Team up for better learning: evaluating team-based learning in anatomy education

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ABSTRACT

This study evaluated the effectiveness of team-based learning (TBL) in teaching musculoskeletal anatomy compared to traditional lectures. A total of 267 second-year medical students participated. Student performance was assessed using pre- and post-tests, and results were analyzed with a paired t-test ($p<.05$), revealing significantly higher anatomy scores following TBL. Student perceptions were explored through a Likert-scale questionnaire analyzed descriptively, and focus group discussions (FGDs), which were transcribed and analyzed using thematic analysis. Students reported that TBL enhanced their understanding of musculoskeletal anatomy and added value by illustrating clinical relevance, encouraging active learning, promoting discussion and communication skills, improving motivation, and reinforcing class preparedness. TBL also fostered knowledge integration, critical thinking, and peer teaching. Despite its benefits, students noted challenges such as limited in-depth discourse, varying group dynamics, subjective peer evaluations, and logistical constraints like unsuitable room setups. Overall, the findings suggest that TBL is an effective alternative to traditional lectures in anatomy education, supporting both academic performance and the development of key competencies essential for future medical professionals.

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1. INTRODUCTION

Early clinical exposure, integration of basic and clinical sciences, and student-centered learning have characterized medical education curriculum improvements in recent decades [1]. While these improvements have improved many elements of medical training, they have also reduced time for core disciplines like anatomy [1]. This tendency worries educators and clinicians since low anatomical knowledge is linked to clinical errors, poor surgical planning, and diagnostic insecurity [2], [3].

Traditional anatomy lectures contain a lot of material in a short time [4], [5]. Lectures typically encourage passive learning and do not stimulate students' cognitive processes [4], [6]. Their inadequate application, integration, and retention of knowledge hinders the development of professional abilities including teamwork, communication, and critical thinking [6]. Medical educators are exploring active learning methodologies, including team-based learning (TBL), to address these problems [7].

The fast development of educational technologies including cloud-based smart technologies, computer simulations, and augmented reality has transformed learning settings across disciplines [8], [9]. These tools enable interactive, open, and immersive anatomy teaching that improves knowledge retention, critical thinking, and teamwork [8]. Dynamic visuals, real-time collaboration, and simulated clinical situations can boost student engagement and knowledge in active learning models like TBL [8], [10].

TBL improves student engagement and learning results in big classrooms through controlled, collaborative learning and teaching [8]. Students prepare and apply knowledge in class, shifting the focus from teacher-centered instruction to student-centered learning [7], [11]. Traditional TBL sessions have four main components, namely: i) preparation, where students study assigned materials before class; ii) readiness assurance testing (RAT), which includes individual and team tests to ensure core concept understanding; iii) application exercises, where teams solve complex, clinically relevant problems; and iv) peer evaluation, which promotes accountability and reflection on team contributions [12], [13].

Permanent teams, serious problems, the same problem for all teams, and simultaneous reporting are TBL fundamentals. These aspects promote cooperation, accountability, and high-level cognitive engagement while allowing teachers to test learning and provide quick feedback [7]–[12]. TBL improves academic achievement, student motivation, communication and cooperation abilities, and learner satisfaction [14], [15]. Despite rising evidence of TBL's benefits in medical education, its use in anatomy instruction—particularly musculoskeletal anatomy—is underexplored. TBL was compared to lecture-based methods for teaching musculoskeletal anatomy in this study. It examined student performance and perceptions of TBL's pros and cons in anatomy teaching. Understanding how TBL affects learning in this core subject can reveal its ability to improve anatomical knowledge, abilities, and attitudes needed for successful medical practice.

The novelty of this study lies in its context and design. Unlike previous research, this study implemented a mixed-methods crossover design to directly compare TBL and traditional lectures within the same cohort, which ensured each student experienced both methods. This study also examined TBL in the specific context of musculoskeletal anatomy–an area of anatomy education where active learning approaches have been scarcely studied. By integrating quantitative performance data with qualitative insights from students, this study provides a comprehensive evaluation of TBL's impact on anatomy learning. This approach offers new evidence on how TBL benefits not only immediate test performance but also influences student engagement, teamwork, and perceptions of clinical relevance in an anatomy course, thereby addressing a gap in the literature on sustainable active learning practices in anatomy education.

