Open Access

ORIGINAL ARTICLE

Perceptions and Preferences of Medical Students Regarding Contemporary Pedagogical Tools

Sadia Abdul Qayyum[1], Syed Mukkaram Ali[1], Syed Hafeez-ul-Hassan[2], Maira Rizvi[3]

Department of Forensic Medicine & Toxicology, Liaquat National Hospital & Medical College, Karachi, Pakistan[1]
Department of Physiology, Liaquat National Hospital & Medical College, Karachi, Pakistan[2]
Liaquat National Medical College, Karachi, Pakistan[3]

ABSTRACT

Background: Contemporary pedagogical tools in medical education encompass modern, student-centered teaching strategies that move beyond traditional lectures.
Objective: To explore perceptions and preferences regarding the use of contemporary pedagogical tools among medical students.
Methods: A descriptive cross-sectional study was conducted at Liaquat National Medical College, Karachi, from 1st July to 30th September 2024. Using a census approach, 500 MBBS students from all five academic years completed a validated online questionnaire assessing their preferences for five active learning strategies (Clinical Rotations, Problem-Based Learning, Practical Sessions, Team-Based Learning, Flipped Classroom) and three didactic learning strategies (PowerPoint Presentations, Lectures, and Videos). Data were analyzed using SPSS version 24.0 with descriptive and inferential statistics.
Results: Clinical rotations were the most preferred teaching method, showing the highest levels of engagement (83.8%), comprehension (74.2%), critical thinking (70.6%), conceptual clarity (61.4%), and individual learning fit (67.45%). Problem-based learning also performed strongly, particularly for critical thinking (71.0%), while videos ranked similarly for conceptual clarity and learning fit (~60%). The flipped classroom was the least preferred across all domains, with engagement as low as 23.1%. Clinical rotations significantly outperformed the flipped classroom in all domains ($p < 0.001$; rank-biserial $r = 0.58–0.63$), while problem-based learning and videos also showed significant advantages ($p = 0.002–0.004$; $r = 0.30–0.35$).
Conclusion: Medical students demonstrated a clear preference for Clinical rotations, problem-based learning, and videos over passive lectures or flipped classrooms. To prepare competent, practice-ready physicians, programs should blend structured teaching with these highly engaging, real-world instructional methods.

Key Words: Clinical rotations, Education, Medical, Teaching Material, Problem-based learning, Learning

DOI: https://doi.org/ 10.53685/jshmdc.v7i1.428

Corresponding Author:
Sadia Abdul Qayyum
Associate Professor
Department of Forensic Medicine & Toxicology
Liaquat National Hospital & Medical College, Karachi, Pakistan
Email address: sadia.abdul@lnh.edu.pk
Received: 4-12-2025, 1st Revision: 20-04-2026
2nd Revision: 10-05-2026, Accepted: 05-06-2026

How to cite this article: Qayyum SA, Ali SM, Hassan SH, Rizvi M. Perceptions and preferences of medical students regarding contemporary pedagogical tools. J Shalamar Med Dent Coll. 2026; 7(1): 26-33. doi: https://doi.org/ 10.53685/jshmdc.v7i1.428

INTRODUCTION

Contemporary pedagogical tools refer to modern teaching approaches that emphasize active, student-centered learning rather than traditional lecture-based instruction. These include problem-based learning (PBL), team-based learning (TBL), flipped classrooms (FC), interactive lectures, videos, practicals, PowerPoint presentations, and clinical rotations.[1]

Conventional classroom education, often referred to as didactic learning (DL), typically adopts an instructor-led approach in which knowledge is transmitted from educators to students, sometimes at the expense of conceptual understanding.[2] While this model is systematic in covering content, it has been criticized for limiting opportunities for active participation,

independent thinking, and application of knowledge to real-world contexts. In contrast, a student-centered perspective emphasizes active learning, fostering deeper cognitive engagement, critical thinking, and analytical skills essential for long-term retention.[3]

