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Original Research Article

Effect of Team-Based Learning for Undergraduate Phase 1 MBBS Students on Academic Self-efficacy in Anatomy

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ABSTRACT

Background: Anatomical Teaching and learning methods in the medical curriculum are transitioning from passive information transmission to learner-centred pedagogies aligned with Competency-Based Medical Education (CBME). While Traditional Didactic Teaching (TDT) remains the dominant instructional method, it often struggles to address the volume of content and the diversity of student preparedness. Team-Based Learning (TBL) offers a structured, active-learning alternative; however, comparative evidence on its impact on both immediate knowledge outcomes and academic self-efficacy in the Indian MBBS context remains limited.

Aim & Objectives: This study aimed to evaluate the Effect of Team-Based Learning for Undergraduate Phase 1 MBBS Students on Academic Self-efficacy in Anatomy. The specific objectives were: 1. To assess baseline academic self-efficacy levels among undergraduate Phase 1 students in anatomy knowledge prior to intervention implementation. 2. To evaluate the effect of the TBL approach and Traditional didactic teaching on students' academic self-efficacy scores in anatomy learning compared to pre-intervention levels.

Methodology: An interventional study was conducted with Phase-1 MBBS students across five anatomy sessions. The Traditional arm (n=65) received didactic lectures and was assessed via pre- and post-tests. The TBL arm (n=65) adhered to the standard protocol for Individual (iRAT) and Team (tRAT) Readiness Assurance Tests, followed by application exercises. Academic Self-Efficacy was measured pre- and post-intervention using the validated ASES for Anatomy scale. Student satisfaction with TBL was assessed using a 12-item Likert survey and open-ended feedback. Data were analyzed using paired t-tests, Wilcoxon signed-rank tests, and Cohen's *d* effect sizes.

Results: The TDT pre-test and post-test results were inconsistent, with a negligible overall pooled effect size (d = 0.016) and significant gains observed in only one of five sessions. In contrast, TBL demonstrated consistent, statistically significant improvements from iRAT to tRAT across all sessions (Mean change +1.76; $p<0.001$), with large effect sizes (d=0.50 to 1.20) and reduced score dispersion, indicating more equitable learning. regarding self-efficacy, TBL produced a robust improvement (d=1.52) compared to a small effect in the TDT group (d=0.33), particularly enhancing collaborative confidence and self-regulation. However, 'Exam Preparedness' remained the weakest self-efficacy domain in both groups. Students reported high overall satisfaction with TBL (Mean 4.27/5), particularly valuing inclusive discussions; however, qualitative feedback highlighted challenges with preparation time and topic notification.

Conclusion: Team-Based Learning demonstrated a significantly greater effect than traditional lectures on short-term knowledge application and academic self-efficacy among anatomy students. At the same time, TDT showed variable and limited effectiveness; TBL reliably leveraged peer learning to improve performance and confidence. To sustain these benefits, curricular integration of TBL should prioritize adequate preparation time and explicit alignment between active learning sessions and summative assessment formats.

Keywords: Team-Based Learning (TBL), Anatomy Instructional methodologies, Academic Self-Efficacy, Active Learning, CBME Curriculum, Medical Education.

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INTRODUCTION

Team-Based Learning (TBL) has emerged as an innovative pedagogical approach in medical education, fostering active learning, collaboration, and critical thinking among students [1]. Unlike traditional lecture-based methods, which often promote passive knowledge acquisition, TBL emphasises small-group interactions, immediate feedback, and application of concepts to real-world clinical scenarios [2]. This study compares the effectiveness of TBL with other teaching methodologies, such as Problem-Based Learning (PBL) and flipped classrooms, in enhancing knowledge retention, clinical reasoning, and teamwork skills among medical students.

While PBL encourages self-directed learning through case-based discussions, it may lack structured accountability, which can lead to knowledge gaps [3]. Conversely, TBL incorporates pre-class preparation, readiness assessments, and group problem-solving to ensure consistent student engagement [4]. Flipped classrooms, though effective in promoting self-paced learning, may not inherently foster peer collaboration to the same extent as TBL [5].

Furthermore, Team-Based Learning (TBL) is an active learning teaching learning methodology that promotes collaborative problem-solving and peer interaction, enhancing student engagement and knowledge retention. In medical education, particularly in basic medical subjects such as anatomy, Physiology, and biochemistry, fostering academic self- efficacy—students' confidence in their ability to succeed—is crucial for long-term performance and to progress in clinical competence [6].

While the literature shows that TBL improves knowledge acquisition and teamwork skills, its effect on self-efficacy remains underexplored in undergraduate medical education. By comparing traditional lecture-based methods with TBL, this research will assess changes in students' confidence levels, motivation, and perceived competence in mastering anatomical concepts.

