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Original Article

Anatomy Section

Effectiveness of Team-based Learning as Teaching-learning Method in Neuroanatomy for Phase 1 MBBS Students: A Quasi-experimental Study

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ABSTRACT

Introduction: Team-Based Learning (TBL), originally developed in business education, has emerged as an effective pedagogical strategy in the health sciences due to its structured, collaborative framework that promotes active knowledge application and teamwork. Traditional lecture-based approaches are often inadequate in fostering higher-order cognitive skills, underscoring the need for innovative Teaching-Learning (TL) methods such as TBL. This approach facilitates deeper understanding and enhances long-term retention, particularly in complex disciplines such as neuroanatomy.

Aim: To assess the effectiveness of TBL as a TL method in neuroanatomy among Phase I Bachelor of Medicine and Bachelor of Surgery (MBBS) students and to obtain feedback following the session.

Materials and Methods: A quasi-experimental study was conducted to evaluate TBL among Phase I MBBS students of the 2024-2025 batch in the Department of Anatomy at NRI Medical College, Chinakakani, Guntur, Andhra Pradesh, India, over a duration of two months (February 2025 to March 2025). The study was conducted among all 200 students using convenience sampling. The TBL process comprised three stages: self-preparation (Stage 1), Individual Readiness Assurance Tests (IRAT) and Team Readiness Assurance Tests (TRAT) (Stage 2), and team-based clinical application (Stage 3). Online anonymous feedback was collected using a pre-validated questionnaire on the usefulness of TBL through Google Forms. The responses were recorded on a 5-point Likert scale and presented as percentages in tabular form. Multiple Choice Question (MCQ)-based pre-test and post-test scores were analysed using descriptive statistics and a paired t-test with Statistical Package for the Social Sciences (SPSS) software.

Results: The mean score of the pre-test, IRAT, was 3.78, while the TRAT score was 6.75. The post-test score, conducted after two weeks to assess content retention, was 8.14, demonstrating a statistically significant improvement in content retention ($p < 0.001$). Most students agreed that TBL enhanced engagement, team interaction, and the clinical application of knowledge.

Conclusion: TBL combines the advantages of both small and large group TL formats, as it promotes active participation, critical thinking, and peer-assisted learning when students work in teams, while also facilitating interactive discussion with the instructor. Its structured approach enables in-depth understanding of complex subjects such as neuroanatomy. Therefore, its incorporation into the curriculum is recommended for Phase I MBBS students, wherever appropriate.

Keywords: Active learning, Knowledge retention, Medical education, Self-directed learning

INTRODUCTION

Owing to the shift in curriculum design from a teacher-centric approach to a learner-centric mode, TL methods have been adapted to promote active learning among students [1-3]. Interactive lectures, quizzes, seminars, brainstorming sessions, buzz groups, flipped classrooms, snowballing, audience response systems, computer-assisted learning, and TBL are various interactive Large Group Teaching (LGT) methods, while tutorials, Case-Based Learning (CBL), Problem-Based Learning (PBL), Direct Observation and Assisted Performance (DOAP), bedside teaching, and jigsaw are Small Group Teaching (SGT) methods available in the literature.

The TBL incorporates both LGT and SGT as interchangeable components [4,5]. This method was first adopted in business schools and later extended to medical education [6]. TBL is conducted in three main stages. Stage 1 is a pre-classroom self-preparatory phase in which students receive information about the topic and its objectives. Stage 2 assesses student performance through Readiness Assurance Tests (RAT), conducted IRAT and in TRAT. The third stage, Team Application (T-App), involves teams working on clinically oriented, context-based questions to be presented within a stipulated time. During team activities, collaborative skills develop along with the exchange of knowledge [7].

Anatomy is a foundational medical science with extensive content to be learned. The subject is delivered in general mainly through lectures, embryology model studies, charts, tutorial-based study of bones, cadaveric dissection and demonstration through DOAP. These methods facilitate active learning to some extent but lack a standard teaching learning format with assessment. Structured methods such as TBL, when incorporated into the curriculum, help students develop the affective domain through collaborative learning and enhance cognitive skills from basic recall to higher levels of application [4,7-9].

The TBL has been adopted as a teaching–learning method in many medical schools abroad and in India, primarily involving students in clinical years [2,8,10,11]. A few studies [12-16] conducted in India have addressed Phase I students; however, studies on TBL in Neuroanatomy are scarce. The aim of present study was to implement a Neuroanatomy TBL module in a feasible manner for a large group of 200 students; as such an approach has not been previously reported from this region.

