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Innovations in Case-Based Learning to Enhance Clinical Reasoning among Graduate Students: A Mixed-Methods Study

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Abstract

Objective: Integration of theoretical knowledge with practical application is acquired by clinical reasoning. This study evaluated the effectiveness of innovations in Case-Based Sessions (CBS) in bridging the theory-practice gap, promoting application of knowledge, and enhancing clinical reasoning among MPhil students in the Endocrine and Reproductive Sciences course in the Department of Biological & Biomedical Sciences (BBS) at AKU

Methodology: It was a pilot study which involved a mixed-method exploratory approach; conducted from August 2024 to January 2025 involved 5 MPhil students and 3 facilitators in the Endocrine and Reproductive Sciences course. CBS followed a flipped classroom model, including pre-reading, in-class case discussions, and post-class study questions as a case-based assignment. Thematic analysis was done after focus group discussions (FGD) with students, survey responses and reflections from facilitators were also acquired.

Results: The quantitative data revealed relevance of pre reading material, engagement of students during interactive discussions and enhanced ability to solve short-answer questions. Theme 'Case-Based Learning Experience and Structure' recognized usefulness of CBS that significantly enhanced application of theoretical knowledge with 'impact on their critical thinking and clinical reasoning skills'. The availability of valuable diverse resources was endorsed in; "Resource Exploration". Faculty observed that CBS helped in better integration of clinical and basic sciences with greater engagement of students.

Conclusion: The sessions on clinical cases bridged the gap from theory to practice by integrating basic science knowledge with application in clinical practice. CBS enhanced clinical reasoning and critical thinking abilities and improved engagement of students in Endocrine & Reproductive Science course for MPhil students in BBS

Keywords: Case-Based Sessions (CBS), Clinical Reasoning, Medical Education, Mixed-Methods Study

Introduction

The traditional teaching methods, such as didactic lectures, though they offer foundational knowledge, often fall short in actively engaging students and equipping them with the problem-solving skills and critical thinking abilities required to navigate real-world complexities.[1] Case-based learning (CBL) requires active learning and teaching strategies based on concrete case-based sessions (CBS) that require advanced preparation by the learners.[2] These approaches engage students with hypothetical or real-world scenarios, encourage active participation, enable critical thinking and problem-solving skills, to promote deeper understanding and retention of concepts.[3] These sessions address present multifaceted scenario cases, including comprehensive medical histories, physical assessments, and encourage students to approach and solve these cases.

The current generation of students needs support for preparation for examinations, which can be facilitated by assignments given in the classroom. Classroom assessments can take various forms, such as individual analyses, group discussions, or detailed written reports,[6,7] and can be given to students in the form of case-based assignments (CBA).

This study was guided by Kolb's Experiential Learning Theory. Case-based sessions were conceptualized as concrete learning experiences, while the flipped classroom design supported reflective observation, abstract conceptualization, and active experimentation through pre-class preparation, discussion, and in class application of knowledge. Despite numerous studies on CBL in various disciplines, there is still limited evidence of the efficiency of teaching and learning by CBS in basic health sciences, especially for graduate students.[8] This gap in the literature highlights a need for empirical investigation into the role and effectiveness of CBL and CBS within graduate-level basic health sciences programs, particularly in disciplines traditionally taught through lecture-based approaches. Understanding how CBL supports conceptual integration and applied learning at this level is essential for informing curriculum design and pedagogical innovation. Accordingly, the present study aims to evaluate the implementation and educational impact of CBS in a graduate-level basic health sciences course. By examining perceptions of students' and faculty and analyzing their learning experiences, this study seeks to address the identified gap and contribute evidence to support theory-informed, clinically integrated teaching strategies in graduate health sciences education at a private medical university.