In medical education, particularly during clinical rotations, judgment, communication, and decision-making are central to active learning approaches. Case-based learning and Problem-based learning are widely adopted pedagogical strategies that prepare students for patient care by applying knowledge to validated patient scenarios in small group settings.[4] Recent investigations among medical students report PBL as the second most preferred teaching strategy, with 26.3% of participants identifying it as their chosen method of learning.[5] Collaborative techniques, such as think-pair-share (TPS), further encourage peer interaction and cooperative learning; 90% of first-year medical students agreed that it improves engagement and motivation to learn.[5] Innovative models such as the flipped classroom have also demonstrated effectiveness by shifting passive content acquisition to pre-class study, thereby reserving classroom time for higher-order education tasks such as synthesis and evaluation.[6]

These instructional modalities reflect the international trajectory of medical education reform. The World Federation for Medical Education (WFME) and the Association for Medical Education in Europe (AMEE) emphasize the importance of enabling students to actively shape their own learning, gain early exposure to clinical practice, and participate in interactive classroom sessions.[7]

Learning perception and preferences among undergraduate medical students vary considerably, resulting in diverse instructional demands.[8] A study in Pakistan reported that 42.3% of medical students demonstrated high preparedness for self-directed learning, which was significantly associated with stronger academic performance and greater confidence in critical thinking.[9] Conversely, students with weaker self-regulation achieved comparatively poorer outcomes, underscoring the importance of cultivating self-directed and self-regulated learning in medical education. These findings highlight that students do not respond uniformly to identical teaching practices, and the interaction between pedagogy and cognitive abilities must be considered when designing medical curricula. Recognition of individual learning modalities enables educators to tailor instructional approaches to optimize comprehension and knowledge acquisition.[10]

Although active learning approaches have been widely studied, much of the available evidence originates from high-income countries with well-resourced institutions. In South Asia, including Pakistan, research remains limited and often focused narrowly on single modalities such as problem-based learning or flipped classrooms, without evaluating multiple active instructional strategies in parallel. Prior investigations have predominantly addressed preclinical cohorts, leaving a gap in understanding the distinct learning needs of clinical students.

This study aimed to explore perceptions and preferences regarding the use of contemporary pedagogical tools among medical students

METHODS

A descriptive cross-sectional study was conducted at the Department of Forensic Medicine, Liaquat National Medical College, Karachi, Pakistan, from 1st July to 30th September 2024. A census approach was adopted. All MBBS students of 1st to 5th years (both males and females) were invited to participate in the study, and those who provided informed consent were included. A total of 500 students (Female 347; Male 153), 100 students from each class, consented and completed the survey, with a response rate of 97.8%. Contemporary pedagogical tools are structured teaching strategies beyond traditional lectures, designed to actively engage students in the learning process. The tools assessed include clinical rotations, problem-based learning, practical sessions, Team-based learning, flipped classroom, videos, PowerPoint presentations, and traditional lectures. Students' perceptions and preferences for these strategies were measured across 6 domains: Engagement, Comprehension, Critical thinking, Interaction, Conceptual clarity, and Individual learning fit. For data collection, an online questionnaire adapted from the validated Inventory of Learning Styles (ILS) was developed using Google Forms11,12. Students were invited through institutional email and class WhatsApp groups. The questionnaire included 8 teaching strategies, categorized into 5 active learning (AL) methods (Clinical Rotations, Problem-Based Learning, Practical Sessions, Team-Based Learning, Flipped Classroom) and 3 didactic learning (DL) methods (PowerPoint Presentations, Lectures, and

Videos). A five-point Likert scale (1 = very poor, 2 = poor, 3 = average, 4 = good, 5 = excellent) was used to rate each method. Higher ratings for these teaching strategies were interpreted as stronger student perceptions of usefulness and greater preference for the respective teaching methods

Ethical Approval

Ethical approval to conduct the study was obtained from the Institutional Ethical Review Board (APP#1044-2024-LNH-ERC) of Liaquat National Hospital and Medical College, Karachi, Pakistan, on 10th June, 2024.