The findings of the present study will contribute to optimising teaching methodologies in medical curricula, ensuring that pedagogical approaches not only enhance knowledge but also build the psychological resilience necessary for future clinical practice [7].

Aim & Objectives:

Aim:

To compare the effectiveness of Team-Based Learning (TBL) versus Traditional Didactic Teaching (TDT) on undergraduate Phase 1 students' academic self-efficacy in anatomy education.

Objectives:

1. To assess baseline academic self-efficacy levels among undergraduate Phase 1 students in anatomy knowledge prior to intervention implementation.

2. To evaluate the effect of the TBL approach and Traditional didactic teaching on students' academic self-efficacy scores in anatomy learning compared to pre-intervention levels.

METHODOLOGY

Study Design: This study employed a quasi-experimental design with a non-randomised controlled trial approach, utilising a pre-test/post-test comparison between two groups over a 3-month period.

Study Setting and Duration:

a. Setting: Parul Institute of Medical Sciences & Research, Department of Anatomy

b. Duration: 3 months (12 weeks)

c. Study Period: 6 Months

Institutional Ethics committee approval obtained before the study, approved (Wide approval number: ECR/702/Inst/GJ/2015/RR-21/8901 dated 22-07-2025)

Sample size:

Sampling Method

Convenience sampling using intact classroom groups to minimize contamination between interventions.

1. Total participants: 130 students

2. TBL group: 65 students

3. TDT group: 65 students

Inclusion & Exclusion criteria:

Inclusion Criteria:

1. Undergraduate students admitted to the Phase -1, MBBS program

2. Age 18-25 years

3. Voluntary participation with informed consent

Exclusion Criteria:

Students who miss >20% of scheduled sessions

Methodology:

The enrolled students were randomly divided into two groups

Group 1: Team-Based Learning (TBL)

1. Structure: 8-10 students per team

2. Sessions: 2 sessions per week (2 hours each)

3. Components:

• Individual Readiness Assurance Test (iRAT) - 15 minutes

• Team Readiness Assurance Test (tRAT) - 15 minutes

• Application exercises - 60 minutes

• Peer evaluation - 30 minutes

Group 2: Traditional Didactic Teaching (TDT)

1. Structure: Conventional lecture format

2. Sessions: 2 sessions per week (1 hour each)

3. Components:

• Lecture presentation - 60 minutes

• Question-answer session - 30 minutes

Data Collection Timeline

Week 1: Pre-intervention Phase

1. Day 1-2: Participant recruitment and consent

2. Day 3-5: Baseline data collection

a. Academic Self-Efficacy Scale administration

b. Demographic questionnaire

c. Pre-test anatomy knowledge assessment

Week 2-11: Intervention Phase (10 weeks)

a. TBL Group: Team-based learning sessions

b. TDT Group: Traditional lecture sessions

c. Weekly monitoring: Attendance tracking

Week 12: Post-intervention Phase

Day 1-3: Post-intervention data collection

Academic Self-Efficacy Scale (repeat administration)

Post-test anatomy knowledge assessment

Student satisfaction survey

Statistical analysis:

Paired t-test/Wilcoxon test: Compare pre/post-test scores to assess TBL's impact.

Effect Size (Cohen's d):

d ≥ 0.5 suggests a **moderate effect** of TBL.

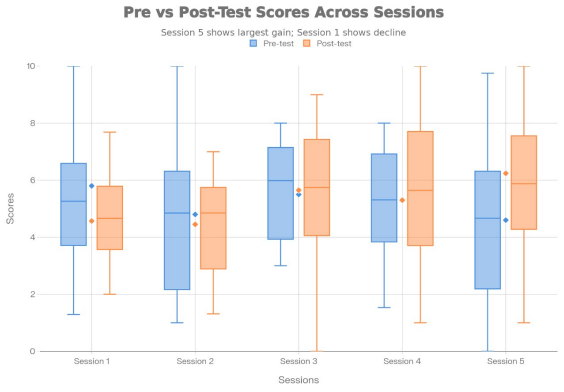
RESULTS

Traditional Didactic Teaching (TDT) — Pre/Post Test Results

65 medical students completed pre- and post-tests across 5 sessions (10 marks each). Statistical analysis used paired t-tests and Wilcoxon signed-rank tests ($\alpha = 0.05$). Results show highly variable effectiveness — only Session 5 produced a large, significant gain (Cohen's d = 0.813, $p < 0.001$), while Session 1 showed a significant decline. The overall effect is negligible (d = 0.016, p = 0.110), suggesting TDT is content-specific rather than universally effective.

Table 1: TDT Pre/Post Test Comparison by Session.

