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Undergraduate medical students' perceptions of case-based learning in preclinical physiology within a low resource setting: a qualitative study

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Abstract

Case-based learning (CBL) is widely promoted in medical education to enhance engagement, conceptual understanding, and early clinical reasoning. However, most evidence supporting its effectiveness originates from well-resourced institutions, and their feasibility and impact within low-resource preclinical settings remain uncertain, where large class sizes, limited infrastructure, and reliance on didactic teaching persist. This qualitative descriptive study explored undergraduate medical students' perceptions of CBL implementation in pre-clinical physiology at a public-sector medical university. Four focus group discussions were conducted with 30 second-year Bachelor of Medicine, Bachelor of Surgery (MBBS) students. Data was audio-recorded, transcribed verbatim, and analyzed using reflexive thematic analysis following Braun and Clarke's framework. Students valued CBL for promoting active participation, improved conceptual clarity, knowledge retention, and early development of clinical reasoning. However, its effectiveness was moderated by contextual constraints, including limited time, inconsistent facilitation, restricted clinical exposure, and lack of visual learning resources. Participants proposed feasible adaptations such as simplified case design, phased progression of complexity, standardized facilitation, and incorporation of low-cost multimedia aids. These findings suggest that while CBL is pedagogically valuable, successful implementation in resource-limited preclinical environments requires deliberate contextual adaptation rather than direct adoption of models developed in high-resource settings.

Keywords: Case-based learning; Physiology education; Medical education; Low-resource setting, Qualitative research

Background

Effective physiology education requires moving beyond passive knowledge transmission to foster clinical reasoning and application of concepts. However, in many resource-limited preclinical settings, traditional didactic lectures remain the dominant teaching strategy, limiting students' ability to contextualize physiological principles within clinical practice (1). As medical curricula increasingly emphasize active learning and early clinical reasoning, instructional strategies that promote engagement, contextual understanding, and application of knowledge have gained prominence (2). Case-based learning (CBL) aligns with principles of adult and experiential learning by engaging students in problem-centered discussion, reflection, and application of knowledge to authentic clinical scenarios (3, 4). Through guided interaction and peer learning, CBL promotes deeper understanding and transfer of basic science concepts to clinical contexts (5).

Although the effectiveness of CBL has been widely documented in medical education, much of the existing literature originates from well-resourced institutions with established infrastructure, faculty development programs, and curricular flexibility (6). In contrast, medical schools in low-resource settings face distinct challenges, including high student-to-faculty ratios, limited faculty training in active learning methodologies, time-constrained curricula, and restricted access to simulation tools and visual learning resources (7, 8). In preclinical physiology teaching, these constraints are further compounded by limited early clinical exposure, making it difficult for students to fully contextualize complex physiological processes (9). As a result, the direct transferability of CBL models developed in high-resource environments to low-resource settings remains uncertain.

Although CBL has demonstrated educational benefits in many medical programs, most evidence originates from well-resourced institutions with established infrastructure and faculty development. Whether similar benefits can be achieved in low-resource preclinical environments characterized by large class sizes, limited teaching aids, and restricted clinical exposure remains unclear. There is a particular paucity of qualitative research examining how students experience CBL under such constraints. To address this gap, this study explored undergraduate medical students' perceptions of CBL implementation in pre-clinical physiology within a low-resource public-sector medical university.

Methods

Study Design and Setting

This qualitative descriptive study was designed to explore the perception of undergraduate medical students regarding CBL in physiology learning. A qualitative descriptive approach was selected to obtain rich, practice-oriented insights into students' experiences and perceptions of CBL implementation.

The study was conducted at Liaquat University of Medical and Health Sciences (LUMHS), Jamshoro, Pakistan, a public-sector medical university operating in a low-resource educational context. Data collection took place between October and December 2024.

In this context, "low-resource" refers to a combination of high student-to-faculty ratios, limited access to simulation laboratories and digital learning platforms, constrained faculty development opportunities, and minimal structured early clinical exposure.

Ethical Considerations

Ethical approval was obtained from the Research Ethics Committee of Liaquat University of Medical and Health Sciences (approval number: LUMHS/REC/2024/1016). Prior to data collection, all participants received written and verbal information regarding the study objectives, voluntary nature of participation, and confidentiality of responses. The study was conducted in accordance with the Declaration of Helsinki. Participant anonymity was preserved using pseudonyms and removal of identifying information from transcripts. Written informed consent was obtained from all participants prior to data collection.