2. METHOD

This study employed a mixed-methods design to compare the effectiveness of TBL and lectures in teaching musculoskeletal anatomy and to explore students' perceptions of both methods. A mixed-methods approach was chosen to allow triangulation of data, enhancing the trustworthiness of findings through methodological and data-source integration [3].

2.1. Quantitative component

The quantitative aspect aimed to assess differences in student performance under TBL and lecture-based instruction. A total sampling approach was used, involving 267 second-year medical students at the Faculty of Medicine, Hasanuddin University. Students were divided into two groups based on class assignment using a crossover design. Group 1 received lectures for topic 1 (upper extremity) and TBL for topic 2 (lower extremity), while Group 2 experienced the reverse, as seen in Figure 1. Students were further stratified into small groups by academic performance and gender. Student performance was measured using equivalent pre-tests and post-tests for each topic. Within-group comparisons (pre- vs. post-test improvement) and between-method comparisons (TBL vs. lecture post-test scores) were conducted using paired-sample *t*-tests in SPSS version 16.0 (IBM Corp.), with significance set at $p<.05$.

2.2. Student perception survey

To gather students' perceptions, a 30-item questionnaire combining Likert-scale items and open-ended questions was administered after the teaching sessions. The questionnaire's validity was assessed by item-total Pearson correlation, and its reliability by Cronbach's alpha. Cronbach's alpha was .730, indicating acceptable internal consistency. Given the sample size of 238 complete responses, the minimum Pearson r for significance at the .05 level was approximately .126. Out of 30 items, 29 met this criterion for validity; only one item (Q8) had a lower correlation with the total score ($r=.120$) and was considered invalid, so it was excluded from analysis. Table 1 presents the Pearson correlation results for each item. Descriptive statistics (percentages of responses) were used to summarize the survey results.