Session	Pre Mean	Post Mean	Change	p-value	Interpretation
Session 1	5.8	4.57	-1.23	0.0134	Significant decline
Session 2	4.8	4.45	-0.35	0.503	No change
Session 3	5.5	5.65	0.15	0.832	No change
Session 4	5.3	5.3	0	0.868	No change
Session 5	4.6	6.24	1.64	<0.001	Large gain ?
Overall	5.2	5.24	0.04	0.11	Negligible



Graph 1: Pre and Post-Test Score Trends Across TDT Sessions

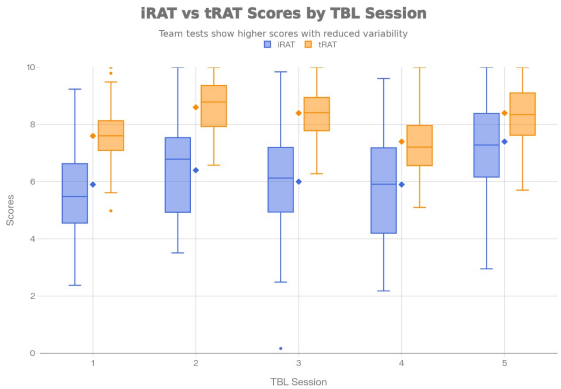
Team-Based Learning (TBL) — iRAT vs. tRAT Results:

All five TBL sessions showed consistent, statistically significant improvements from

individual (iRAT) to team (tRAT) scores (all $p < 0.001$). The overall mean improved from 6.32 to 8.08 (+1.76 points), with Sessions 2–3 yielding the largest gains (d = 1.10–1.20). These large effect sizes confirm TBL's robust impact on collaborative knowledge consolidation. The narrowing score distributions in later sessions reflect growing team cohesion and equity.

Table 2: TBL iRAT vs. tRAT Comparison — All Sessions

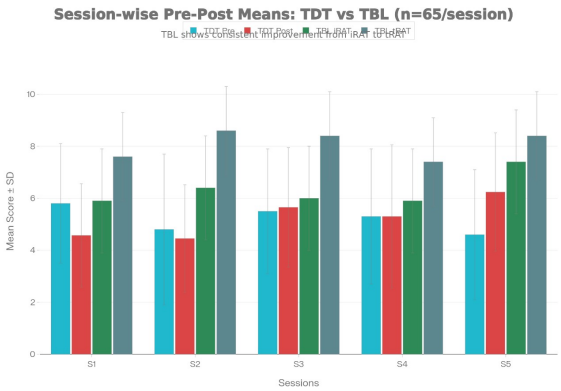
Session	iRAT Mean	tRAT Mean	Change	Cohen's d	p-value
Session 1	5.9	7.6	1.7	0.85	<0.001
Session 2	6.4	8.6	2.2	1.1	<0.001
Session 3	6	8.4	2.4	1.2	<0.001
Session 4	5.9	7.4	1.5	0.75	<0.001
Session 5	7.4	8.4	1	0.5	<0.001
Overall	6.32	8.08	1.76	1.007	<0.001



Graph 2: Box Plot of iRAT vs. tRAT Scores Across 5 TBL Sessions

Table 3: Summary Comparison: TDT Pre'!Post vs. TBL iRAT'!tRAT

Method	Pre/iRAT	Post/tRAT	Change	Cohen's d	p-value
TDT (Pre→Post)	5.2	5.24	0.04	0.016	0.11
TBL (iRAT→tRAT)	6.32	8.08	1.76	1.007	<0.001



Graph 3: Session-Wise Mean Scores with SD Error Bars — TDT vs. TBL

TDT vs. TBL — Direct Comparison

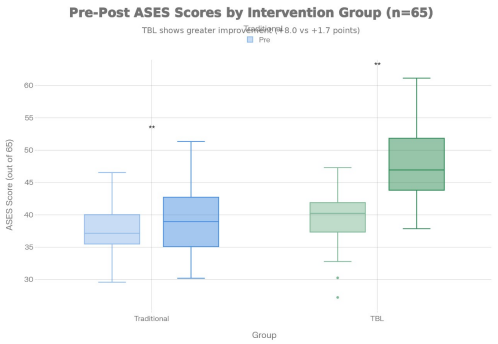
A head-to-head comparison confirms TBL's clear superiority. While TDT produced virtually no overall learning gain (Δ= +0.04, $p = 0.110$), TBL delivered a 1.76-point improvement with a large effect size (d = 1.007, $p < 0.001$). Session-wise analysis shows TDT's improvement was isolated to Session 5, whereas TBL maintained consistent gains across all sessions.