MATERIALS AND METHODS

A quasi-experimental study was conducted on TBL for Phase 1 MBBS students of the 2024-25 batch in the Department of Anatomy

at NRI Medical College, Chinakakani, Andhra Pradesh, India over a period of two months- February 2025 to March 2025 after obtaining approval from the Institutional Ethical Committee (IEC 2025 F012).

Inclusion and Exclusion criteria: In the present study, convenience sampling was used. All eligible first-year MBBS students who participated in the TBL session during the study period were included, while absentees were excluded. A total of 200 students initially constituted the study population. Among them, 189 students participated in the TBL session and were included in the final analysis. Eleven students who were absent on the day of the intervention were excluded.

Study Procedure

Neuroanatomy was taught to students through demonstration of dissected wet specimens, SGT at dissection tables, and interactive lectures over a period of 20 days. TBL was planned after the completion of regular teaching in Neuroanatomy, with the objective of helping students integrate the subject with functional and clinical correlations.

In Stage 1, an initial orientation session was conducted for all 200 students in the form of a mini-lecture outlining the various stages of TBL. Subsequently, an assignment was administered to facilitate self-directed learning, wherein students were instructed to study the content in accordance with the stated objectives and prescribed learning materials, with emphasis on clinical correlation.

Objectives for TBL in neuroanatomy:

- To study the external features, internal features, and blood supply of the spinal cord;
- To study the external features, internal features at different levels, and blood supply of the medulla;
- To study the external features, internal features at different levels, and blood supply of the pons;
- To study the external features, internal features at different levels, and blood supply of the midbrain;
- To study the external features, internal features, neural connections through peduncles, and blood supply of the cerebellum;
- To study the cerebrum, including sulci and gyri, functional areas, classification of white matter with examples, the internal capsule in detail, and blood supply.

Stage 2 of TBL was conducted after an interval of 10 days to allow adequate time for preparation. It has two components: IRAT and TRAT. For IRAT (pre-test), 10 single best-answer type MCQs were answered independently by all students within 10 minutes in the lecture gallery under strict invigilation. Each correct answer was awarded one mark, and incorrect answers were awarded zero.

Study setting for team activity: One day before the session team formation was done by faculty based on the marks obtained by students in the first internal assessment to see that every team included students with high, moderate, and low performance levels. In addition circular Seating arrangement for each team was also done in the dissection hall equipped with an audio amplification system. This enabled each student to face all the other students in their team during discussion.

This mixed-ability grouping facilitated effective exchange of knowledge and ideas among team members. A total of 189 students were divided into 24 teams, with each team comprising 7-8 members. Six facilitators were involved in the TBL session, with one session facilitator assigned to every four teams. A TBL coordinator (content expert) supervised all teams throughout the session.

In TRAT, students worked on the same MCQs given in IRAT but as a team, discussing various answer options. The time allotted for TRAT was 20 minutes, followed by 10 minutes of discussion led by the content expert [Table/Fig-1].

[Table/Fig-1]: Shows the arrangement of students in teams in the dissection hall during TBL, with the content expert/moderator standing and facilitators seated centrally.

In the stage 3/T-APP, each team was provided with a handout containing seven case-based scenarios followed by a set of questions for SGD. Adequate time was provided to facilitate thorough discussion of each case among team members. This stage was allotted one hour and 15 minutes for within-team discussion, followed by 30 minutes for closure discussion by the content expert.

A modification was introduced at this stage: each team was instructed to record their final answers in a booklet for presentation during the discussion with the coordinator at the end of T-APP. This enabled students to identify knowledge gaps as a team and incorporate additional points from other teams' responses during the discussion.

Formal verbal feedback was obtained from students at the end of the session through facilitators (15 minutes). Students reported that the session promoted active learning, improved their approach to application-based learning, and facilitated knowledge exchange with mutual respect among team members. Students were also encouraged to provide constructive peer feedback within their teams. Faculty members also provided overall positive verbal feedback regarding the implementation of TBL.

During TRAT and T-APP, facilitators observed the teams, guided them by asking leading questions, and encouraged teamwork. The TBL coordinator/content expert monitored all teams throughout the session. During the discussion, the coordinator/content expert ensured equal participation from all teams.

All students were instructed to submit their assignment book, with questions and answers for the case scenarios prepared during T-APP, along with logbook to be verified and signed by facilitators the following day. This activity was assigned five marks as part of formative assessment: four marks for complete submission and one mark for timely submission. Incomplete submissions were identified, and students were given an opportunity for resubmission.

