the TBL setup (Nieder et al., 2005; Vasan et al., 2008). This could be attributed to peer discussion and group learning.

Although there was a significant rise in the OSPE mean score in the second semester compared to the first, no such change was spotted with the MCQ Exam, indicating that the improvement in the exam performance was exclusive to the anatomy practical topics. This may be attributed to the better understanding of the students to the practical anatomy concepts. The PTBL structure is an adequate setup that can broaden the anatomical knowledge of students, while at the same time prepare them for examinations by implanting exam-taking strategies. Peer teaching, better understanding the reasoning behind judgments and explanation of the assessment criteria by an immediate feedback are major factors that support this hypothesis.

## CONCLUSION

Practical-based team based learning (PTBL) is a valuable pedagogical tool supplementing the anatomy education and can be employed as an effective tool for providing immediate feedback during anatomy learning. Both the perceptions of the students and the improvement in the average student scores display it as an effective active learning instrument in anatomy education.

## REFERENCES

- ANANTHARAMAN LT, RAVINDRANATH Y, DAYAL S, SHANKAR N (2019) Peer-assisted learning versus didactic teaching in osteology for first-year Indian undergraduate medical students: a quasi-experimental study. *Surg Radiol Anat*, 41(10): 1163-1171.
- ANDERSON LW, KRATHWOHL DR, AIRASIAN PW, CRUIKSHANK KA, MAYER RE, PINTRICH PR, et al. (2001) A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives, abridged edition. White Plains, NY: Longman.
- BLOOM B, ENGLEHART MF, HILL W, KRATHWOHL D (1956) Taxonomy of educational objectives: The classification of educational goals. Handbook I: Cognitive domain. Longmans, Green. New York, Toronto.
- BOCK A, MODABBER A, HÖLZLE F, PRESCHER A, CLASSEN-LINKE I (2019) Improvement of anatomical knowledge and surgical skills in head and neck region - An interdisciplinary hands-on course for clinical students. *Ann Anat*, 224: 97-101.
- BURGESS A, ROBERTS C, AYTON T, MELLIS C (2018) Implementation of modified team-based learning within a problem based learning medical curriculum: a focus group study. *BMC Med Educ*, 18(1): 74.
- DRAKE RL (2014) A retrospective and prospective look at medical education in the United States: Trends shaping anatomical sciences education. *J Anat*, 224(3): 256-260.
- DE SAM LAZARO SL, RILEY BR (2019) Developing critical thinking in OT education: effectiveness of a fishbowl approach. *J Occup Ther Educ*, 3(2): 1.
- ELADL MA, ABDALLA ME, RANADE A (2018) A mixed method study to validate a two-way feedback between student and faculty to improve learning of anatomy. *Anat Cell Biol*, 51(2): 98-104.
- JABBAR HA, JARRAHI AH, VAMEGH MH, MOH'D ALHABAHEH DA, MAHMOUD NA, ELADL MA (2017) Effectiveness of the team-based learning (TBL) strategy on medical students' performance. *J Taibah Univ Med Sci*, 13(1): 70-76.
- JAIME PC, TRAMONTT CR, GABE KT, DOS REIS LC, DE MATTOS MAIA T (2018) Students' perceptions of team-based learning in an undergraduate nutrition school. *Med Ed Publish*, 7.
- JOHANSSON E, HOLMIN TE, JOHANSSON BR, BRAIDE M (2018) Improving near-peer teaching quality in anatomy by educating teaching assistants: An example from Sweden. *Anat Sci Educ*, 11(4): 403-409.
- HULME AK, LUO K, ŠTRKALJ G (2019) Musculoskeletal anatomy knowledge retention in the macquarie university chiropractic program: a cross-sectional study. *Anat Sci Educ*, doi: 10.1002/ase.1879.
- LLOYD M, BOR R, NOBLE LM (2018) Clinical communication skills for medicine: Elsevier Health Sciences.
- MARCOS P, ARROYO-JIMÉNEZ M, ARTACHO-PERULA E, MARTINEZ-MARCOS A, BLAIZOT X, ALFONSO-ROCA M, BRANDA L, INSAUSTI R (2004) Self-directed learning in the Gross Anatomy medical curriculum. *Eur J Anat*, 8(3): 147-153.
- MCCOY L, PETTIT RK, KELLAR C, MORGAN C (2018) Tracking active learning in the medical school curriculum: a learning-centered approach. *J Med Educ Curric Dev*, 5: 2382120518765135.
- NIEDER GL, PARMELEE DX, STOLFI A, HUDES PD (2005) Team-based learning in a medical gross anatomy and embryology course. *Clin Anat*, 18(1): 56-63.
- OAKES DJ, HEGEDUS EM, OLLERENSHAW SL, DRURY H, RITCHIE HE (2019) Using the Jigsaw method to teach abdominal anatomy. *Anat Sci Educ*, 12(3): 272-283.
- VANKOVA M (2012) Modern trends in anatomy teaching. *Scripta Scientifica Medica*, 44(1): 7-10.
- VASAN NS, DEFOUW DO, HOLLAND BK (2008) Modified use of team-based learning for effective delivery of medical gross anatomy and embryology. *Anat Sci Educ*, 1(1): 3-9.
- VIANA RB, CAMPOS MH, SANTOS DAT, XAVIER ICM, VANCINI RL, ANDRADE MS, DE LIRA CAB (2019) Improving academic performance of sport and exercise science undergraduate students in gross anatomy using a near-peer teaching program. *Anat Sci Educ*, 12(1): 74-81.
- WHITE C, BRADLEY E, MARTINDALE J, ROY P, PATEL K, YOON M, WORDEN MK (2014) Why are medical students 'checking out' of active learning in a new curriculum? *Med Educ*, 48(3): 315-324.
- WHITE LJ, MCGOWAN HW, MCDONALD AC (2019) The effect of content delivery style on student performance in anatomy. *Anat Sci Educ*, 12(1): 43-51.
- WOODCOCK J, LACKEY-CORNELISON W, ISAAC C (2019) Engage students through active learning and peer teaching in a prosection-based anatomy lab. *FASEB J*, 33(1 supplement): 605.6-6.
- YAN J, DING X, XIONG L, LIU E, ZHANG Y, LUAN Y, QIN L, ZHOU C, ZHANG W (2018) Team-based learning: assessing the impact on anatomy teaching in People's Republic of China. *Adv Med Educ Pract*, 9: 589-594.