Methodology

It was a pilot study which involved a mixed-method exploratory approach conducted at the -Aga Khan University, Karachi from August 2024 to Jnauary 2025 after approval from the Aga Khan University Ethics Review Committee (ERC: 2024-9866-28623) The study engaged MPhil BBS students (n=5) enrolled in the elective course of Endocrine and Reproductive Sciences, along with three faculty members who facilitated the CBS. A purposive sampling technique was employed, and written informed consent was acquired from all participants for the quantitative and qualitative arms of the study.

The CBS (n=6) focused on real-world scenarios and aligned with the course's learning objectives; the scenarios were developed in collaboration with clinical experts (Table 1). The Flipped Classroom Model (FCR) was implemented; reference books, scholarly articles, and videos were uploaded to the University's Virtual Learning Environment (VLE) one week prior to the scheduled CBS as pre-reading material. An interactive discussion on cases was carried out with the students during the in-class sessions. As a post-class activity, students from both batches were assigned case-based study questions (Case-Based Assignments on topics mentioned in Table1) to reinforce learning through application (Figure1).

Quantitative data were collected from students by a structured questionnaire. Responses were recorded on a 5-point Likert scale (1=fair, 2=satisfactory, 3=good, 4= excellent, 5=outstanding). The survey was administered at the end of the course. Reflections were acquired from the faculty involved in the facilitation of both batches.

A semi-structured interview guide for the focus group discussions (FGDs) was developed and refined following expert review and approval. Two FGDs were conducted: one with students and one with facilitators. Both discussions were moderated by a faculty member who was not involved in the study to reduce potential bias. Each FGD lasted approximately 45–60 minutes and was held in a private, comfortable setting to promote open and meaningful discussion. The recordings were then transcribed verbatim, after which a thematic analysis, which included the coding, categorisation, and interpretation of the data, was done to extract the salient themes and patterns in the data. To guarantee the credibility and trust value of the findings, several validation options were used. First, member checking was involved, in which the identified themes and interpretations were put forward to the respondents of the focus-group discussion and validated, which in turn, alongside respondent-validation, allowed the respondents to affirm or streamline the interpretations of the researchers.

Those reflections that were received (two separate sets) were approached to ask the faculty members who facilitated the batches both questions via email, and the responses were open-ended. Triangulation of the data collected during the focus-group discussions with survey responses and faculty reflection was car-

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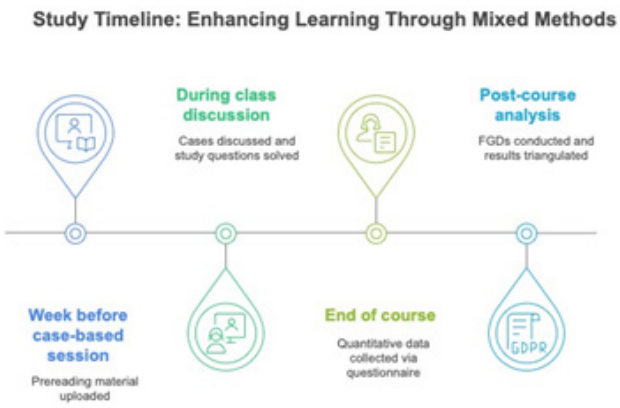

Figure 1: Scheme of Case Based Sessions in Endocrine Reproductive Sciences Module

ried out.

Results

The information about the survey was obtained through five 23 28 year-old female students. They highlighted the efficiency of the whole FCR components. The pre-reading material was perceived as very helpful, especially in understanding case scenarios and in assimilating knowledge, and delivered an average rating of 4.8 (Table 2). The degrees of timeliness and adequacy showed slightly lower scores (meaning 4.6) but were still positive (Table 3). Response to six main statements about the in-session experience was gained. Table 3 shows the perceived activities that are highly effective. The learners scored the collective and interactive quality of the sessions at 4.8 and praised the support and guidance of the tutor. The rating of conceptual learning and feedback was 4.6. CBA enhanced the capacity by students to answer short-answer questions, and all respondents rated the activity as excellent.