Time allocation for various components of TBL session:

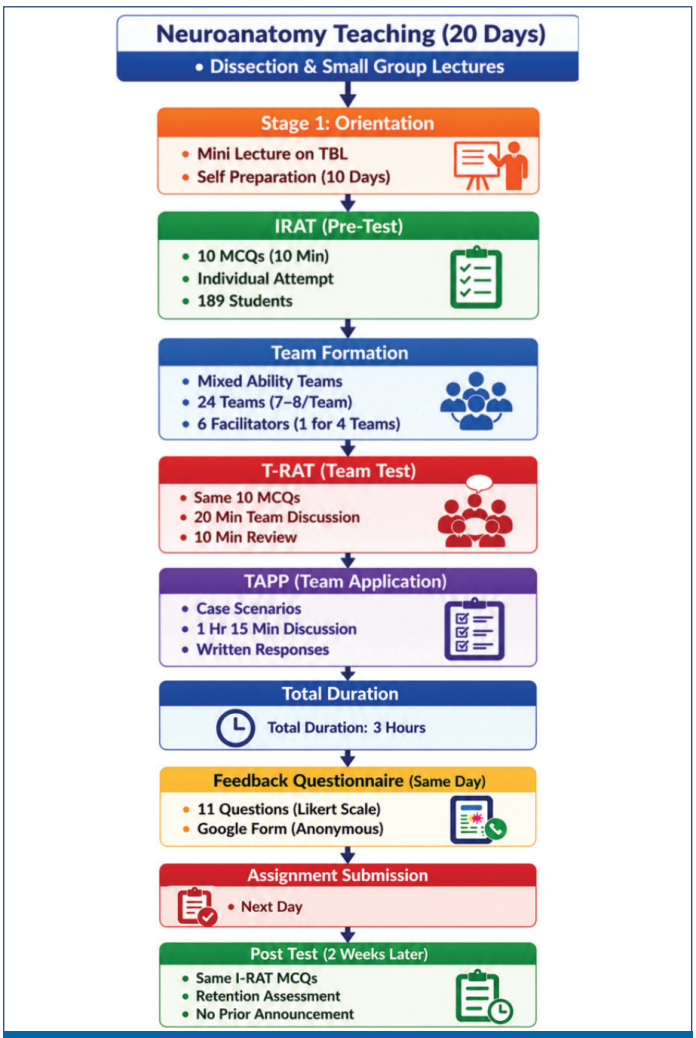
- IRAT: 10 minutes;
- Team allotment and arrangement: 20 minutes;
- TRAT and discussion: 30 minutes;
- T-APP and discussion: 1 hour 45 minutes;
- Formal feedback and closure: 15 minutes.

Total duration: Three hours

Feedback collection: Additionally, an online feedback questionnaire on TBL was completed by students on the same day, and the responses were statistically analysed. This questionnaire consisting of 11 items on TBL was modified and designed for the present study based on validated questionnaires from previous studies [12,13] with necessary modifications for language and convenience. Content validity was established through expert review by medical education specialists to ensure relevance, clarity, and comprehensiveness of the items. The questionnaire demonstrated good overall internal consistency, with a Cronbach's alpha of 0.830 indicating reliable measurement of student perceptions.

The questionnaire was administered anonymously to all participants using Google Forms, and the link was shared through the official WhatsApp group. Responses were recorded using a five-point Likert scale (1-5), ranging from "Strongly Agree" to "Strongly Disagree." Out of 189 participants, 188 provided feedback. However, as the feedback was anonymous, the participant who did not respond could not be identified. Although the feedback from the 189th participant was submitted at a later date, it was not considered due to its delayed submission.

A post-test was conducted using the same MCQs as the IRAT to assess content retention and was administered two weeks after the whole TBL without prior announcement [Table/Fig-2].



[Table/Fig-2]: Flowchart of neuroanatomy TBL process.

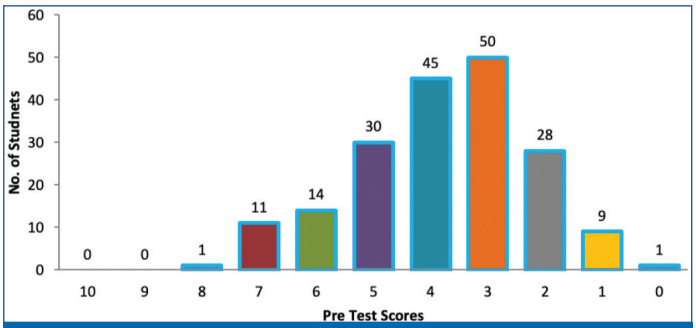
STATISTICAL ANALYSIS

The collected data were entered into Microsoft Excel and analysed using SPSS software (13.0 version). The scores obtained in the pre-test/IRAT, TRAT, and post-test were summarised using descriptive statistics, including mean, Standard Deviation (SD), and minimum and maximum values. Frequency distribution of pre-test and post-test scores (0-10 marks) was calculated to understand score distribution patterns. To determine the effectiveness of TBL, a paired t-test was applied to compare the mean pre-test and post-test scores. A p-value of <0.01 was considered statistically significant. Responses to the structured feedback questionnaire items were analysed using percentage distribution. The proportion of students who agreed or strongly agreed with each statement was calculated to evaluate student perception of TBL. Data were presented in the form of tables and frequency distribution bar diagrams.