Statistical Analysis

Data entry and analysis were performed using SPSS version 24. Quantitative variables were reported as mean ± SD, and categorical variables as frequencies with percentages. Nonparametric methods were used to present pedagogical preference data (measured on a five-point Likert scale). Normality was assessed using the Shapiro-Wilk test for Likert scores. Median and interquartile range (IQR) were reported for all Likert-scale items. The Mann-Whitney U test was used to compare median Likert scores between individual teaching methods. The flipped classroom was used as the reference comparator for all pairwise comparisons, as it was consistently the lowest-ranked method. Rank-bi serial correlation (r) was calculated as the effect size measure for each Mann-Whitney comparison, with thresholds of 0.1 (small), 0.3 (medium), and 0.5 (large) applied as per Cohen's benchmarks. p-value $\leq$0.05 was considered statistically significant.

RESULTS

A total of 500 medical students (69.4% female and 30.6% male) with a mean age of 21.0 ± 0.75 years participated in the study, creating a female-to-male ratio of 1:2.25. Equal distribution across all five academic years (100 students per year) ensured fair representation from both preclinical and clinical years.

Clinical rotations were the most preferred tool; 83.8% of students reported high engagement, and 74.2% reported better comprehension. Videos and problem-based learning were strongly preferred, while flipped classrooms were consistently scored lowest for engagement (23.1%) and comprehension (30.3%) (Figure 1). The difference in engagement between clinical rotations and flipped classrooms was highly significant ($p<0.001$). For clinical rotations specifically, the conceptual clarity median was 4 (3–5), with 61.4% rating it highly or very highly preferred, and the individual learning fit median was 4 (3–5), with 67.45% rating it highly or very highly preferred — the highest among all eight methods. This suggests students felt clinical rotations aligned best with how they personally learn, likely because of the hands-on, real-world, self-directed nature of the experience (Table 2).

Table 1: Demographic profile of medical students

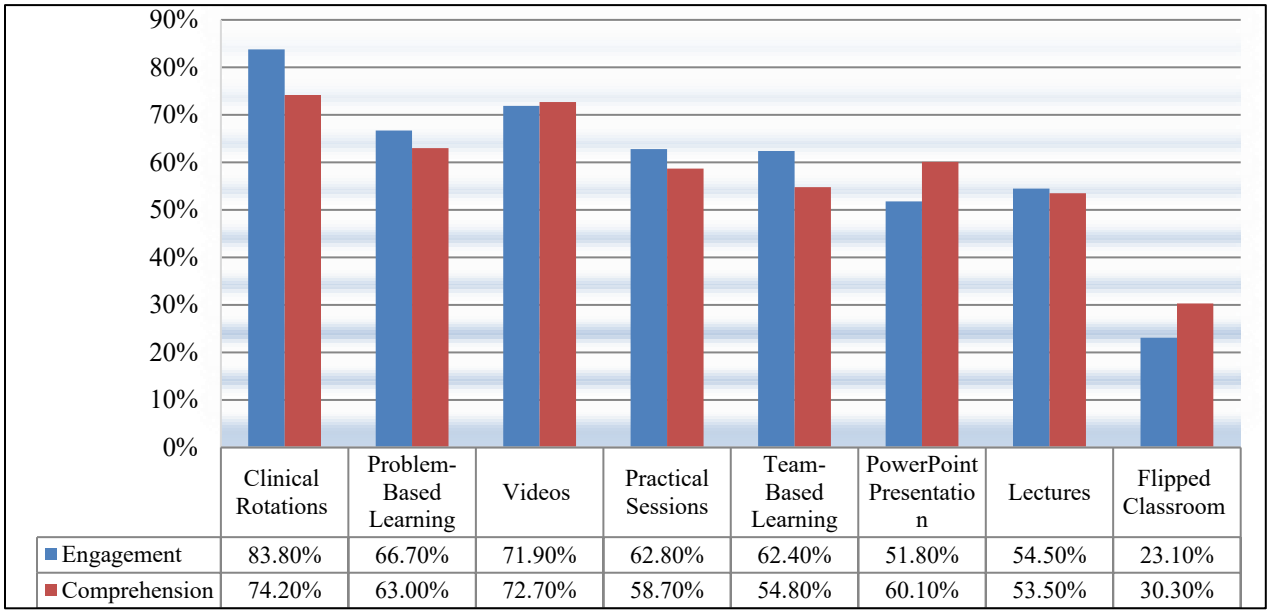
Variable	Category	n (%)
Gender	Female	347 (69.4)
	Male	153 (30.6)
Year of MBBS Study	1st Year	100 (20.0)
	2nd Year	100 (20.0)
	3rd Year	100 (20.0)
	4th Year	100 (20.0)
	5th Year	100 (20.0)