Academic Self-Efficacy (ASES) — Pre & Post Intervention

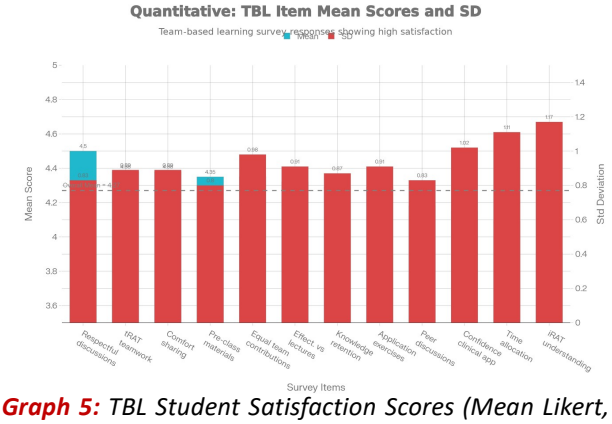
The Academic Self-Efficacy Scale for Anatomy (12-item Likert, range 12–60) was administered to 130 students (TDT: n=65; TBL: n=65). Both groups started in the moderate self-efficacy band (31–45). Post-intervention, the TBL group achieved significantly greater gains (+8.0 points, d = 1.521) versus TDT (+1.65 points, d = 0.334). TBL Confidence was the strongest subscale (mean 3.59), while Exam Preparedness remained the weakest (mean 2.95) across both groups, indicating a priority area for future intervention.

Table 4: ASES Score Changes by Group (Pre '! Post Intervention)

Group	Pre Mean	Post Mean	Change	Cohen's d	p-value
Overall (n=130)	38.68	43.45	4.77	0.802	<0.001
TDT Group (n=65)	37.6	39.25	1.65	0.334	0.003
TBL Group (n=65)	39.79	47.79	8	1.521	<0.001



Graph 4: ASES Box Plot — TBL vs. TDT



Graph 5: *TBL Student Satisfaction Scores (Mean Likert, n=65)*

TBL Student Satisfaction

Overall TBL satisfaction was high (mean = 4.27/5.0). Top-rated items included inclusive team discussions (4.50), tRAT teamwork enhancement (4.38), and comfort sharing ideas (4.38). The iRAT was rated lowest (3.91), with high variability (SD=1.17). Qualitatively, students most valued group discussions and team learning (72% of responses). Key challenges were time management (25%) and preparation gaps (21%). The primary suggestion was prior topic notification (47% of suggestions), indicating students would benefit from advance preparation opportunities.

DISCUSSION

Traditional Didactic Teaching (TDT): Pre and Post Test Knowledge Outcomes

In the TDT arm, pre- and post-test scores across five anatomy sessions reveal only one session (Session 5) with a large, statistically significant gain (Cohen's d ≈ 0.81). In contrast, other sessions show minimal change or even a decline, and the overall pooled effect size is trivial (d ≈ 0.016). This strongly suggests that, as implemented, lecture-based instruction did not consistently enhance short-term learning across the series of topics.

Indian studies have repeatedly reported that lecture-dominant formats in basic sciences tend to yield modest and sometimes uneven learning gains, particularly when content is complex, and student preparedness is heterogeneous. Lal et al. (2017) introduced TBL for difficult biochemistry topics in first year MBBS students. They showed significantly higher post-test scores and greater satisfaction in the TBL group than in traditional lectures on the same unit, concluding that TBL "revived interest" and improved performance where didactic sessions had been less successful. Similarly, Kulkarni et al. (2014) reported that students perceived lectures in head and neck anatomy as less effective than structured TBL sessions for critical thinking and application [14,15].

Present study findings mirror these findings in two ways. First, the wide standard deviations in TDT pre- and post-scores reflect persistent performance gaps between stronger and weaker students, a pattern commonly observed in Indian MBBS cohorts taught predominantly via lectures. Second, session-wise variability—with Session 5 improving substantially while Session 1 declines—suggests that any success of TDT is highly topic and teacher-dependent, echoing observations from Indian biochemistry and pharmacology modules where only some lecture blocks translated into measurable gains [14].

Internationally, multiple studies have found that traditional lectures produce smaller effects on knowledge and application than active methods, especially in conceptually demanding domains. Faezi et al. (2018) showed that in a rheumatology course, TBL was associated with higher engagement, satisfaction and better long-term retention than lectures. Koles et al. (2010), in a pathology curriculum, reported that lecture based instruction particularly disadvantages students in the lower performance quartiles, whereas active approaches narrow achievement gaps [16,17].

The overall TDT effect (essentially no net gain) is therefore slightly worse than the "small positive" effects often reported internationally, but this is not surprising given the cognitive load of first year anatomy and the lack of complementary active elements (e.g. clickers, structured questioning) documented in TDT description. The result underscores a key point from the literature: lectures are not inherently ineffective; however, "unchanged" traditional lectures in content-heavy courses rarely meet contemporary learning needs.