RESULTS

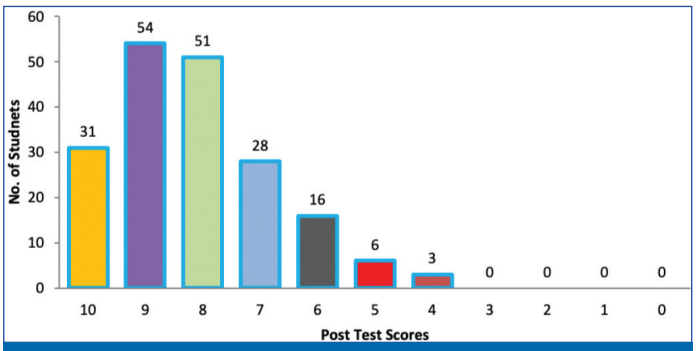
Out of the 200 Phase I MBBS students (2024-2025 batch), a total of 189 students participated in the study. The participants' ages ranged from 17 to 19 years. Mean age of the students was 18.60±1.22 years. Among the participants, 107 (57%) were female and 82 (43%) were male.

Out of 189 students, the majority demonstrated low initial performance in the pre-test (IRAT), with 95 (50.3%) students obtaining scores of 3-4 out of 10 marks. A total of 44 (23.3%) students achieved moderate scores of 5-6, while 38 (20.1%) students scored 2 and below. Only 12 (6.3%) students attained a high score of 7 and above, indicating that relatively few students performed at a high level [Table/Fig-3].



[Table/Fig-3]: Frequency distribution of IRAT/pre-test scores.

From the bar graph, out of 189 students, the majority 164/189 (86.8%) scored 7 and above out of 10 marks in the post-test, indicating a high level of performance. A smaller proportion of students 22/189 (11.6%) obtained moderate scores of 5-6, while only 3/189 (1.6%) scored 4 and none (0%) scored 3 or below. Overall, the distribution clearly shows a positive change in performance, with a shift of scores from the lower ranges to the higher end in the post-test [Table/Fig-4].



[Table/Fig-4]: Frequency distribution of post-test scores (retention test).

The descriptive statistics show a clear improvement in student performance from the I-RAT to the T-RAT and post-test. The mean score increased from 3.78 in the I-RAT to 6.75 in the T-RAT and further to 8.14 in the post-test, with corresponding increase in the median and mode, indicating overall better performance. Although the SD slightly decreased in the T-RAT and remained moderate in the post-test, the higher minimum, maximum and reduced range values suggest improved and more consistent student achievement in the later assessments [Table/Fig-5].

Measures	IRAT score (n=189)	TRAT score (n=24 teams)	Post-test score (n=189)
Mean	3.78	6.75	8.14
Standard Deviation (SD)	1.55	1.07	1.40
Standard Error	0.11	0.22	0.10
Median	4.00	7.00	8.00
Mode	3.00	6.00	9.00
Range	8.00	4.00	6.00
Minimum	0.00	4.00	4.00
Maximum	8.00	8.00	10.00
Count	189	24	189

[Table/Fig-5]: Descriptive statistics of IRAT, TRAT and Post-test scores.

The paired t-test results show a substantial improvement in scores from the pre-test to the post-test. The mean increased from 3.78 to 8.14, and the calculated t-value (-29.06) indicates a very large difference between the two assessments. Since the two-tailed p-value was <0.001 the improvement was statistically highly significant [Table/Fig-6].

Measures	Pre-test score	Post-test score
Mean	3.78	8.14
Standard Deviation (SD)	1.54	1.40
Observations	189	189
t-value	-29.06	
p-value	<0.001	

[Table/Fig-6]: Paired t-test comparing pre-test and post-test scores (n=189).
t-test: paired two sample for means

The T-APP stage carried five marks for submitting the assignment on the next day. Out of 189 students, 165 submitted complete work and received full marks (5/5). The remaining 24 students submitted late or incomplete work; they were encouraged to resubmit within two days and were given four marks after verification by the facilitators.