Non-normal distribution was confirmed across all groups ($p < 0.05$), so appropriate non-parametric tests were applied. The overall comparison showed significant differences across all eight methods for both conceptual clarity ($p < 0.001$) and individual learning fit ($p < 0.001$). Pairwise comparisons with correction for multiple testing, using flipped classroom as reference, confirmed all other methods scored significantly higher on both domains. (Table 2)

Clinical rotations ranked highest for conceptual clarity (61.4%) and for individual learning fit (67.45%), with large effect sizes compared with flipped classroom ($r =0.59$ and $r=0.63$; $p< 0.001$). PBL and videos followed ($p=0.002–0.004$; $r=0.30–0.35$), then practical sessions and TBL ($p<0.01$; $r =0.25–0.28$). Even lectures and PowerPoint scored higher than flipped classroom ($p< 0.05$; $r=0.20$), which had the lowest ratings overall (28.1% and 29.7%) (Table 2).

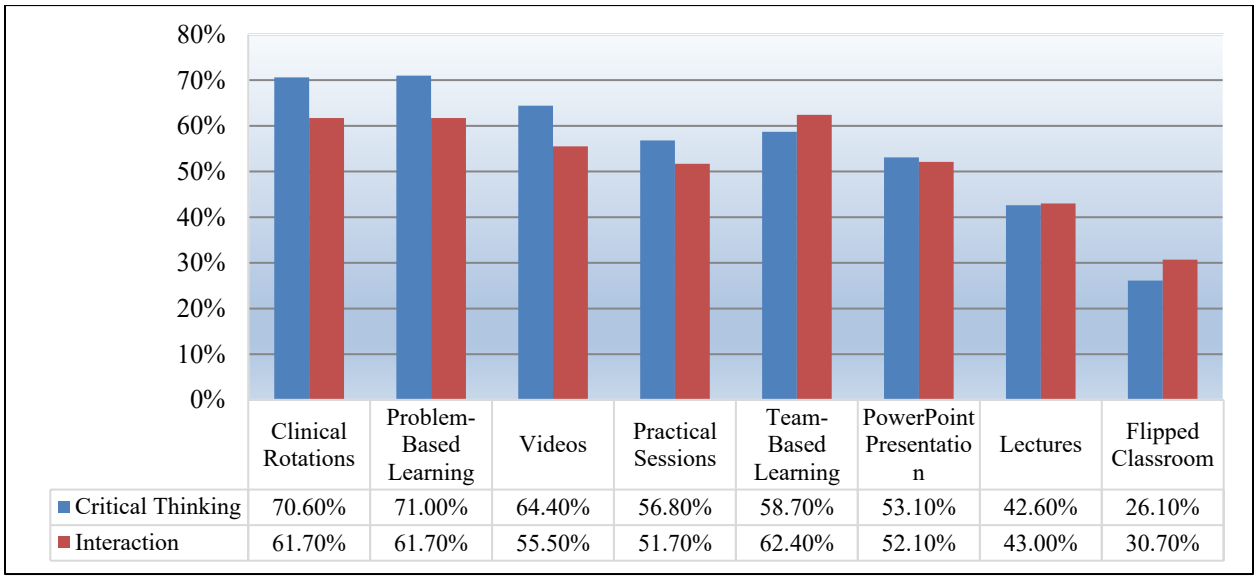
Table 3 presents the comparison of Active Learning (AL) and Didactic Learning (DL) preferences. Students are generally less familiar with AL. Only 7.9% reported being very familiar with AL methods, compared with 11.6% for DL, and a striking 80.5% indicated no preference or prior exposure. Among students who preferred AL, 39.3% noted its strong memorization, and 39.6% reported that it boosted their engagement. Additionally, nearly 37.6% credited the approach with helping them develop strong problem-solving skills. DL was favored for knowledge