An overview of the thematic examination of the focus group discussion and faculty reflections is summed up in Table 4. The open-ended survey responses revealed the appropriateness of clinical cases, and one of the students stated, "They were directly related to our learning outcomes." A second respondent put forward, "They provided a useful use of theoretical knowledge." The third student mentioned the issue of learning how to solve a problem and how to think critically and pointed out that "Each case presented its own complications that I needed to analyze, find pertinent variables, and come up with an appropriate solution or treatment."

Discussion

The key findings of this study demonstrate that the integration of CBS within a flipped classroom model significantly enhanced student engagement, clinical reasoning, and critical thinking in the learning of physiology. Students reported improved understanding of physiological concepts, greater ability to apply theoretical knowledge to clinical scenarios, and increased motivation and enjoyment of the learning process. By working through authentic clinical cases, students analysed medical histories, physical examination findings, diagnostic considerations, and laboratory investigations, thereby strengthening their grasp of pathophysiological mechanisms and clinical reasoning skills and able to reflect on the cases in the form of assignments (Table1) which is documented in the literature.[4]

The flipped classroom design adopted in this study shifted the learning paradigm from passive information transfer to active, problem-oriented engagement during in-class sessions (Figure 1).[10] This pedagogical model, previously well received in undergraduate medical education at Aga Khan University,[11] was successfully adapted for graduate students in the present study. Consistent with modern educational theory, the instructor's role evolved from a "sage on the stage" to a "guide on the side," [12] enabling learners to take ownership of their learning and actively construct knowledge. Providing pre-class access to learning materials facilitated comprehensive preparation and encouraged exploration of multiple educational resources, including videos, key slides, and reference articles. This preparatory phase enriched students' conceptual understanding and optimized in-class discussions (Table 2).

Table 1. CASE-BASED ASSIGNMENTS FOR THE CASE-BASED SESSIONS

TOPIC	STUDY QUESTIONS
ADRENOCORTICAL HORMONES	1: Discuss cortisol regulation in the body?
	2: Enlist the important effects of cortisol?
	3: Make a flowchart to illustrate steps of aldosterone secretion?
	4: Discuss the regulation (stimulus/response) of Na+ & K+ ions through aldosterone secretion?
	5: Effect of Renin Angiotensin Aldosterone System on ECF & arterial pressure?
	6: Enlist 2 important functions of ANP?
	7: What is the role of 21ß-hydroxylase?
	8: Enlist 5 important physiological functions of catecholamine?
PARATHYROID HORMONES	1: Which hormones are responsible for calcium homeostasis?
	2: What are the effects of Vitamin D?
	3: What is the role of PTH?
	4: Discuss regulation of PTH secretion?
	5: Outline the hormonal interplay of calcium homeostasis.
DIABETES INSIPIDUS	1: Which hormone is responsible for conserving water?
	2: What is the site of action of ADH?
	3: What is the mechanism of action of ADH?
	4: What is the synthesis of ADH?
	5: How is the hormone transported? And where is it stored?
	6: What causes the release of ADH?
	7: What are osmoreceptors?
	8: How is this hormone regulated?
	9: What are the possible causes of polydipsia and polyuria?
REPRODUCTIVE SYSTEM	1: What are the functions of Inhibin?
	2: Enlist 3 important function of oxytocin.
	3: Enlist the factors which help in parturition.
	4: Describe the reflex responsible for lactation.
THYROID HORMONE	1: Write 5 brief functions of thyroid gland?
	2: How does hypothalamus pituitary thyroid axis work?
	3: What is the mechanism of action of thyroid hormone?
	4: Enlist the normal effects of thyroid hormone on metabolic body functions?
	5: Define hypothyroidism & list its two major causes?

The approach also promoted collaborative learning, peer interaction, and meaningful engagement with real-world clinical problems. Students reported higher motivation and enjoyment, as the flexibility of self-paced learning reduced stress related to time constraints and deadlines.[13] It provided them with the privilege to search a wide range of sources like videos, key slides, and reference articles, which provided a broad and enriched understanding of the topics. The introduction of various supporting measures further enhanced the academic performance, clinical reasoning, shared teamwork, and information retention in the in-class activities (Table 3).