The overall feedback on TBL demonstrated a highly positive perception among students. Across all items, the majority of respondents expressed agreement or strong agreement, with positive responses ranging from 79.25% to 98.39%. Overall, approximately 88.79% of students either agreed (54.25%) or strongly agreed (34.54%) with statements supporting the effectiveness of TBL. Neutral responses were relatively low (ranging from 1.59% to 19.68%), and disagreement was minimal (0.00% to 10.63%), indicating strong acceptance and satisfaction with the TBL methodology. Although up to 12.79% of students opined that they could not understand the stages of TBL (Question 1) beforehand through the orientation lecture, the positive responses to Questions 2, 3, and 4 regarding the stages of TBL and their advantages indicate that the session was successfully implemented [Table/Fig-7].

Questions with response	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I understood stages of TBL before hand	34 (18.08%)	93 (49.46%)	37 (19.68%)	20 (10.63%)	4 (2.12%)
I-RAT helped me to understand the gaps in my knowledge	64 (34.04%)	117 (62.23%)	7 (4.25%)	0	0
T-RAT helped me to solve the questions with better understanding of content	78 (41.48%)	101 (53.72%)	9 (4.78%)	0	0
T-App helped me to understand how to apply basic knowledge in clinical cases	71 (37.76%)	111 (59.04%)	5 (2.65%)	0	1 (0.53%)
Discussion by content expert after T-RAT and T-APP clarified the doubtful areas	86 (45.74%)	97 (51.59%)	5 (2.65%)	0	0
I liked the way in which team formation was done	68 (36.17%)	89 (47.34%)	27 (14.36%)	3 (1.59%)	1 (0.53%)
All the team members contributed well during the discussion	47 (25%)	102 (54.25%)	33 (17.55%)	6 (3.19%)	0
Group dynamics were monitored well that enabled active participation by all team members	58 (30.85%)	108 (57.44%)	19 (10.10%)	2 (1.06%)	1 (0.53%)
TBL fostered active learning	71 (37.76%)	110 (58.51%)	6 (3.19%)	0	1 (0.53%)
TBL is useful in learning complex content	79 (42.02%)	98 (52.12%)	8 (4.25%)	3 (1.59%)	0
I would like to have a TBL at regular intervals in the course	99 (52.65%)	86 (45.74%)	3 (1.59%)	0	0

[Table/Fig-7]: Student responses to the online feedback questionnaire (188 students provided feedback).

All faculty members 7/7 (6 facilitators and 1 content expert) opined that TBL is an engaging, involving, and thought-provoking, student-centric teaching-learning method that demands teamwork for precise planning and execution.

DISCUSSION

In the present study, TBL was used as a teaching–learning method in Neuroanatomy for Phase I MBBS students, including all its stages. There was a clear improvement in performance from pre-test to post-test. Students also gave very positive feedback about team formation, the different stages, and the overall module.

In order to acquire knowledge of clinical sciences, the basic sciences must be appropriately integrated using case-based or context-based teaching modules [17]. Exposing medical students to multiple clinical problems or contexts after acquiring knowledge in the basic sciences promotes active learning and facilitates the transfer of knowledge when they encounter new problems [18]. Furthermore, the National Medical Commission of India has recommended that course planners and academicians reduce didactic lectures to less than one-third (180 out of 620 total allotted teaching hours), with the remaining two-thirds delivered as SGT [19].

The TL methods such as CBL, TBL, and PBL use clinical case scenarios as a central element. However, CBL lacks structured organisation of groups [20], whereas PBL requires a broad understanding and interpretation of clinical problems as a self-directed learner [21]. TBL and CBL are student-centric TL methods, with no significant differences observed in examination scores between them [22]. In the present study, a large group was taught using TBL, as it provides structured active learning with well-defined team formation.

Academically weaker students may face difficulty when directly exposed to TBL and may prefer lectures as a TL method [12]. Phase I MBBS students are novice learners with mixed abilities; therefore, in the present study, traditional teaching was conducted first, followed by guided learning based on predefined objectives to reinforce acquired knowledge, and subsequently TBL was implemented. In the present study, the minimum pre-test and post-test scores were 0 and 4, respectively, whereas the maximum scores were 8 and 10, indicating improvement in both the lowest and highest performance levels with TBL.

The selection of topics for TBL should be done cautiously to ensure active participation by students at all stages [13]. Content that is complex to learn independently and has clinical relevance is considered more suitable for TBL according to students [10]. Neuroanatomy is a complex subject that is difficult for undergraduate medical students to understand and memorise [23]. This highlights the need to adopt diverse teaching-learning strategies, particularly for complex topics. TBL implementation in Neuroanatomy, as conducted in the present study, has been scarcely reported previously, and the majority of students (94%) found it useful.