retention (10.9%), 12.2% for engagement, 10.6% for problem-solving, and 25.8% of students felt comfortable asking questions, though 38.9% remained hesitant. Only 4.0% chose DL as their overall preference in medical education, 26.4% preferred AL, and 28% leaned towards a blended learning approach. Meanwhile, 41.6% were either undecided or not clear. There is a significant predilection for AL over DL in knowledge retention ($p < 0.004$), engagement ($p < 0.001$), and problem-solving ($p < 0.001$). Cramer's V ranged from 0.26 to 0.41, indicating moderate associations.



	Clinical Rotations	Problem-Based Learning	Videos	Practical Sessions	Team-Based Learning	PowerPoint Presentation	Lectures	Flipped Classroom
Engagement	83.80%	66.70%	71.90%	62.80%	62.40%	51.80%	54.50%	23.10%
Comprehension	74.20%	63.00%	72.70%	58.70%	54.80%	60.10%	53.50%	30.30%

Figure 1: *Preferences of contemporary pedagogical tools in Engagement and Comprehension*



	Clinical Rotations	Problem-Based Learning	Videos	Practical Sessions	Team-Based Learning	PowerPoint Presentation	Lectures	Flipped Classroom
Critical Thinking	70.60%	71.00%	64.40%	56.80%	58.70%	53.10%	42.60%	26.10%
Interaction	61.70%	61.70%	55.50%	51.70%	62.40%	52.10%	43.00%	30.70%

Figure 2: *Preferences of Contemporary Pedagogical Tools in Critical Thinking and Interaction.*

Table 2: Preferences of contemporary pedagogical tools in conceptual clarity and Individual fit

Learning Model	Conceptual Clarity			Individual Learning Fit		
	Median (IQR)	Highly/Very Highly Preferred (%)	p-value*	Median (IQR)	Highly/Very Highly Preferred (%)	p-value*
Clinical Rotations	4 (3–5)	61.4%	< 0.001	4 (3–5)	67.45%	< 0.001
Problem-Based Learning	4 (3–5)	60.1%	0.002	4 (3–5)	57.5%	0.003
Videos	4 (3–5)	60.1%	0.004	4 (3–5)	57.8%	0.003
Practical Sessions	4 (3–5)	53.8%	0.008	4 (3–4)	59.1%	0.007
Team-Based Learning	4 (3–5)	51.2%	0.009	3 (3–4)	50.5%	0.010
PowerPoint Presentations	4 (3–4)	50.9%	0.042	4 (3–5)	47.9%	0.038
Lectures	3 (2–4)	45.9%	0.047	3 (3–4)	54.5%	0.044
Flipped Classroom	3 (2–4)	28.1%	—	3 (1–4)	29.7%	—

*Values are presented as the median (IQR) of Likert ratings. Individual Learning Fit reflects how well each method suits a student's personal learning style. Kruskal-Wallis H test identified significant overall differences across methods for both conceptual clarity ($p < 0.001$) and individual learning fit ($p < 0.001$). *p-values reflect pairwise post-hoc Mann-Whitney U comparisons with Bonferroni correction against Flipped Classroom taken as a reference.*