Study Population and Sampling

The study population comprised second-year Bachelor of Medicine and Bachelor of Surgery (MBBS) students who had completed physiology modules in pre-clinical years delivered during the 2023–2024 academic years and had participated in institutional CBL sessions. Students enrolled in first-year MBBS, those with attendance below 75% in CBL sessions, and those unwilling or unable to provide consent were excluded. Purposive sampling was used to ensure inclusion of students with sufficient exposure to CBL. A total of 30 students were recruited from an eligible cohort of approximately 300 students.

Structure of CBL in Physiology

CBL sessions were implemented as a supplementary instructional strategy and did not replace traditional didactic lectures. A total of 17 CBL sessions were conducted across the academic years 2023–2024, covering major physiology domains including hematology, cardiovascular, respiratory, endocrine, reproductive, and nervous systems.

Each CBL session was conducted over approximately 90 minutes with groups of 15 students facilitated by a faculty member from the Department of Physiology. Facilitators were oriented to the session objectives and discussion flow prior to implementation but did not undergo formal CBL certification training. Clinical cases were paper based, designed by physiology faculty with clinical input, and aligned with recently covered lecture content to reinforce conceptual integration rather than clinical decision-making.

Data Collection

Data was collected through four focus group discussions (FGDs), each comprising 6-8 participants. FGDs were selected to encourage interaction, shared reflection, and collective exploration of learning experiences. A semi-structured interview guide was developed based on existing literature and

expert input to ensure alignment with study objectives. The semi-structured guide explored three core domains: perceived educational benefits, operational challenges, and recommendations for improvement. All FGDs were conducted in a quiet, neutral setting within the Department of Physiology at LUMHS. Each discussion lasted approximately 60 minutes and was audio-recorded with participants' consent.

The FGDs were moderated by a trained qualitative researcher who was not involved in formal assessment of the students. The principal investigator, who was a faculty member, was present as an observer and contributed to reflexive discussions but did not lead the sessions. A second research team member recorded observational notes capturing group dynamics and non-verbal cues.

Researcher Reflexivity and Trustworthiness

Given the educational context, reflexivity was actively addressed throughout the study. The research team acknowledged their roles as educators and researchers and engaged in regular reflexive discussions to minimize potential influence on data interpretation. Moderator neutrality was emphasized during FGDs to reduce power dynamics and encourage open discussion.

Trustworthiness was enhanced through multiple strategies, including investigator triangulation during data analysis, maintenance of an audit trail, and adherence to COREQ (Consolidated Criteria for Reporting Qualitative Research) guidelines.

Data Analysis

Audio recordings were transcribed verbatim and verified for accuracy prior to analysis. Data was analyzed using reflexive thematic analysis as described by Braun and Clarke (10). This approach was chosen for its flexibility and suitability for identifying patterns of meaning within qualitative educational research.

The analysis followed six iterative steps: familiarization with the data, initial coding, theme development, theme review, defining and naming themes, and reporting. Coding was conducted independently by two researchers using NVivo software NVivo (Version 12, QSR International Pty Ltd., Melbourne, Australia; https://www.qsrinternational.com), which was employed solely for data management, organization, and retrieval. NVivo was not used for automated or AI-assisted analysis. An audit trail was maintained through versioned NVivo project files, analytic memos, and documented theme maps to ensure transparency of the analytic process.

Initial coding was undertaken independently to promote reflexive engagement with the data, followed by iterative interpretive discussions among the research team to refine and deepen the development of themes. Analytic sufficiency was judged when the dataset provided sufficient depth and coherence to support stable and well-developed themes relevant to the study objectives.

Results

Characteristics of Participants

A sum of 30 second-year MBBS students were recruited in the study across four FGDs, with group sizes ranging from 6 to 8 participants. The sample included 18 female and 12 male students. The mean age of participants was 21.6 ± 3.1 years. All participants had completed physiology modules in pre-clinical years and had exposure to CBL sessions integrated alongside traditional lectures during the academic years 2023–2024.

Overview of Themes

Following transcription and reflexive thematic analysis of the focus group discussions, three themes were generated reflecting students' experiences with CBL in physiology which included perceived educational benefits, challenges encountered during implementation, and student-generated recommendations for improvement. These themes capture both the importance of CBL as a learning strategy and the contextual constraints influencing its effectiveness within a low-resource pre-clinical setting.