Peer-assisted teaching and learning is one of the major advantages of this TL method, providing opportunities for students to learn from and unlearn misconceptions through team discussions during stages 2 and 3. In this study, team formation was not random; instead, students with varying performance levels were grouped together to ensure effective knowledge exchange during discussions [24].

The logistics of the present study were unique, as TBL was successfully planned and conducted for all 189 students, who were divided into 24 teams in a single large hall. The teams were arranged in a circular pattern to enable face-to-face interaction, unlike in many other studies that utilised conventional classroom seating. In a previous study, students reported that effectiveness was compromised when they were not allowed to take notes or

retain copies of MCQs from RAT and T-APP [10]. In the present study, students were allowed to write answers in notebooks during the T-APP stage, which enabled them to present confidently during discussions and add additional points.

In the present study, a modification in the T-APP stage involved replacing peer evaluation with simple verbal feedback to avoid friendship bias [8]. Evaluation during the T-APP stage was based on time-bound submission of logbook assignments, which helped students recapitulate the discussions. The logbook submissions were verified and awarded marks by facilitators for formative assessment, thereby promoting student responsibility. These were not analysed further, as they were descriptive and reflected intra-team, inter-team, and expert discussions.

Although SGT is student-centric, it requires an adequate number of facilitators with managerial skills to ensure active participation and effective learning throughout the activity [25]. In contrast, TBL requires only a single moderator as a content expert to clarify doubts at the end of team discussions. In the present study, observers or standardised facilitators were also involved to encourage active participation from every student, which helped enhance peer communication skills [8]. Facilitator-led discussions were perceived as beneficial by 98% of students.

It is well known that retention of subject content declines over time, and therefore, instructional strategies that promote long-term retention are essential [26]. Long-term retention is considered a positive outcome of TBL [11]. In the present study, the post-test was conducted two weeks after the TBL session to assess knowledge retention, and the majority of students (164/189) scored seven or above out of 10. There was a statistically significant improvement in the mean post-test scores compared to pre-test scores in the present study, consistent with findings from other studies [14-16,27-29]. This improvement persisted even when the post-test was conducted after two weeks, supporting the strong impact of TBL [Table/Fig-8] [13-16,27-29].

The majority of students (95%) reported that the IRAT, TRAT, and T-APP stages were beneficial, and overall, TBL promoted active learning, critical thinking, communication skills, and knowledge retention. Similar positive outcomes have been documented in previous Indian studies, as summarised in [Table/Fig-8], which shows consistent improvements in student performance, engagement, and satisfaction across diverse disciplines and Institutions [13-16,27-29]. Notably, 98.4% of students expressed interest in attending TBL sessions regularly. Although identifying and implementing effective strategies for teaching basic sciences can be challenging, it remains an essential requirement in medical education [30]. These findings support the use of TBL as a structured, student-centred approach capable of enhancing learning even in complex subjects such as Neuroanatomy.

Limitation(s)

The present study had certain limitations. It was conducted as a single-session intervention, which may not fully reflect the impact of repeated exposure to TBL. The absence of a control group limits direct comparison with conventional teaching methods. The study was carried out in a single Institution, which may affect the generalisability of the findings. Knowledge retention was assessed only after two weeks, and long-term retention was not evaluated. Use of identical MCQs for both pre-test and post-test assessments in this approach may have led to a testing effect, where participants' improved scores could be influenced by prior exposure to the questions, thereby reflecting question familiarity in addition to actual knowledge gain. Additionally, student feedback was self-reported and may be subject to response bias.

CONCLUSION(S)

The findings of the present study indicate strong student acceptance and satisfaction with the TBL methodology. TBL proved to be an effective instructional strategy that promotes application of knowledge, teamwork, active engagement, and a deeper understanding of complex subjects such as Neuroanatomy. These results support its integration into Phase I MBBS curricula, wherever appropriate. Future studies may explore the periodic implementation of TBL at the end of each gross anatomy region to assess longitudinal knowledge gains, along with the development of integrated TBL modules incorporating horizontal integration in Phase I and vertical integration across Phases II and III.