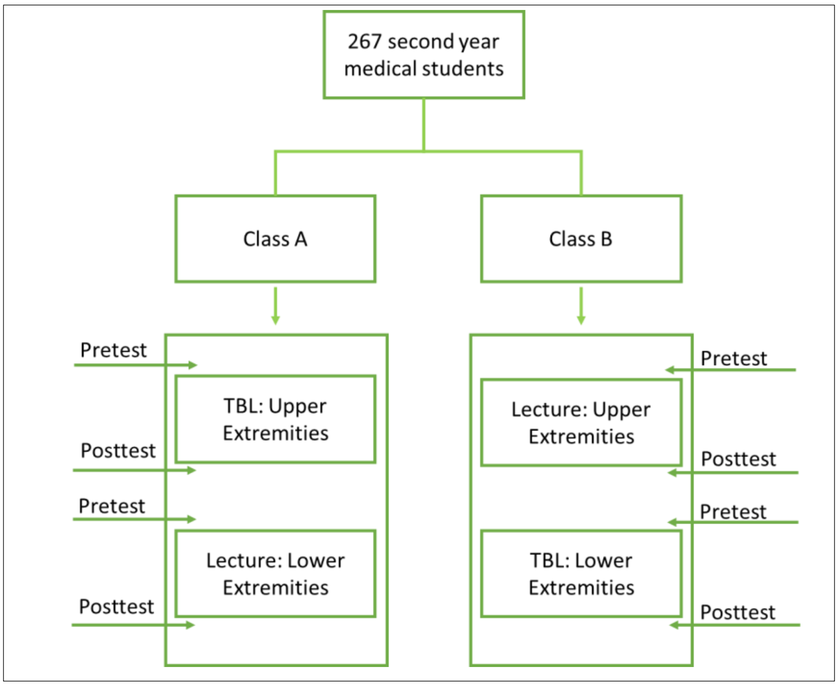

Figure 1. The research phases

Table 1. Person correlation analysis of questionnaire items

Question number	Pearson correlation
Q1	.526**
Q2	.526**
Q3	.463**
Q04	.536**
Q05	.610**
Q06	.256**
Q07	-.210**
Q08	.12
Q09	.455**
Q10	.512**
Q11	.582**
Q12	.586**
Q13	.597**
Q14	.560**
Q15	.499**
Q16	.414**
Q17	.641**
Q18	.548**
Q19	.639**
Q20	.567**
Q21	.660**
Q22	.668**
Q23	.588**
Q24	.600**
Q25	.433**
Q26	.127
Q27	.367**
Q28	-.126
Q29	.473**
Q30	.577**

**sign show strong correlation (positive or negative)

2.3. Qualitative component

The qualitative component aimed to explore students' experiences with TBL in greater depth. A phenomenological approach was adopted to capture the lived experiences of learners, grounded in a constructivist paradigm that views knowledge as co-constructed through interaction and reflection [16].

Qualitative data were collected through open-ended responses on the survey and three focus group discussions (FGDs), each comprising 10 participants selected via voluntary response and subsequent random sampling from those who volunteered. All FGDs were audio- and video-recorded, with transcripts produced verbatim. The data were analyzed using thematic analysis following Braun and Clarke [17] six-phase framework: familiarization, initial coding, theme development, review, definition, and final reporting. To enhance trustworthiness, we monitored data saturation during collection and determined that saturation was achieved when no new themes emerged by the third FGD. Coding was performed manually using a color-coding technique. Two researchers independently coded the transcripts to improve reliability; discrepancies in coding were discussed and resolved collaboratively until consensus was reached (no formal kappa statistic was calculated). Themes were validated through peer debriefing sessions and member checking with selected FGD participants, ensuring credibility of the interpretations. We maintained reflexivity throughout, acknowledging the researchers' insider perspectives and striving to minimize potential bias. Representative quotes for each theme are provided (with participant identifiers), and additional examples are available in Table 2 to enhance transparency and auditability.

Table 2. Themes and sample quotes from TBL study

Theme	Sample of quotes
Perceived benefits of TBL	"*I learnt to understand, not only to remember*" "*In TBL, we explained, we listened to others, we saw teachers' explanation… it was more effective in learning*" "*In TBL, I finally knew the relation of anatomy structures to clinical cases*" "*TBL encouraged me to discuss in solving the problems*" "*TBL promoted me to learn independently*" "*TBL generated my intention to learn…*"
Obstacles to learning in TBL	"*There was one person who dominated the discussion… others felt reluctant to join*" "*Peer assessment was so subjective*" "*I tried to distribute the marks evenly*" "*The time provided for GRAT was so limited*" "*Not all questions were discussed by the teacher*" "*I did not have the guts to discuss because I was afraid to be wrong*" "*There was one person who dominated the discussion, and he was the smart one, and the others felt reluctant to join the discussion*"
Comparison to lecture	"*Lecture was boring and made me sleepy*" "*In lecture, we only heard what the teacher said. We did not have time to discuss*" "*TBL was nice since the concept was not like lecture, it was more like sharing with the expert, so we could grasp the knowledge better*"
Influence on learning behaviors	"*I studied more before TBL because of the IRAT*" "*I learnt before TBL because I could not be a listener, I would be embarrassed if I just keep silent*"

3. RESULTS AND DISCUSSION
3.1. Comparison of learning outcomes between team-based learning and lecture

A total of 267 complete pre- and post-test result pairs were analyzed. The score data met the assumption of normal distribution ($p>.05$), permitting the use of parametric tests. Both Class A (TBL then lecture) and Class B (lecture then TBL) demonstrated significant score improvements from pre-test to post-test under both instructional methods. However, the post-test scores after TBL were significantly higher than those after lectures in both classes ($p<.001$). In Class A, the mean post-test score was 63.28 following TBL vs. 49.92 following the lecture; in Class B, the mean post-test was 65.16 after TBL vs. 59.53 after the lecture, as seen in Table 3. These results indicate that TBL was more effective than lectures in enhancing students' understanding of musculoskeletal anatomy, at least in the short term. Although both teaching methods led to learning gains, TBL produced a greater improvement, suggesting superior immediate comprehension of the material.