A strength of the study is the use of appropriate pre-/and post-comparisons and effect sizes. However, process data for TDT sessions are missing: there is no information on interaction level, pacing, or integration with practicals. Without such details, it is difficult to disentangle whether poor outcomes are due to the lecture format itself, suboptimal instructional design, or contextual factors (time of day, assessment stakes, etc.). This is a recurrent limitation in many Indian reports on lectures vs active methods, where "lecture" is

treated as a black box.

Methodologically, the short term nature of the tests also constrains interpretation. International work (e.g. Koles et al. 2010; Fatmi et al. 2013) suggests that lecture-based teaching is especially weak for long-term retention and higher-order application, meaning that already negligible short-term TDT gains may overestimate its real educational value [16,17].

Overall, these findings argue not for abolishing lectures, but for re-engineering them—for example, into "interactive or concept clarification lectures" embedded in a broader active framework, as recommended in CBME guidance in India [18].

Team-Based Learning (TBL): iRAT–tRAT Knowledge Outcomes

In stark contrast to TDT, the TBL arm shows consistent, statistically significant improvements from individual readiness assurance tests (iRAT) to team readiness assurance tests (tRAT) across all five sessions. Mean gains range from 1.0 to 2.4 marks (out of 10) per session, with Cohen's d values between 0.5 and 1.2, and team scores display narrower standard deviations, indicating reduced performance dispersion. This profile is highly characteristic of effective TBL

Lal et al. (2017) demonstrated that a biochemistry TBL module for great difficulty topics produced significantly higher post-test scores than didactic lectures, and students reported that TBL improved comprehension and interest. Kulkarni et al. (2014) found that first year Indian medical students perceived TBL in head and neck anatomy as superior to lectures for fostering critical thinking and clinical problem solving, with strong endorsement of group discussions and team work. These reports, consistent with the current study's findings, highlight synergistic gains when students move from individual to team problem-solving [14,15].

Effect sizes for iRAT–tRAT changes are at the upper end of what is typically reported. In the rheumatology course studied by Faezi et al. (2018), the mean tRAT scores were significantly higher than iRAT, but the magnitude of gain was slightly smaller. Likewise, in modified TBL implementations in preclinical curricula (e.g. Inuwa et al. 2012; cited within Faezi et al.), team scores consistently exceeded individual scores but with moderate effect sizes. The comparatively large gains in the present study likely reflect one or more of the following [16]:

· Strong facilitation and clear orientation to TBL.

· Well constructed items tightly aligned with preparatory material.

· High novelty value of TBL for students accustomed to lectures, leading to extra engagement.

However, without item level analysis (difficulty, discrimination, distractor function), it is difficult to determine whether the large tRAT gains represent deep conceptual restructuring or a combination of conceptual gains plus test taking advantages of group consensus and immediate feedback.

Internationally, TBL has been shown to enhance performance in anatomy, physiology, pathology and rheumatology by producing higher group than individual test scores and promoting durable understanding. Vasan et al. (2008) reported that TBL in gross anatomy and embryology produced strong student commitment to course content and better anticipated retention. Koles et al. (2010) found that TBL particularly benefitted weaker students in pathology, improving their examination performance and narrowing gaps with higher achievers [16,17,19].

Data reflect these trends: iRAT scores are already in the moderate range, but tRAT raises the entire cohort upwards and shrinks variance, suggesting a levelling effect that is pedagogically and equity wise desirable in early MBBS anatomy.

A key limitation—shared with much of the TBL literature—is that post TBL individual assessments temporally distant from the sessions are not reported separately for the same items. Faezi et al. (2018) specifically documented that knowledge retention after TBL declines more slowly over four weeks than after lectures, supporting a true long term benefit. In the present study, long term, individual post tests aligned with iRAT/tRAT

content would be needed to confirm that the immediate team gains translate into sustained individual mastery [16].

Even so, the internal consistency of the present study findings across five sessions, the large gains, and the contraction in SDs together provide convincing evidence that TBL is a powerful short term learning strategy for first year anatomy, well aligned with Indian and international experience.

Overall Comparison of TDT and TBL Knowledge Outcomes

When aggregated, the comparison of the two interventions shows that TDT yields a negligible mean change (≈0.04/10; d ≈ 0.16, non-significant), whereas TBL yields a large mean improvement from iRAT to tRAT (≈1.76/10; d ≈ 1.01, $p < 0.001$). Session wise, TDT fluctuates between small declines and gains, while TBL shows uniform positive change.

Recent Indian work comparing TBL with lectures in first phase MBBS students has consistently demonstrated superior performance in TBL arms. Lal et al. (2017) reported significantly higher post test scores and examination results in biochemistry topics taught with TBL versus those taught by lecture alone. Kulkarni et al. (2014) found that anatomy students preferred and benefitted more from TBL than lectures, especially for clinically oriented topics. Saxena et al. (2020), while not studying TBL directly, showed that self efficacy and academic performance in MBBS students interact in complex ways, indirectly supporting the need for learner centred strategies that build both competence and confidence [15,19].