Sl. no	Authors and year	Students addressed and place of study	Sample size	Methodology and modifications	Parameters assessed	Conclusion
1	Kulkarni V et al., [13] 2014	Anatomy students, Bengaluru, Karnataka	Session 1-47, Session 2-42	Anonymous Likert scale survey post-TBL	Student opinions on TBL 1 and TBL 2 analysed using Mann-Whitney U test	Students reported positive perceptions of TBL with improved engagement across sessions.
2	Dhali RS et al., [14] 2025	Anatomy students, Bengaluru, Karnataka	100 (4 teams of 25)	Student and faculty feedback post-TBL	Satisfaction Index calculated for questionnaire items	Both students and faculty showed high satisfaction with TBL.
3	Thirunaaukarasu D et al., [15] 2024	III-year students, Tamil Nadu	22 (4 teams of 5-6 each)	Pre- and post-TBL test; all TBL steps followed	Student reaction evaluated by 7-item Likert-scale questionnaire	TBL improved performance and was well received by students.
4	Dnyanesh S et al., [16] 2024	Phase I MBBS students, Belagavi, Karnataka	65 (8 teams of 8)	Pre- and post-TBL test; all TBL steps followed	Test score comparison; student feedback collected	TBL significantly enhanced learning outcomes and understanding.
5	Sivachandra Raju S et al., [27] 2025	Phase II MBBS students, Chittoor, Andhra Pradesh	87 (TBL n=41, SDL n=46; 8–9 teams)	G-RAT via scratch cards; T-APP not done; pre- and post-tests	Test score comparison (paired/unpaired t-test); student satisfaction via Likert scale	TBL was more effective than SDL with higher scores and satisfaction.
6	Shivanand et al., [28] 2026	Phase III Part I MBBS students, Kalaburagi, Karnataka	100	TBL group: IRAT + TRAT + perception questionnaire; Control: pre/post-test	Post-test scores; student perceptions	TBL improved academic performance and was positively perceived.
7	Maji R and Bhattacharyya S, [29] 2026	Phase I MBBS students, Kolkata, West Bengal	250 (4 batches, 8 teams per batch)	TBL scores: IRAT 30%, TRAT 30%, PBA 40%; perception via Google Forms	Cumulative TBL score; student satisfaction	TBL showed high effectiveness with strong student satisfaction.
8	Present study	Phase I MBBS students, Chinakakani, Andhra Pradesh	189 (24 teams; single TBL session)	IRAT as pre-test; post-test after 2 weeks; T-APP formative assessment; feedback via Google Forms	Pre- and post-test score comparison; student feedback	TBL significantly improved scores and was well accepted by students.

[Table/Fig-8]: Comparison of recent Indian studies on Team-Based Learning (TBL) [13-16,27-29].

REFERENCES

[1] Agrawal A, Sharma A, Sharma A, Agrawal C. Challenges faced by medical faculty in implementation of competency-based medical education and lessons learned. J Edu Health Promot. 2024;13:345.

[2] Hassan S, Ibrahim MS, Gul Hassan N. The structural framework, implementation strategies and students' perception of team-based learning in undergraduate medical education of a medical school in Malaysia. Education in Medicine Journal. 2018;10(1):55-68.

[3] Luscombe C, Montgomery J. Exploring medical student learning in the large group teaching environment: examining current practice to inform curricular development. BMC Med Educ. 2016;16:184.

[4] Krishna Teja C, Abida S, Yogesh A, Modern techniques of teaching and learning in medical education: A descriptive literature review, MedEd Publish Jan 2021;10:18.

[5] Singh K, Bharatha A, Sa B, Adams OP, Majumder MAA. Teaching anatomy using an active and engaging learning strategy. BMC Med Educ. 2019;19(1):149.

[6] Michaelsen LK. Getting started with team learning. In: Michaelsen LK, Knight AB, Fink LD, editors. Team-based learning: a transformative use of small groups in college teaching. 1st ed. Sterling (VA): Stylus Publishing; 2004. p. 27-50.

[7] Parmelee D, Michaelsen L, Cook S, Hudes P. Team-based learning: a practical guide. AMEE Guide No. 65. Med Teach. 2012;34(5):e275-e287.

[8] Pires EMSG, Meeuwissen SNE, Savelberg HHCM. From theory to practice: the impact of Team-based learning on medical students' communication skills. Perspectives on Medical Education. 2025;14(1):74-84.

[9] Xie ZB, Cheng XY, Li XY, Zhang YF. Team-based learning pedagogy enhances the education quality: a systematic review and meta-analysis. BMC Med Educ. 2025;25(1):580. Doi: 10.1186/s12909-025-07175-x. PMID: 40259292; PMCID: PMC12010525.

[10] Nieder GL, Parmelee DX, Stolfi A, Hudes PD. Team-based learning in a medical gross anatomy and embryology course. Clin Anat. 2005;18:56-63.

[11] Chytas D, Noussios G, Paraskevas G, Demesticha T, Protogerou V, Salmas M. Incorporation of team-based learning in the cadaveric anatomy laboratory: an overview. Morphologie. 2023;107(357):176-81.