This finding aligns with prior studies highlighting TBL's strengths in promoting active learning, self-directed preparation, and the application of knowledge in collaborative settings [14], [15], [18], [19]. The integration of clinical scenario discussions in TBL may have contributed to a deeper understanding and initial retention of anatomical concepts. It should be noted, however, that our assessment captured only immediate learning outcomes; we did not evaluate long-term knowledge retention in this study.

Table 3. Results of paired *t*-tests for post-test scores under TBL vs. lecture

Class	TBL/lecture	Mean	Std. Deviation	Sig.
Class A	Post TBL	63.2786	17.6105	<.001
	Post lecture	49.9191	17.4693	
Class B	Post lecture	59.5325	21.4156	<.001
	Post TBL	65.1605	19.0385	

3.2. Students' perceptions based on questionnaire

Validity and reliability tests confirmed that the questionnaire was suitable for assessing student perceptions (as noted, 29 of 30 items were valid and the instrument was reliable). The survey results revealed overwhelmingly positive perceptions of TBL's benefits, as shown in Table 4. A large majority of students agreed that TBL helped direct their learning (84%), increased their curiosity (86%), enhanced the clinical relevance of anatomy (89%), and promoted collaboration with peers (80%). Furthermore, 73% reported having more understanding of anatomy in clinical contexts after learning via TBL. However, some more mixed opinions were noted. Only 35% of students agreed that all group members contributed actively in the TBL discussions, and just 35% felt that the peer assessment component made them more engaged. While nearly half (48%) of the students preferred TBL over lectures, 44% were neutral on this preference, reflecting diverse learning inclinations among the cohort. While the majority favored TBL for engagement and clinical relevance, the moderate agreement on peer contribution highlights a need for better facilitation and peer assessment strategies. These insights align with calls for active learning models that simultaneously foster content mastery and professional behaviors [18]–[21].

Table 4. Descriptive analysis of questionnaire

Statement	Totally agree and agree (%)	Neutral (%)	Disagree and totally disagree (%)
Learning objectives given before TBL was helpful in directing my learning	84	15	1
I study the reading material before TBL	62	34	3
The reading material was useful in mastering the TBL topic	77	23	0
All group members contribute in discussion process	35	48	17
GRAT explanation was helpful in identifying mistakes and analyzing clinical case	91	8	0
Clinical case promoted discussion in our group	77	21	2
Clinical case increased my curiosity in learning	86	13	0
Clinical case was helpful in relating basic anatomy with clinical application	89	11	0
TBL result should be included in Final result	50	33	17
I have more understanding on anatomy application in clinical case after TBL	73	24	3
TBL gave me opportunity to collaborate with others	80	20	0
TBL improve my discussion skill	66	31	2
TBL increase my motivation in learning	66	33	0
TBL give me opportunity to learn actively	77	22	1
TBL made me learning to understand	84	16	0
I graded all group member based on their contribution in discussion	63	28	9
Peer assessment made me discuss more actively	35	45	19
I like to learn TBL more than lecture	48	44	8
TBL should be implemented for other anatomy teaching	59	36	5

3.3. Discussion of qualitative findings

The qualitative data offered valuable insight into students' experiences and perceptions of TBL in musculoskeletal anatomy. Overall, students reported that TBL provided meaningful educational experiences that promoted deeper understanding, motivation, and engagement, while also highlighting areas for improvement in the implementation of TBL.