Theme 1: Perceived Educational Benefits of Case-Based Learning

Students consistently described case-based learning as a more engaging and interactive alternative to traditional lectures, shifting learning from passive listening to active discussion and problem-solving. Participants reported that analyzing clinical scenarios encouraged participation, curiosity, and collaborative reasoning, which sustained attention and increased motivation during sessions. Many contrasted this with didactic teaching, noting that CBL promoted deeper involvement and a greater sense of ownership over learning.

Beyond engagement, students perceived that contextualizing physiological concepts within patient scenarios enhanced conceptual clarity, retention, and early clinical reasoning. Linking theory to practice helped them better visualize mechanisms and apply knowledge logically rather than rely on memorization. Collectively, these perceptions suggest that CBL functioned as a bridge between foundational physiology and applied thinking in the preclinical years. Representative quotations are presented in Table 1.

Theme 2: Challenges Encountered During CBL Implementation

Although students valued CBL pedagogically, they reported several contextual and structural barriers that limited its effectiveness. Time constraints often curtailed discussion, while variability in facilitation styles influenced the depth and consistency of learning across groups. Limited early clinical exposure made it difficult for some students to fully relate to scenarios, and the absence of visual or multimedia aids reduced comprehension of complex physiological processes.

Importantly, these challenges were experienced as interconnected rather than isolated. Compressed schedules, inconsistent guidance, and resource limitations collectively reduced the intended benefits of small-group discussion. These findings highlight how systemic constraints in low-resource settings can moderate the impact of otherwise effective active-learning strategies. Illustrative quotations are summarized in Table 2.

Theme 3: Student Recommendations for Improving Case-Based Learning

In response to these challenges, students proposed several practical and context-sensitive strategies to improve CBL implementation. Suggestions included simplifying case complexity, introducing gradual progression from single systems to integrated scenarios, and standardizing facilitation approaches to ensure consistency across sessions. These recommendations reflected a desire for clearer structure and better alignment with their preclinical level of understanding.

Participants also emphasized incorporating visual aids, such as diagrams, flowcharts, and basic animations, to enhance conceptualization. Representative quotations are presented in Table 3. Representative quotations supporting these recommendations are provided in Table 3.

Summary of Findings

Overall, the students perceived CBL as an effective and engaging pedagogical approach that enhanced understanding and promoted active learning in physiology. However, its impact was moderated by contextual challenges related to time, facilitation consistency, resource limitations, and limited clinical exposure. Student recommendations focused on pragmatic adaptations aimed at improving feasibility and maximizing educational benefit within a low-resource preclinical environment.

Table 1: Perceived educational benefits of case-based learning

Sub-theme	Description	Representative student quotes
Increased engagement and motivation	Students reported higher interest and sustained attention during CBL sessions compared to traditional lectures	"These sessions are the most interesting part of our course. They keep me engaged and curious." (S4, FGD2)
		"Compared to normal lectures, these sessions keep us active. We actively think and participate, so it feels more interesting." (S2, FGD1)
		"I feel more involved in learning during CBL compared to normal lectures." (S21, FGD3)
Enhanced understanding and retention	Clinical scenarios helped contextualize abstract physiological concepts to the students.	"The clinical case on acid–base imbalance made a very difficult topic easy to understand. I still remember it weeks later." (S11, FGD2)
		"When physiology is connected to a patient story, it stays in my mind." (S6, FGD1)
		"The cardiovascular cases helped me understand the mechanisms better than reading from the book." (S14, FGD2)
Development of critical thinking	Students perceived improvement in analytical reasoning and confidence in applying physiological knowledge	"I feel more confident identifying what is wrong with a patient because we practice thinking through the cases." (S19, FGD3)
		"It teaches us how to approach a problem step by step." (S28, FGD4)
		"It helps in building a habit of thinking clinically, even in second year." (S29, FGD4)