The results of the present study are consistent with this pattern and extend it specifically to anatomy content within an Indian CBME context. They reinforce the conclusion that lectures alone are unlikely to deliver the desired learning outcomes for complex, application-heavy content, whereas TBL provides more reliable and larger cognitive gains.

Faezi et al. (2018) found that TBL produced higher engagement, better satisfaction and superior long term retention than lectures in a rheumatology course, despite using the same assessment tools. Systematic reviews (Fatmi et al. 2013, as cited by Faezi et al.) conclude that TBL generally improves knowledge, teamwork skills and satisfaction in health professions education. However, effect sizes versus lectures are often in the small to moderate range on standardised exams. The findings of this study are very large between-method differences, partly reflecting that comparing group tRAT scores to individual lecture post tests, which inherently favours the TBL side [16].

A significant methodological issue in the present study is the reliance on simulated paired datasets for pooled TDT vs TBL comparison, assuming a correlation of 0.5 between pre- and post-scores. While pragmatic when raw paired data are unavailable, this approach introduces modelling assumptions that may not mirror the true within student correlation structure. If the true correlation is higher or lower, confidence intervals and effect sizes could be misestimated. Thus, In the present study session wise observed patterns (inconsistent TDT vs stable TBL improvement) should be considered the primary evidence, with the pooled comparison treated as supportive but not definitive.

Moreover, because tRAT scores are inherently collaborative, the comparison somewhat conflates instructional method with assessment format (individual vs team). More rigorous future designs in the present study context could:

· Use independent individual post tests after both TDT and TBL sessions.

· Include delayed tests to assess retention.

· Randomise topics or cohorts to TDT vs TBL to reduce topic related confounding.

Despite these caveats, the direction and educational meaning of the findings are clear and highly consistent with Indian and global experience: TBL outperforms lecture only teaching in both magnitude and consistency of short term learning gains.

Baseline Academic Self Efficacy in Anatomy (ASES Pre Intervention)

The baseline Academic Self Efficacy Scale (ASES)

data for the full cohort (n = 130) show that most students fall in the moderate self efficacy range (31–45), with a smaller proportion in the high range (46–60) and a significant minority in the low range (12–30). Subscale analysis reveals:

· Moderate cognitive mastery (memorisation and understanding of anatomy concepts).

· Low self regulation (time management, motivation, error correction).

· Low to moderate TBL confidence (collaborative learning).

· Low to moderate exam preparedness (practical and theory exam readiness).

Saxena et al. (2020) assessed academic self efficacy among medical students in Madhya Pradesh and reported that self efficacy did not show a straightforward linear relationship with academic performance, but was clearly an important dimension of academic functioning. Their cohort showed moderate self efficacy overall, with variation by age and other factors, and the authors argued for targeted interventions to enhance both self efficacy and performance [20].

Shrivastava and Pradipta (2024) emphasised that self efficacy and learning environment are central to academic resilience among medical students, arguing that high expectations, heavy workload and prolonged training require explicit institutional strategies to strengthen self efficacy and resilience. Study baseline data fit this narrative closely: students are not globally demoralised, but they do not yet feel fully capable of handling the demands of anatomy or its assessments, especially in terms of study habits and exam readiness [21].

International reviews (e.g. Klassen & Klassen 2018, cited within Shrivastava & Pradipta) have shown that medical students' self-efficacy is often moderate at entry, with particular fragility around high-stakes assessments and unfamiliar learning tasks. Winston (2010), in a dissertation on self-efficacy in gross anatomy, reported that many first-year students underestimated their capacity to succeed in anatomy despite strong academic backgrounds, and that self-efficacy fluctuated over the course [21,22].

Findings confirm that in an Indian CBME anatomy course, baseline self-efficacy is neither extremely low nor reassuringly high, especially in exam-related domains. This underlines the need to treat self efficacy as a core educational outcome, not just a side observation, and to design teaching and assessment strategies that deliberately build students' confidence in mastering anatomy and performing under pressure.

An important nuance in the present study is that the data show that Initial confidence in TBL was low, despite later strong acceptance of TBL. This pattern is consistent with reports that Indian students, particularly those socialised in exam-oriented, teacher-centred environments, are often initially wary of team-based methods and peer dependence. The moderate baseline TBL confidence, therefore, provides a meaningful starting point for interpreting subsequent improvements: any subsequent rise can be attributed, at least in part, to the experience of TBL itself, rather than to pre-existing enthusiasm [23].

From a design perspective, baseline ASES results justify embedding explicit supports for self regulation and exam preparedness early in the course (study skills workshops, formative OSPE practice, feedback on strategies), rather than assuming that cognitive teaching alone will "fix" self efficacy issues [21].