3.3.1. Perceived benefits of team-based learning

Students consistently described TBL as a learning strategy that fostered active learning, collaboration, and clinical relevance. They praised TBL for making anatomy more engaging and easier to understand through team discussions and clinical case scenarios. These observations echo findings from prior studies that TBL encourages critical thinking, peer interaction, and the contextual application of knowledge [22]–[25]. As one student (P4-2) explained, "*In TBL, we explained, we listened to others, we saw the teacher's explanation… it was more effective in learning*," indicating how the combination of peer explanation and instructor feedback in TBL enhanced their learning experience. The use of clinical cases was particularly valued for adding relevance and potentially improving retention: "*In TBL, I finally knew the relation of anatomy structures to clinical cases*" (P3-1). From a theoretical perspective, these positive outcomes align with established learning theories. TBL's collaborative environment allows students to actively co-construct knowledge through social interaction—by explaining concepts to peers and solving problems together, they scaffold each other's understanding. This dynamic is consistent with socio-constructivist principles, which posit that interaction within a supportive group can significantly enhance individual learning. TBL also embodies key aspects of adult and experiential learning theories by giving learners autonomy and situating learning in real-world contexts [26], [27]. In our study, the clinical case exercises provided concrete experiences that required students to apply their anatomical knowledge, then reflect and discuss within their teams. Such a cycle of application and reflection is a hallmark of experiential learning and it likely contributed to the deeper comprehension students reported. Indeed, students highly valued this active, relevant approach. As one participant (P2-1) noted, "*I learned to understand, not only to remember*," illustrating a clear shift towards deeper learning rather than rote memorization.

3.3.2. Obstacles to learning in team-based learning

Despite the advantages, students also identified several challenges with the TBL approach. Commonly cited barriers included limited time, large group sizes, inflexible classroom layouts, and uneven levels of participation within teams. In some groups, certain students tended to dominate the discussion while others were reluctant to speak up, leading to perceived inequities in the learning process. One student (P10-2) described this issue: "*There was one person who dominated the discussion... others felt reluctant to join*." Such dominance by specific members, coupled with the hesitation of quieter students, was seen as hindering the full collaborative potential of TBL. Another challenge was discomfort with the peer assessment component of TBL. Some students expressed that they felt uneasy about having to evaluate their peers. For instance, they (P3-1 and P9-2) described feeling social pressure and uncertainty when ranking teammates: "*Peer assessment was so subjective*"; "*I tried to distribute the marks evenly.*" These comments suggest that a number of students were reluctant to give honest, differentiated feedback to peers, possibly out of fear of offending classmates or due to the unfamiliarity of the process. These concerns mirror findings from previous studies, which emphasize that peer evaluation systems must be implemented with sensitivity–for example, by ensuring anonymity and providing sufficient time and guidance for providing feedback [27]. While many students appreciated the intent of peer feedback (to promote accountability and reflection), the method and context of its implementation in our study were viewed as significant limitations of the TBL experience. Importantly, the mixed reactions to peer assessment highlight a need for careful instructional design to make this component effective and fair.

Peer evaluation can be a double-edged sword: on one hand, it is intended to foster individual accountability and teamwork skills, but on the other hand, if poorly implemented it may introduce bias or stress that undermines learner equity [11]. The findings suggest that without proper safeguards, more outspoken or popular students might receive disproportionately positive ratings, whereas quieter or less confident students could be undervalued, regardless of their actual contributions. To harness the benefits of peer assessment without compromising fairness, educators should consider several strategies. First, making peer evaluations anonymous can help reduce social pressure and encourage honesty in rating teammates [11]. Second, providing clear rubrics or criteria and training students on how to give constructive peer feedback can improve the quality and credibility of the evaluations [11], [28]. It may also be wise to emphasize a formative use of peer assessment (for feedback and improvement) rather than assigning high-stakes grades based on peer scores alone, so that students focus on the developmental aspect rather than feeling punished by peers [28]. Additionally, instructors can actively monitor group dynamics and intervene when necessary to ensure that all team members have equal opportunities to contribute [12]. Structured group roles (rotating responsibilities such as leader, scribe, and presenter) could counteract the problem of one person dominating the discussion, as every member would have a defined way to participate [11]. By refining peer assessment practices along these lines, TBL practitioners can enhance individual accountability while maintaining an inclusive and supportive team learning environment.