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TOPIC	STUDY QUESTIONS
PREGNANCY	1: What is double Bohr effect?
	2: What is fetal programming?
	3: What is the role of the placenta in 'Fetal Programming'?
	4: Enlist 2 factors which contribute to fetal programming.
	5: What is the function of Human Chorionic Gonadotropin?
	6: Enlist three functions of Human Chorionic Somatomammotropin.
	7: Write down 2 similarities of hCS and GH.
	8: What is fetoplacental maternal unit?
	9: What is the physiological basis for pseudo anemia in pregnancy?

Table 2. Usefulness of Pre-reading Material

Statement	Average Rating
Promoted vigorous learning and engagement	4.8
Promoted interaction with the facilitator	4.8
Allows chances of conceptual learning.	4.6
Achieved problem-solving skills.	4.6
Tutor provided adequate guidance	4.8
Constructive feedback by tutor	4.6

Scale: 1=fair, 2=satisfactory, 3=good, 4= excellent, 5=outstanding

Table 3. Effectiveness of In-Session Class Activities

Statement	Average Rating
Timely sharing of Pre-reading material	4.6
Pre-reading material was adequate	4.6
The pre-reading reading content was applicable to the case.	4.8
Helped to grasp clinical cases.	4.8
Empowered implementation of knowledge during the session.	4.8
Helped in developing ideas of basic sciences to explain pathophysiology	4.6

Scale: 1=fair, 2=satisfactory, 3=good, 4= excellent, 5=outstanding

Participants also demonstrated marked improvements in critical thinking and clinical reasoning, with greater ability to apply theoretical physiology to clinical contexts (Table 3).These findings are consistent with prior studies showing that exposure to realistic clinical scenarios enables graduate learners to apply knowledge effectively and develop competencies aligned with evidence-based practice.[15] The perceived relevance and interest generated by the cases likely contributed to improved cognitive engagement, diagnostic accuracy, and decision-making skills.[16]

The theme; "Structure and Experience of Case-Based Learning Sessions" (Table 4) discusses that through this innovative approach, graduate students enhanced the interaction among peers as well as the facilitators. The framework provided a platform to students for 'Analytical Skills Development'; interact with concepts, exchange ideas, and deal with real patient cases as supported by literture.[17] This innovation further enabled the students to enhance their comprehension of clinical issues and sharpen their diagnostic and decision-making abilities by 'exploration of new resources'.18Similar to our study, CBSs in physiology also enhanced analytical and problem-solving skills of first-year BDS students and improved their assessment scores as when compared to traditional didactic lectures.[19]

Table 4. Thematic Analysis of Focus Group Discussions & Reflections from the Faculty

Theme	Sub-Theme	Quote
Structure and Experience of Case-Based Learning Sessions	Application of Theoretical Knowledge	"The course allowed the procurement of knowledge in classroom setting to be applied to actual clinical situations which made the content more practical. The smooth flow of information gained through readings into the classroom discussion of cases helped me through CBL."
	Flexible Schedule	"The flexible schedule allowed us to manage our time effectively and do my tasks with ease."
	Relevance of Cases	"The cases were highly relevant to real-life clinical practice, making the learning process both engaging and meaningful."
	Student Engagement	"The interactive nature of the course kept me actively involved."
	Balanced flexibility	"Ample time was available for case-based discussions and assignments in this course that made learning more manageable and enjoyable."
	Continued Use of Case-Based Learning	"I believe this case-based learning approach should definitely continue, as it's been incredibly effective for us."
Impact on Critical Thinking and Clinical Reasoning	Problem-Solving Skills	"This course greatly improved my ability to think critically and solve complex clinical problems."
	Integration of Basic and Clinical Science	"The course helped bridge the gap between basic science and clinical application, making everything more cohesive."
	Analytical Skills Development	"Working through cases that required deeper thinking and reasoning."
Resource Exploration	Diverse resources	"We were able to explore additional sources, e.g., articles, textbooks."
	Supplemental learning	"Pre-reading material & videos helped us in better understanding the challenging cases."
	Incorporation of Research Papers	"I would suggest incorporating research articles as a part of CBL will be very helpful."
Reflection from Facilitator		
● While CBS enhances clinical reasoning and active learning, careful planning, faculty training, and structured facilitation are essential to maximize its effectiveness. ● CBS promotes Active Engagement by fostering interactive discussions, allowing students to analyze real-life clinical cases, apply their knowledge, and collaborate with peers. ● The sessions have Clinical Relevance, which helps in relating basic science concepts to patient cases. CBS enhances students' understanding of endocrine-reproductive physiology and pathophysiology		