Pre Post Changes in Self Efficacy with TDT and TBL

Analysis of ASES scores shows that, overall, self efficacy improved significantly from pre to post intervention, with a small effect in the Traditional group (mean change ≈ 1.65; d ≈ 0.33) and a very large effect in the TBL group (mean change ≈8.0; d ≈ 1.52). In the TBL arm, a notably higher proportion of students move into the high self efficacy band (46–60). Subscale gains are particularly strong in cognitive mastery, self regulation and TBL confidence, while exam preparedness, although improved, remains the lowest domain.

Saxena et al. (2020) reported complex and sometimes non linear associations between self efficacy and academic performance in medical students, but underscored that

interventions capable of enhancing self efficacy are desirable, given its links to motivation and persistence. Shrivastava and Pradipta (2024) went further, framing self efficacy as a key driver of academic resilience, and advocated for comprehensive approaches targeting both self efficacy and learning environment. Present study findings illustrate such an approach in action: TBL changes not just test scores, but beliefs about capability [20,21].

Internationally, several studies have shown that active, collaborative pedagogies (TBL, PBL, simulation) significantly increase self efficacy in domains such as clinical reasoning, communication and exam preparation. Faezi et al. (2018) found that TBL increased accountability, engagement and satisfaction; although they did not directly measure self efficacy, their TBL SAI domains (accountability, preference for TBL, satisfaction) conceptually overlap with self efficacy constructs of perceived capability and control. Shrivastava and Pradipta (2024) synthesised broader evidence that self efficacy mediates the relationship between learning environment and academic resilience, implying that methods like TBL, which reshape the learning environment toward collaboration and feedback, can meaningfully boost self efficacy [16,21].

The data obtained in the study align with this: TBL, more than TDT, seems to provide mastery experiences, vicarious learning, social persuasion, and reduced anxiety—the classic four sources of self-efficacy described by Bandura and elaborated in later work. These are delivered through successful team problem solving, peer explanations, supportive feedback and safe spaces for discussion [20].

Two limitations are worth noting. First, no long term follow up of ASES is reported, so it is unclear whether the large TBL related self efficacy gains persist through end of year exams or into clinical phases. Self efficacy is dynamic and may decline under sustained exam pressure if not continually supported. Second, because ASES is self report, gains may partly reflect novelty and positive affect immediately after an engaging intervention, rather than stable re calibration of self beliefs [24].

Moreover, despite large TBL gains, exam preparedness remains the weakest subscale. This is consistent with Saxena et al. (2020), who found that self efficacy alone does not guarantee better examination performance without explicit alignment between learning activities and assessment formats. It suggests that to fully translate TBL based confidence into exam success, assessment aligned supports (mock OSPEs, blueprint aligned MCQs, feedback on test taking strategies) are still needed [20].

Overall, however, the evidence that TBL has a much stronger impact than TDT on students' beliefs in their own academic capabilities is both educationally and psychologically significant, fitting neatly into the emerging discourse on academic resilience in Indian medical education [21].

TBL Student Satisfaction and Qualitative Feedback

TBL satisfaction survey shows high overall satisfaction (mean ≈ 4.27⁄5), with the highest ratings for respectful and inclusive discussions, enhancement of teamwork through tRAT, comfort in sharing ideas, helpfulness of pre class materials, equal team contributions and the perception that TBL is more effective than lectures for learning anatomy. The lowest rating is for "iRAT improved my understanding" (mean 3.91), and qualitative data highlight time constraints, preparation gaps and content difficulty as key challenges, alongside strong calls for prior topic notification and more TBL sessions.

Kulkarni et al. (2014) reported that students in Indian head and neck anatomy TBL sessions found TBL more constructive and interactive than lectures, especially valuing problem solving, team interaction and the opportunity to clear doubts. Lal et al. (2017) similarly found that biochemistry TBL was perceived as innovative, beneficial, and particularly useful for understanding difficult topics, though they also noted the high preparation demands. Students' comments—valuing group discussion, concept clarity, a safe space to ask questions, and increased interaction with faculty—are closely aligned with these findings [14,15].

At the same time, logistical concerns in the data obtained (insufficient preparation time, large/complex topics within the allotted duration, perceived iRAT difficulty) echo the cautionary notes in the Indian literature. Kulkarni et al. observed that topic selection is critical for TBL success and that some content may be better introduced through lectures before TBL is used in application. Lal et al. emphasised that TBL is resource and preparation-intensive for both faculty and students, and cannot be realistically applied to all topics [15].

Internationally, Faezi et al. (2018) reported high engagement and favourable reactions to TBL, though prior systematic reviews (Fatmi et al. 2013) highlighted mixed student reactions when workload and peer assessment cultures shift sharply from norms. Across multiple contexts, students tend to strongly endorse peer learning, engagement, enjoyment and perceived depth of understanding, but may complain about increased workload and the need for sustained preparation [16].