3.3.3. Comparison to lecture

When comparing TBL to the traditional lecture format, most students favored TBL for its interactivity. They described lectures as a largely passive experience in contrast to the engaging, participatory nature of TBL. As one student (P4-3) bluntly stated, "*Lecture was boring and made me sleepy*." Another student (P5-1) noted, "*In lecture, we only heard what the teacher said. We didn't have time to discuss*," underscoring the lack of opportunity for dialogue or deep exploration in a typical lecture setting. These perceptions reflect broader shifts in student expectations, as today's learners often seek more active involvement, and they highlight the limitations of traditional didactic models in cultivating higher-order learning [6]. The ability to discuss and apply knowledge during class was a key factor that made TBL more appealing to students than lectures.

3.3.4. Influence on learning behaviors

Students reported that TBL positively influenced their study habits and learning behaviors. In particular, the TBL structure incentivized better pre-class preparation and appeared to aid memory retention. Many students noted that knowing there would be an individual readiness assurance test (IRAT) pushed them to study the anatomy material more thoroughly before class. One student (P6-1) explained, "*I studied more before TBL because of the IRAT*," indicating that the readiness assurance process effectively motivated advance preparation. Students also felt that TBL helped improve their recall of knowledge and ability to apply it clinically. They attributed this to the iterative process of using information in team activities and receiving immediate feedback. Several comments alluded to better long-term recall; for example, students mentioned that discussing and reasoning through cases helped "lock in" the knowledge. This perception is consistent with reports from other studies that active learning strategies can yield long-term benefits for retention [18], [25]. That said, it remains to be determined whether the perceived memory benefits of TBL in our study translate into objectively superior long-term retention of anatomical knowledge. We did not include follow-up tests weeks or months after the sessions, so we cannot directly confirm that TBL learners retained more information over time than their lecture-only counterparts.

Future research should incorporate delayed post-tests or longitudinal assessments to evaluate knowledge retention beyond the immediate post-course exam. It would also be valuable to examine students' performance in subsequent courses or clinical skills exams (such as objective structured clinical examinations or OSCEs) to see if those who learned via TBL demonstrate better application of anatomy knowledge in clinical contexts. By tracking outcomes over a longer term and in practical settings, we can more fully assess the lasting educational impact of TBL on students' knowledge and skills.

4. CONCLUSION

This study found that TBL improved medical students' musculoskeletal anatomy knowledge more than lectures. Quantitative study showed TBL sessions had greater post-test results than lectures. Qualitative data showed that students considered TBL more interesting, clinically relevant, and successful at facilitating cooperation, active learning, and critical thinking than lecturing. Students liked TBL's framework and interactivity, but group dynamics, peer assessment, and time allocation needed improvement. Our crossover design, in which all participants attended both TBL and lectures, showed that each class profited more from TBL. Several drawbacks should be considered. First, students with strong ideas or favorable experiences may have been more likely to participate in FGDs. This may have skewed qualitative findings toward positive TBL impressions. Second, we only measured "understanding" by pre- and post-test score gains. Although beneficial, these metrics do not fully reflect higher-order cognitive advances, critical thinking, or long-term anatomical information retention. To better examine the long-term effects of TBL on learning outcomes, future research should include longitudinal follow-up assessments and performance-based evaluations such clinical simulations or OSCEs. TBL is a promising anatomy education technique that improves short-term academic performance and develops important physician competencies. Medical educators should use TBL in anatomy classes and focus on group facilitation, peer assessment, and more diversified student learning and retention assessments. By doing so, educators may optimize TBL's benefits and ensure that active, TBL creates successful and fair educational experiences for all students.

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AUTHOR CONTRIBUTIONS STATEMENT

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C : **C**onceptualization	I : **I**nvestigation	Vi : **Vi**sualization
M : **M**ethodology	R : **R**esources	Su : **Su**pervision
So : **So**ftware	D : **D**ata Curation	P : **P**roject administration
Va : **Va**lidation	O : Writing - **O**riginal Draft	Fu : **Fu**nding acquisition
Fo : **Fo**rmal analysis	E : Writing - Review & **E**diting	

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

INFORMED CONSENT
We have obtained informed consent from all individuals included in this study.