[12] Bhojaraja VS, Goud BK, Kumar J, Srinivasan A, Shetty JK. A comparative study on perceptions of medical students from the different curriculum on team-based learning. AdeshUniv J Med Sci Res. 2021;3:79-84.

[13] Kulkarni V, Appaji AC, Poonam DN, Ramesh BR. Student perceptions of Team-based learning in head and neck anatomy. Int J AnatRadiol Surg. 2014;3(3):01-05.

[14] Dhali RS, Saha S, Chakrabarty S, Badyal DK, Samuel CJ. Introduction of team-based learning in anatomy among Phase 1 students in medical college, Kolkata, West Bengal. SSR Inst Int J Life Sci. 2025;11(4):8165-71.

[15] Thirunaaukarasu D, Karthikeyan E, Norman P, Geetha M, Felicia P, Tejas J. Team based learning: An effective teaching-learning method in undergraduate teaching in community medicine. Int J Community Med Public Health. 2024;11:2358-61.

[16] Dnyanesh S, Shirahatti A, Bhimalli SM, Yadav SK, Dnyanesh K. Team-based learning (TBL) in medical education: Fostering collaboration and enhancing learning outcomes. Med J DY PatilVidyapeeth. 2024;17:1036-42.

[17] Van der Veken J, Valcke M, De Maeseneer J, Schuwirth L, Derese A. Impact on knowledge acquisition of the transition from a conventional to an integrated contextual medical curriculum. Med Educ. 2009;43(7):704-13.

[18] Norman G: Teaching basic science to optimize transfer. Med Teach. 2009;31(9):807-11.

[19] Competency Based Medical Education Curriculum (CBME) Guidelines, 2024 - National Medical Commission. Distribution of Subject Wise Teaching Hours for Phase -1 MBBS, Annexure 5, Page -53.

[20] Zinski A, Blackwell KTCPW, Belue FM, Brooks WS. Is lecture dead? A preliminary study of medical students' evaluation of teaching methods in the preclinical curriculum. Int J Med Educ. 2017 Sep 22;8:326-333. Doi: 10.5116/ijme.59b9.5f40. PMID: 28945195; PMCID: PMC5699863.

[21] Elaine HJ, Karen G. Problem based learning: An overview of process and impact on learning. Health Prof Educ. 2016; 2(2):75-9.

[22] James Trill B, Panesar B, Dave M, VahidRoudsari R, Javidi H. Is team-based learning an alternative approach for UK undergraduate dental education? A scoping review of the literature. Br Dent J. 2024;236(1):52-56. Doi: 10.1038/s41415-023-6615-x. Epub 2024 Jan 12. PMID: 38225321; PMCID: PMC10789605

[23] Lieu RM, Gutierrez A, Shaffer JF. Student perceived difficulties in learning organ systems in an undergraduate human anatomy course. Journal of the Human Anatomy and Physiology Society. HAPS Educator. 2018;22(1):84-92.

[24] Burgess A, van Diggele C, Roberts C, Mellis C. Planning peer assisted learning (PAL) activities in clinical schools. BMC Med Educ. 2020;20(Suppl 2):453.

[25] Burgess A, van Diggele C, Roberts C, Mellis C. Facilitating small group learning in the health professions. BMC Med Educ. 2020;20(Suppl 2):457.

[26] Custers EJFM. Long-term retention of basic science knowledge: a review study. Adv Health SciEduc Theory Pract. 2010;15(1):109-28. Doi: 10.1007/s10459-008-9101-y. Epub 2008 Feb 15. PMID: 18274876.

[27] Sivachandra Raju S, Vinay Kumar S, Madhav P. Effectiveness and utility of team-based learning in teaching integrated competencies in pharmacology: A randomized comparative crossover study. Strides Dev Med Educ. 2025;23(1):e1533.

[28] Shivanand, Kumar R, Chapparbandi SR, Deshmukh S, Kadeangadi D. Effectiveness of team-based learning as teaching tool and its perception among medical undergraduates in community medicine. Int J Med Pub Health. 2026;16(1):434-40.

[29] Maji R, Bhattacharyya S. Team-based learning: an effective approach for embedding clinical context in a biochemistry classroom. Indian J Med Biochem. 2026;30(1):28-34.

[30] Castillo JM, Park YS, Harris I, Cheung JJH, Sood L, Clark MD, et al. A critical narrative review of transfer of basic science knowledge in health professions education. Med Educ. 2018;52(6):592-604. Doi: 10.1111/medu.13519. Epub 2018 Feb 8. PMID: 29417600.

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