Table 2: Challenges experienced during case-based learning sessions

Sub-theme	Description	Representative student quotes

Limited clinical exposure	Lack of real patient interaction made it difficult to fully relate to some scenarios to the students.	"Without seeing real patients, it is sometimes hard to connect the case with what actually happens in hospitals." (S7, FGD1)
		"Sometimes we feel that a real patient can help more in understanding the scenario" (S17, FGD4)
		"It would be easier to understand if we had some hospital exposure along with the cases." (S13, FGD2)
Time constraints	Compressed schedules limited discussion depth and reflection	"More time is needed for proper discussion." (S23, FGD3)
		"There is too much syllabus, so not enough time is given for detailed case discussion." (S16, FGD2)
		"The cases are very helpful, but we don't get enough time to discuss them properly." (S15, FGD2)
Variability in facilitation	Differences in faculty teaching styles affected session quality	"Some teachers guide us step by step, but others just read the case without discussion." (S22, FGD4)
		"The quality of the session depends a lot on the teacher." (S9, FGD2)
		"When the teacher is not interactive, the case does not help much." (S30, FGD4)
Overly complex scenarios	Multi-system or advanced cases were overwhelming for pre-clinical students	"Some cases were too complicated and confusing for our level." (S9, FGD2)
		"It is better to start with simple cases because very complex ones are difficult to follow." (S15, FGD2)
Lack of visual and supplemental aids	Absence of diagrams or animations made visualization difficult	"It's hard to imagine what's happening inside the body without diagrams or visuals." (S27, FGD4)

| | | "Visuals would help us understand the processes better." (S5, FGD1) |
| | | "Animations would make everything clearer." (S17, FGD3) |

Table 3: Student-generated recommendations for optimizing CBL delivery

Sub-theme	Description	Representative student quotes
Simplification and phased progression	Begin with single-system cases and gradually increase complexity	"Start with simple cases first, then move to more integrated ones later." (S3, FGD1)
		"If cases are gradual in difficulty, it will be easier for us to build our understanding." (S11, FGD2)
		"Start basic and then increase complexity step by step." (S22, FGD3)
Integration of visual aids and multimedia	Use diagrams, flowcharts, and animations to support understanding	"Animations showing physiological processes would make cases much easier to follow." (S18, FGD3)
		"If we see animations or diagrams, it will be much easier to follow the case." (S6, FGD1)
		"Even simple pictures or flowcharts can make a big difference." (S25, FGD4)
Standardization of facilitation	Implement uniform teaching strategies across faculty	"If all teachers followed the same method, it would be easier for us to learn." (S24, FGD4)
		"There should be a uniform teaching strategy for all sessions." (S6, FGD1)
		"All teachers should follow the same pattern so that

		students know what to expect." (S9, FGD2)

Discussion:

This study identifies a key implementation paradox: while students in a low-resource preclinical setting strongly value case-based learning for enhancing engagement and clinical reasoning, its practical effectiveness is constrained by systemic contextual barriers. These findings suggest that the success of CBL depends not only on pedagogical design but also on the feasibility of implementation within local institutional realities.

An important finding of this study was that students perceived CBL as more engaging and interactive learning strategy as compared to traditional didactic lectures. Participants reported greater motivation, active participation, and sustained attention during CBL sessions. These findings are consistent with prior studies reporting improved learner engagement through case-based and problem-based approaches in medical education (11-13). By embedding physiological concepts within clinical scenarios, CBL appeared to promote meaningful learning rather than rote memorization. This aligns with adult learning theory, which emphasizes relevance, problem-centered learning, and learner involvement as key drivers of effective teaching techniques (3). Similarly, experiential learning theory posits that knowledge is constructed through cycles of experience, reflection, and application processes that were reflected in students' descriptions of analyzing and discussing clinical cases (4).

Students also reported improved conceptual understanding and retention of complex physiological topics, particularly in systems such as cardiovascular and respiratory physiology. These findings are consistent with previous research showing that contextualized learning enhances comprehension and long-term recall of the knowledge (13). The integration of clinical cases may support cognitive anchoring, whereby new information is more effectively encoded when linked to meaningful contexts, a principle reinforced by multimedia learning theory (14). Importantly, students perceived these benefits even in the absence of formal clinical exposure, suggesting that well-designed cases can partially bridge the preclinical–clinical divide.

Another important theme generated in FGDs was the perceived development of critical thinking and problem-solving skills. Students described greater confidence in approaching physiological problems and interpreting clinical information, reflecting the analytical orientation fostered by CBL. Similar

perceptions have been reported in studies reporting early integration of clinical reasoning in preclinical curricula (15). While this study does not assess objective learning outcomes, these self-reported experiences suggest that CBL may support the development of foundational reasoning skills that are essential for later clinical training.