ETHICAL APPROVAL
The research related to human use has been complied with all the relevant national regulations and institutional policies in accordance with the tenets of the Helsinki Declaration and has been approved by the Ethical Committee of Health Research Faculty of Medicine Hasanuddin University Number UH16060609.

DATA AVAILABILITY
The data that support the findings of this study are available from the corresponding author [AAN], upon reasonable request.

REFERENCES

[1] M. A. Taylor, "The impact of medical education reform on the teaching and learning of the anatomical sciences," M.S. thesis, Indiana University, United States, 2019.

[2] R. Singh, R. Shane Tubbs, K. Gupta, M. Singh, D. G. Jones, and R. Kumar, "Is the decline of human anatomy hazardous to medical education/profession?—A review," *Surgical and Radiologic Anatomy*, vol. 37, no. 10, pp. 1257–1265, Dec. 2015, doi: 10.1007/s00276-015-1507-7.

[3] M. Estai and S. Bunt, "Best teaching practices in anatomy education: a critical review," *Annals of Anatomy*, vol. 208, pp. 151–157, Nov. 2016, doi: 10.1016/j.aanat.2016.02.010.

[4] L. Demetri, C. A. Donnelley, M. C. MacKechnie, and P. Toogood, "Comparison of case-based learning and traditional lectures in an orthopedic residency anatomy course," *Journal of Surgical Education*, vol. 78, no. 2, pp. 679–685, Mar. 2021, doi: 10.1016/j.jsurg.2020.08.026.

[5] G. Louw, N. Eizenberg, and S. W. Carmichael, "The place of anatomy in medical education: Amee guide no 41," *Medical Teacher*, vol. 31, no. 5, pp. 373–386, Jan. 2009, doi: 10.1080/01421590902825149.

[6] J. Dent, R. M. Harden, and D. Hunt, *A practical guide for medical teachers, e-book: A practical guide for medical teachers, e-book*, 6th ed. Amsterdam: Elsevier Health Sciences, 2021.

[7] P. Ruder, M. H. Maier, and S. P. Simkins, "Getting started with team-based learning (TBL): an introduction," *The Journal of Economic Education*, vol. 52, no. 3, pp. 220–230, Jun. 2021, doi: 10.1080/00220485.2021.1925187.

[8] S. Papadakis *et al.*, "Revolutionizing education: using computer simulation and cloud-based smart technology to facilitate successful open learning," in *CoSinE 2022: 10th Illia O. Teplytskyi Workshop on Computer Simulation in Education, and CSTOE 2022: Cloud-based Smart Technologies for Open Education, co-located with the ACNS Conference on Cloud and Immersive Technologies in Education (CITEd 2022)*, 2022, pp. 1–18.

[9] K. Lavidas *et al.*, "Determinants of humanities and social sciences students' intentions to use artificial intelligence applications for academic purposes," *Information*, vol. 15, no. 6, p. 314, 2024, doi: 10.3390/info15060314.

[10] S. Papadakis *et al.*, "Unlocking the power of synergy: the joint force of cloud technologies and augmented reality in education," in *CTE 2022: 10th Workshop on Cloud Technologies in Education, AREdu 2022: 5th International Workshop on Augmented Reality in Education*, 2022, pp. 1–23.

[11] M. Sweet and L. K. Michaelsen, *Team-based learning in the social sciences and humanities*. New York: Taylor & Francis, 2023, doi: 10.4324/9781003447528.

[12] L. K. Michaelsen, A. B. Knight, and L. D. Fink, *Team-based learning: a transformative use of small groups in college teaching*. New York: Taylor & Francis, 2023.

[13] J. Sibley and P. Ostafichuk, *Getting started with team-based learning*. New York: Taylor & Francis, 2023, doi: 10.4324/9781003445012.

[14] S. Dnyanesh, A. Shirahatti, S. M. Bhimalli, S. K. Yadav, and K. Dnyanesh, "Team-based learning (TBL) in medical education: fostering collaboration and enhancing learning outcomes," *Medical Journal of Dr. D.Y. Patil Vidyapeeth*, vol. 17, no. 5, pp. 1036–1042, Sep. 2024, doi: 10.4103/mjdrdypu.mjdrdypu_908_23.