Table 3: Comparison of Active Learning (AL) and Didactic Learning (DL) among Medical Students

Item	AL n (%)	DL n (%)	Unsure / No Preference n (%)	p value	Cramer's V
Familiarity (Very Familiar)	40 (7.9)	58 (11.6)	402 (80.5)	0.12	-
Knowledge Retention Preference	197 (39.3)	54 (10.9)	249 (49.8)	0.004	0.32
Engagement Preference	198 (39.6)	61 (12.2)	241 (48.2)	< 0.001	0.41
Problem Solving Preference	188 (37.6)	53 (10.6)	259 (51.8)	< 0.001	0.38
Comfort in Asking Questions Preference	177 (35.3)	129 (25.8)	194 (38.9)	0.002	0.29
Teamwork & Communication Preference	158 (31.6)	49 (9.9)	293 (58.7)	0.015	0.26
Overall Preference for Medical Education Approach	132 (26.4)	20 (4.0)	348 (69.6)	0.008	0.30

Chi-square test of independence applied. A p-value <0.05 was taken as statistically significant

DISCUSSION

Students from all five MBBS academic years were assessed on their preferences for five active learning strategies (Clinical Rotations, Problem-Based Learning, Practical Sessions, Team-Based Learning, Flipped Classroom) and three didactic learning strategies (PowerPoint Presentations, Lectures, and Videos).

The data highlights a strong preference among medical students for active, case-based learning rather than standard didactic teaching. Clinical rotations and problem-based learning emerged as the most effective formats, earning the highest median scores for conceptual clarity. Furthermore, over 60% of students strongly endorsed these interactive approaches, demonstrating their vital role in effective knowledge retention in medical education. Medical students' priority for clinical rotations highlights the enduring importance of real patient exposure, which connects theoretical knowledge with practical application.[13] Experiential learning environments further enhance diagnostic reasoning, communication skills, and the development of professional identity.[14] Comparable findings have been reported in other Asian countries, where early clinical exposure has been shown to improve academic satisfaction and strengthen confidence in patient care.[15] The strong inclination towards Problem-based learning aligns with international studies demonstrating that problem solving fosters self-directed learning, Professional responsibility, and integrated knowledge acquisition.[16] Literature from South Asia and Africa suggests that problem-based learning promotes critical thinking and teamwork, equipping students to manage complex clinical decisions.[17,18]Students' preference for PBL reflects readiness to broaden their learning capability and an avenue for teachers and students to interact and communicate effectively.

The use of multimedia and video presentations was highly valued, demonstrating that the extended application of digital media plays a pivotal role in medical learning. Multimedia instruction incorporates

diverse approaches and supports individualized progress.[19] Previous studies have shown that students retain knowledge more effectively when learning from videos than when reading text-based materials.[20] As the digital lessons are accessible and can be replayed, they provide particular benefit in contexts such as Pakistan, where educational resources may be limited.[21] Conversely, flipped classrooms (FC), although internationally recognized for promoting higher-order thinking, are most effective when sessions are carefully preplanned, facilitators are actively engaged, and reliable technological infrastructure is available.[22] Similar challenges have been observed in other South Asian countries, where adoption of FC has been slow due to inconsistent institutional support and occasional student noncompliance.[23] These findings highlight the need to adapt instructional strategies to local realities and student expectations rather than directly replicating Western models.

In the context of blended learning, traditional lectures and PowerPoint presentations received limited enthusiasm, indicating that reliance on a single mode of teaching does not adequately meet students' expectations. Although these methods remain useful for conveying foundational knowledge, they are insufficient for fostering critical thinking and skill development.[24]

The findings of this study provided a comprehensive view of how medical students perceive various teaching strategies. These results are representative of the entire cohort.