The data pattern—very positive views on collaboration, inclusion and perceived effectiveness; relatively lower enthusiasm for the preparatory test (iRAT) and time allocation—is entirely consistent with these international observations. It suggests that students accept TBL's value but are sensitive to whether its logistical implementation is humane and predictable.

Pedagogically, the data obtained in the study, especially, qualitative data highlight that TBL, while effective and appreciated, can fail or be resented if certain design conditions are not met:

· Insufficient prep time or late topic notification undermines readiness and makes iRAT feel punitive rather than diagnostic.

· Over ambitious topic scope for a single TBL session overloads students and faculty.

· Language and medium diversity (noted in the demographics) may hinder some students' participation unless teams and materials are thoughtfully managed.

These issues are well documented in TBL best practice guidelines: Parmelee et al. and Michaelsen et al. stress the necessity of clear pre class expectations, appropriate reading load, and adequate time in class for discussion, as well as context sensitive adaptation rather than rigid formula [1,12].

From an implementation standpoint, the findings argue for:

· Standardising pre class preparation (topics and materials shared at least 24–48 hours in advance).

· Careful selection of topics for TBL (preferably clinically relevant, application rich areas).

· Transparent communication of iRAT's purpose as supporting learning, not high stakes judgment.

· Ongoing monitoring of team dynamics and proactive faculty coaching to prevent dominance or free riding.

If these refinements are enacted, there is already strong satisfaction data and learning gains suggest that TBL could become a cornerstone pedagogy in the anatomy curriculum, aligned with CBME reforms and the broader push toward self-directed, collaborative learning in Indian medical education [18].

Overall, the study's results sit squarely within—and add important local evidence to—the growing consensus that well-designed TBL offers clear advantages over traditional lectures for early medical students, not only in knowledge outcomes, but also in self-efficacy, engagement, teamwork and academic resilience. At the same time, the critical issues highlighted—measurement limitations, reliance on team scores, gaps in exam preparedness, and implementation logistics—are essential to address in future cycles if TBL is to move from a promising innovation to a sustainable, system-level change.

CONCLUSION

Team-Based Learning (TBL) demonstrated consistent, statistically significant improvements in knowledge acquisition across all sessions, with large effect sizes and reduced performance gaps among students. in contrast, Traditional Didactic Teaching (TDT) produced inconsistent results with negligible overall gains, benefiting only specific topics rather

than the entire cohort.

While both methods improved academic self-efficacy, TBL produced a substantially larger effect size (0.33 vs. 0.52 for lectures), significantly boosting students' confidence in cognitive mastery, self-regulation, and collaborative learning. However, "Exam Preparedness" remained the weakest domain in both groups, suggesting that although TBL builds competence, specific exam-oriented support remains necessary.

Students reported high satisfaction with TBL, particularly valuing the respectful, inclusive environment and the effectiveness of peer discussions over lectures. However, logistical issues—specifically insufficient preparation time, late topic notification, and the difficulty of the Individual Readiness Assurance Test (iRAT)—were key concerns that need addressing in future implementations.

The study strongly supports the integration of TBL into the Indian MBBS curriculum. It is a more equitable and effective pedagogy for first-year anatomy than pure lecturing, aligning with NMC mandates for active, student-centred learning. Future iterations should focus on refining the pre-class preparation phase and incorporating long-term retention assessments to maximise the benefits of these interventions.

Limitations

1. The study compared individual scores in lectures (pre vs. post) against team scores in TBL (iRAT vs. tRAT). This comparison inherently favours TBL due to the advantage of collaborative testing.

2. Assessments were immediate (post-test/ tRAT only). If delayed post-tests or individual exams are not administered after TBL, they should be included if the knowledge gains are retained over the long term or translate into individual performance.

3. The high satisfaction and engagement with TBL may partially reflect student enthusiasm for a new method, which could fade as the novelty wears off.

4. Faculty and students' co-operation is absolutely required, lots of coordination between them is instrumental for the successful execution of the TBL

Recommendations

1. Future iterations should include an unassisted individual post-test *after* the TBL session and a delayed retention test (e.g., at 4 weeks) to confirm that team discussions translate into lasting individual mastery.

2. To address student concerns, strictly release preparatory materials 48–72 hours in advance and calibrate iRAT difficulty to ensure it assesses readiness without causing undue anxiety.

3. Link to Assessment: Bridge the gap in "Exam Preparedness" self-efficacy by explicitly mapping TBL application exercises to university exam formats (e.g., including exam-style questions at the end of sessions).

4. Crossover design with raw data collection to allow for a direct, statistically robust comparison between teaching methods.

Conflicts of Interests: None

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