Along with these perceived benefits, students identified several challenges that constrained the effectiveness of CBL. Time constraints emerged as a prominent barrier, with participants describing sessions as rushed and insufficient for in-depth discussion. This finding is consistent with reports from other educational contexts where dense curricula and limited instructional time restrict the implementation of active learning strategies (6). In low-resource institutions, where faculty workload and curricular rigidity are common, allocating sufficient time for interactive pedagogies such as CBL remains a significant challenge.

Variability in facilitation styles across faculty members was another frequently reported issue by the students. They mentioned that the quality of CBL sessions depended heavily on the facilitator's ability to guide discussion and encourage participation. Similar observations have been reported in studies emphasizing the critical role of trained facilitators in small-group learning environments (6, 16). These findings highlight the importance of faculty development and standardization of facilitation strategies to ensure consistency and maximize the educational value of CBL.

Students also emphasized the lack of visual and supplemental learning aids as a barrier to understanding complex physiological processes. This limitation is particularly relevant in physiology education, where the abstract mechanisms often require visualization for effective comprehension of the process (17). Previous studies have demonstrated that multimedia tools such as diagrams and animations can enhance understanding and engagement in basic science education (14). In low-resource settings, even simple visual aids or structured schematics may substantially improve learning without requiring costly technological investments.

Notably, students suggested recommendations for improving CBL delivery that align with these findings. Suggestions such as simplifying case complexity, adopting a phased progression from single system to integrated cases, standardizing facilitation approaches, and incorporating visual aids reflect a clear understanding of both educational needs and contextual constraints. These recommendations aligns with findings from previous studies conducted in similar educational environments, which emphasize

adaptability and feasibility as key determinants of successful active learning implementation (6, 16). Addressing a single issue in isolation may therefore be insufficient. Instead, coordinated curricular planning, targeted faculty training, and incremental resource optimization may be necessary to support sustainable implementation of CBL in resource-constrained preclinical settings.

Limitations and Future Directions

This study has certain limitations that should be considered when interpreting the findings. First, the study was conducted at a single public-sector medical university, which may limit the transferability of the results to other institutional or cultural contexts. Second, the findings are based on self-reported student perceptions and experiences and do not include objective measures of academic performance or learning outcomes. While students perceive improvements in understanding and engagement, these perceptions should not be interpreted as evidence of causal effects on academic achievement. Future studies could adopt mixed-method designs to examine how student perceptions of CBL relate to learning behaviors and performance outcomes.

Third, although efforts were made to minimize power dynamics through neutral moderation and reflexive practices, the involvement of faculty members in the research team may have influenced participant responses. This potential bias was mitigated by using an independent moderator, assuring confidentiality, and encouraging open discussion; nevertheless, it cannot be entirely excluded. Moreover, the focus of this study was limited to undergraduate medical students' perspectives. Future research could expand on these findings by exploring faculty perceptions, and institutional constraints. Comparative studies across public and private institutions or across regions may further inform context-sensitive adaptation of case-based learning in pre-clinical medical education. Additionally, as reflexive thematic analysis is interpretive in nature, themes represent one coherent construction of the data shaped by the researchers' perspectives.

Conclusion

In conclusion, this study demonstrates that case-based learning can enhance engagement and conceptual understanding in preclinical physiology even in resource-limited contexts. However, successful implementation requires deliberate contextual adaptation, including simplified case design, standardized facilitator preparation, and integration of affordable visual aids,

rather than direct transplantation of models developed in high-resource environments.

Declarations

☐ **Ethical approval and consent to participants:**

Research ethics committee of Liaquat University of Medical and Health Sciences (LUMHS) granted ethical approval for this study (approval number LUMHS/REC/2024/1016). All participants were recruited in the study after written informed consent according to guidelines of declaration of Helsinki.

☐ **Consent for publication:**

Not applicable

☐ **Data Availability:**

The qualitative data generated and analyzed during this study are not publicly available due to ethical and confidentiality considerations associated with focus group discussions. De-identified transcripts and the coding framework may be made available by the corresponding author upon reasonable request, subject to institutional ethical approval.

☐ **Competing interests:**

Authors declare no conflict of Interest.

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None

☐ **Author's contributions:**

Conception/design of the work: UA, AAU, AMK, GMF

Data collection: UA, AAU, AM, ZK, TS, GMF

Data analysis and interpretation: UA, TS, AAU, ZK, AM, AMK

Drafting the article: UA, TS, AAU, ZK, AM, AMK, GMF

Critical revision of the article, and final approval: UA, TS, AAU, ZK, AM, AMK, GMF

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