CONCLUSION

Medical students demonstrated favorable perceptions and preferences toward active learning approaches compared with traditional teaching methods. Clinical rotations, problem-based learning, and multimedia tools were perceived as most effective for enhancing engagement, comprehension, and critical thinking, whereas flipped classroom strategies received lower preference ratings. These findings support the integration of blended pedagogical approaches that combine structured instruction with interactive learning experiences in medical education.

Limitations and future recommendations

The study was conducted at a single institution, which may limit the generalizability of the findings to other medical colleges with different resources, teaching strategies, and curricular structures. Although the study provides useful quantitative insights into students' learning preferences, it does not incorporate qualitative methods, such as focus group discussions or in-depth interviews, that could have provided a richer contextual understanding.

Future research should involve multiple centers, including both public and private medical institutions, to better reflect national trends and institutional disparities. Additionally, incorporating faculty perspectives along with student feedback would provide a more balanced and comprehensive understanding of teaching and learning practices in medical education.

REFERENCE

1. Karkera S, Devendra N, Lakhani B, Manahan K, Geisler J. A review on modern teaching and learning techniques in medical education. EIKI J Eff Teach Methods. 2024; 2(1). 63-80. doi: 10.59652/jetm.v2i1.128
2. Shi XY, Lu BR, Yin Q, Wang QW, Fang YQ, Sun ZG. Whether case-based teaching combined with the flipped classroom is more valuable than traditional lecture-based teaching methods in clinical medical education: a systematic review and meta-analysis. BMC Med Educ. 2025; 25(1): 906. doi:10.1186/s12909-025-07465-4
3. Martín-Alguacil N, Avedillo L. Student-centered active learning improves performance in solving higher-level cognitive questions in health sciences education. Int Med Educ. 2024; 3(3): 346-362. doi: 10.3390/ime3030026
4. Al-Bedaery R, Baig S, Khare Y, Sullivan-Mchale J. Humanising case-based learning. Med Teach. 2024; 46(10): 1348-1355. doi: 10.1080/0142159X.2024.2308066
5. Guenther AR, Abbott CM. Think-pair-share: promoting equitable participation and in-depth discussion. PRiMER. 2024; 8: 7. doi:10.22454/PRiMER.2024.444143.
6. Paralikar S, Shah CJ, Joshi A, Kathrotia R. Acquisition of higher-order cognitive skills (HOCS) using the flipped classroom model: a quasi-experimental study. Cureus. 2022; 14(4): e24249. doi:10.7759/cureus.24249
7. Li Z, Cai H, Yang X, Lin J, Cao W, Zhang P, Ren J, Zheng D. The effectiveness of the "Early clinical exposure" course based on narrative medicine in cultivating the professional qualities of undergraduates in clinical medicine: a mixed-methods study. BMC Med Educ. 2026; 26(1): 593. doi: 10.1186/s12909-026-08885-6.
8. Rossiter L, Turk R, Judd B, Brentnall J, Grimmett C, Cowley E, McCormick K, Thackray D. Preparing allied health students for placement: a contrast of learning modalities for foundational skill development. BMC Med Educ. 2023; 23(1): 161.doi: 10.1186/s12909-023-04086-7
9. Khan EH, Sethi A, Junaid SM, Khattak T, Khattak M. Readiness for self-directed learning among undergraduate medical students in Khyber Pakhtunkhwa during COVID-19,