[15] P. Vlachopoulos, S. K. Jan, and R. Buckton, "A case for team-based learning as an effective collaborative learning methodology in higher education," *College Teaching*, vol. 69, no. 2, pp. 69–77, Apr. 2021, doi: 10.1080/87567555.2020.1816889.

[16] C. H. Meydan and H. Akkaş, "The role of triangulation in qualitative research: converging perspectives," in *Principles of Conducting Qualitative Research in Multicultural Settings*, A. Elhami, A. Roshan, and H. Chandan, Eds., Hershey, PA: IGI Global Scientific Publishing, 2024, pp. 101–132, doi: 10.4018/979-8-3693-3306-8.ch006.

[17] V. Braun and V. Clarke, "Using thematic analysis in psychology," *Qualitative Research in Psychology*, vol. 3, no. 2, pp. 77–101, 2006, doi: 10.1191/1478088706qp063oa.

[18] C. Taglieri *et al.*, "Comparison of long-term knowledge retention in lecture-based versus flipped team-based learning course delivery," *Currents in Pharmacy Teaching and Learning*, vol. 9, no. 3, pp. 391–397, 2017, doi: 10.1016/j.cptl.2017.01.007.

[19] V. Carlos, M. Rodrigues, B. Matos, L. Gonçalves, F. Ribeiro, and M. Fardilha, "Engaging large classes of higher education students: a combination of spaced learning and team-based learning," *Frontiers in Education*, vol. 8, p. 1129763, Sep. 2023, doi: 10.3389/feduc.2023.1129763.

[20] R. E. Carpenter, D. Silberman, and J. K. Takemoto, "The student engagement effect of team-based learning on student pharmacists," *American Journal of Pharmaceutical Education*, vol. 86, no. 5, pp. 395–401, Jun. 2022, doi: 10.5688/ajpe8567.

[21] A. Burgess *et al.*, "Team-based learning (TBL) in the medical curriculum: better than PBL?" *BMC Medical Education*, vol. 17, no. 1, p. 243, Dec. 2017, doi: 10.1186/s12909-017-1068-z.

[22] A. Burgess *et al.*, "Scaffolding medical student knowledge and skills: team-based learning (TBL) and case-based learning (CBL)," *BMC Medical Education*, vol. 21, no. 1, p. 238, Dec. 2021, doi: 10.1186/s12909-021-02638-3.

[23] M. James *et al.*, "Collaborative case-based learning with programmatic team-based assessment: a novel methodology for developing advanced skills in early-years medical students," *BMC Medical Education*, vol. 22, no. 1, p. 81, Dec. 2022, doi: 10.1186/s12909-022-03111-5.

[24] A. A. Cevik, M. Elzubeir, F. M. Abu-Zidan, and S. Shaban, “Team-based learning improves knowledge and retention in an emergency medicine clerkship,” *International Journal of Emergency Medicine*, vol. 12, no. 1, 2019, doi: 10.1186/s12245-019-0222-2.
[25] C. W. Parrish, S. K. Guffey, and D. S. Williams, “The impact of team-based learning on students’ perceptions of classroom community,” *Active Learning in Higher Education*, vol. 24, no. 2, pp. 169–183, Jul. 2023, doi: 10.1177/14697874211035078.
[26] R. Revans, *ABC of action learning*, 1st ed. London: Routledge, 2017, doi: 10.4324/9781315263533.
[27] R. E. Levine, D. M. Billings, L. K. Michaelsen, K. K. McMahon, and D. X. Parmelee, *Team-based learning for health professions education: a guide to using small groups for improving learning*. New York: Taylor & Francis, 2023, doi: 10.4324/9781003447511.
[28] K. Topping, “Peer assessment: channels of operation,” *Education Sciences*, vol. 11, no. 3, 2021, doi: 10.3390/educsci11030091.

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