A novel aspect of this study was the incorporation of post-session classroom-based assignments (CBAs), designed as guided study questions to reinforce analytical thinking and promote application of physiological principles to clinically relevant problems (Table 1). Such structured assignments have been associated with increased learner confidence, improved knowledge application, and enhanced preparedness for class participation and assessments.[20] Triangulation of quantitative and qualitative findings demonstrated strong convergence on the usefulness of these sessions. High quantitative ratings for engagement (4.8), facilitator interaction (4.8), tutor guidance (4.8), conceptual learning (4.6), and problem-solving skills (4.6) were consistently supported by student narratives and facilitator reflections. Qualitative data revealed that interactive, clinically relevant cases and structured facilitation enhanced engagement, critical thinking, and the integration of basic science with clinical reasoning. Students' reports of improved confidence, analytical skills, and preparedness were further explained by the flexible learning structure and access to diverse

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learning resources. Facilitator insights reinforced these findings, emphasizing the role of CBS and CBAs in promoting active learning and clinically meaningful understanding.

The framework of clinically oriented teaching of physiology through case-based lecturing has already been well received by the students of Physiology in our country.[9] In this study, the integration and tutorials of CBS with innovative teaching strategies and CBAs effectively bridged foundational physiological concepts with diagnostic reasoning, reflective thinking, and the progression toward clinical decision-making in graduate medical education.[21]

Limitations: This study involved a small number of students, which limits the generalizability and transferability of the findings. In addition, the single-institution setting restricts external validity. The results are context-specific to the discipline of Endocrine and Reproductive Physiology and to the institutional environment in which the study was conducted, thereby limiting their applicability to other courses, institutions, or student populations.

Furthermore, the potential for researcher bias cannot be excluded, as the facilitators also served as evaluators. The reliance on self-reported data may have further contributed to an overestimation of the intervention's effectiveness.

Conclusion

The sessions on clinical cases bridged the gap from theory to practice by integrating basic science knowledge with application in clinical practice. Case based sessions enhanced clinical reasoning and critical thinking abilities and improved the engagement of students in Endocrine & Reproductive Science course for MPhil students in BBS. Similarly, writing case based assignments enhanced students' ability to reflect on the clinical cases as well as develop the ability to solve short-answer questions.

AI disclaimer

Generative AI tools were used solely for grammatical correction during the preparation of this manuscript. All content, including study design, data analysis, interpretation, and writing, was developed and finalized by the authors, who take full responsibility for its accuracy and integrity.

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Authors' Contribution Statement

LR contributed to the conception, design, acquisition, interpretation of data, drafting of the manuscript, and final approval of the version to be published. SF contributed to the design, acquisition, analysis, and interpretation of data. RA contributed to the acquisition, analysis, interpretation of data, and drafting of the manuscript. SSF contributed to the acquisition, analysis, interpretation of data, and drafting of the manuscript. RR contributed to the acquisition, analysis, interpretation of data, drafting of the manuscript, and critical review of the manuscript. All authors are accountable for their work and ensure the accuracy and integrity of the study.

Conflict of Interest

Authors declared no conflict on interest

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None

Data Sharing Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.