Pakistan. BMC Med Educ. 2025; 25(1): 165. doi: 10.1186/s12909-025-06745-3

10. Hussain I. Exploring the impact of learning styles on tailoring individual learners' needs: a systematic review. J Manag Educ Res Innov. 2024; 2(1): 16-26. doi.org/10.5281/zenodo.11128012
11. Vermunt JD. Inventory of learning styles (ILS). Tilburg, The Netherlands: Tilburg University, Department of Educational Psychology. 1994.
12. Van der Veken J, Valcke M, Muijtjens A, De Maeseneer J, Derese A. The potential of the inventory of learning styles to study students' learning patterns in three types of medical curricula. Med Teach. 2008; 30(9-10): 863-869. doi: 10.1080/01421590802141167
13. Yang M, Yuan C, Jian Z. Assessing medical students' competency before and after clinical rotations: a single-center pilot study in China. BMC Med Educ. 2025; 25(1): 1183. doi: 10.1186/s12909-025-07735-1
14. Couper I, van Schalkwyk S, Blitz J, Fish T, Viljoen K, Smith L. It's all about the patients: a shift in medical students' approach to learning during a novel distributed integrated clinical rotation. BMC Med Educ. 2024; 24(1): 1145. doi: 10.1186/s12909-024-06112-8
15. Shaban EE, Elmelliti H, Shaban A, Shaban A, Zaki HA. Impact of early clinical exposure on medical students' competency development: a systematic review of evidence from Asian and African countries. BMC Med Educ. 2025; 25(1): 1723. doi: 10.1186/s12909-025-08103-9
16. Shareef AS. Developing self-directed learning skills through scaffolding in problem-based learning. Maldives Natl J Res. 2025;13(1):83-101. doi: 10.62338/cgbpdv45
17. Atreya A, Gnawali L, Menezes RG, Nepal S. Enhancing medical education in Nepal through problem-based learning (PBL) and collaborative action research strategies. BMC Med Educ. 2025; 25(1): 689. doi: 10.1186/s12909-025-07267-8
18. Aidoo B. Teacher educators experience adopting problem-based learning in science education. Educ Sci. 2023; 13(11): 1113. doi; 10.3390/educsci13111113
19. Ahmady S, Seyed Alinaghi S, Yarmohammadi S, Afsahi AM, Matini P, Abbaspour F, et al.. Integration of learning technologies in medical students' curriculum: a systematic review. Health Educ. 2025; 125(6): 672-719. doi: 10.1108/HE-10-2024-0117
20. Ploetzner R. The effectiveness of enhanced interaction features in educational videos: a meta-analysis. Interact Learn Environ. 2024; 32(5): 1597-1612. doi: 10.1080/10494820.2022.2123002
21. Saeed S, Khan MH, Siddiqui MM, Dhanwani A, Hussain A, Ali MM. Hybridizing video-based learning with simulation for flipping the clinical skills learning at a university hospital in Pakistan. BMC Med Educ. 2023; 23(1): 595. doi: 10.1186/s12909-023-04580-y
22. Sointu E, Hyypiä M, Lambert MC, Hirsto L, Saarelainen M, Valtonen T. Preliminary evidence of key factors in successful flipping: Predicting positive student experiences in flipped classrooms. High Educ. 2023; 85(3): 503-520. doi: 10.1007/s10734-022-00848-2
23. Ed-dali R. Adopting the flipped classroom model in EFL classrooms: transforming active learning for Moroccan high school students. Asian-Pac J Second Foreign Lang Educ. 2025; 10(1): 58. doi: 10.1186/s40862-025-00369-2
24. Liu K, Liu S, Ma Y, Jiang J, Liu Z, Wan Y. Comparison of blended learning and traditional lecture method on learning outcomes in the evidence-based medicine course: a comparative study. BMC Med Educ. 2024; 24(1): 680 doi: 10.1186/s12909-024-05659-w

AUTHORS' CONTRIBUTION:

SAQ: Conception of the study, manuscript drafting, critical review
SMA: Data acquisition & analysis, interpretation, manuscript drafting, critical review
SHH: Design of the work, interpretation, data analysis, manuscript drafting and critical review
MR: Data analysis, interpretation of data and critical review

All authors approved the final version to be published and agree to be accountable for all aspects of the work, ensuring that any questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

CONFLICT OF INTEREST:
All authors declared no conflict of interest.

GRANT SUPPORT AND FINANCIAL DISCLOSURE:
No specific grant was taken for this research from any funding agency in the public, commercial or not-for-profit sectors.

DATA SHARING STATEMENT:
The data are available from the corresponding author upon reasonable request.

……
……