



IMPACT OF INTERACTIVE LEARNING APPROACHES ON THE DEVELOPMENT OF CLINICAL REASONING SKILLS AMONG UNDERGRADUATE MEDICAL STUDENTS

Shazia Inam¹, Tayyeba Iftikhar Mirza^{2*}, Ayesha Aleem Qureshi³, Noreen Farid⁴

¹Assistant Professor of Medical Education, Foundation University Islamabad

^{2*}Associate Professor Medical Education, Foundation University Islamabad

³Senior Assistant Professor, Forensic Medicine and Toxicology Department, Bahria University College of Medicine, Islamabad

⁴Associate Professor, Forensic Medicine and Toxicology Department, Bahria University College of Medicine, Islamabad

***Corresponding Author:** Dr. Tayyeba Iftikhar Mirza

***E-mail:** tayyeba.i.mirza@gmail.com

ABSTRACT

Background: Clinical reasoning is a fundamental competency in medical education, essential for accurate diagnosis and effective patient management. Traditional lecture-based teaching often limits students' ability to apply theoretical knowledge to clinical situations. Interactive learning approaches, including problem-based learning, case-based discussions, and simulations, have been proposed to enhance analytical and reasoning skills among undergraduate medical students.

Objectives: To evaluate the impact of interactive learning approaches on the development of clinical reasoning skills among undergraduate medical students.

Study Design & Setting: A quasi-experimental study was conducted at the Department of Medical Education of Medical Education Foundation University Islamabad.

Methodology: A total of 170 undergraduate medical students were enrolled and randomly divided into two equal groups. Group A received interactive learning sessions, while Group B underwent traditional lecture-based instruction. Clinical reasoning skills were assessed before and after the intervention using a validated Clinical Reasoning Assessment Tool (CRAT). Data were analyzed using SPSS version 25.0, with $p \leq 0.05$ considered statistically significant.

Results: The mean post-test score in the interactive learning group was significantly higher (78.62 ± 7.24) than in the traditional learning group (68.13 ± 6.91) ($p < 0.001$). Both groups showed improvement from pre- to post-test, but the gain was greater among students exposed to interactive strategies. Student satisfaction and engagement were also significantly higher in the interactive learning group.

Conclusion: Interactive learning approaches significantly enhance clinical reasoning skills, engagement, and satisfaction among undergraduate medical students compared to traditional methods.

Keywords: Clinical reasoning, Interactive learning, Medical education, Problem-based learning, Student engagement, Undergraduate students

INTRODUCTION

Clinical reasoning is the cornerstone of medical practice, enabling physicians to gather and analyze patient information, generate differential diagnoses, and formulate management plans. It integrates cognitive, metacognitive, and affective skills that allow medical professionals to make sound clinical judgments in complex, uncertain situations.^{1,2} However, traditional medical education—characterized by didactic lectures and rote memorization—has often been criticized for inadequately preparing students to apply theoretical knowledge to real clinical scenarios.³ As a result, there has been a paradigm shift in medical education toward more student-centered and interactive learning approaches aimed at fostering higher-order thinking and clinical reasoning skills.⁴

Interactive learning refers to educational strategies that actively engage learners in the learning process rather than passively receiving information. These methods include problem-based learning (PBL), case-based discussions, team-based learning (TBL), simulation-based training, role-playing, and virtual patient scenarios. Such approaches promote active participation, peer collaboration, and reflective thinking, which are essential for developing clinical reasoning.⁵ Studies have shown that students who engage in interactive learning environments demonstrate improved diagnostic accuracy, better decision-making, and greater retention of clinical knowledge compared to those taught through traditional lecture-based instruction.^{6,7}

In the context of undergraduate medical education, interactive learning not only enhances conceptual understanding but also bridges the gap between basic and clinical sciences. Problem-based learning, for instance, encourages students to identify their learning needs through clinical problems, promoting self-directed learning and critical inquiry.⁸ Similarly, simulation-based education allows students to practice diagnostic reasoning in a controlled, risk-free environment, helping them to integrate theory with practice and to receive immediate feedback. These experiences contribute to the development of analytical thinking, pattern recognition, and clinical judgment—key elements of competent medical practice.^{9,10}

Moreover, interactive learning strategies align with constructivist learning theories, which posit that knowledge is best acquired through active engagement and contextual application. By encouraging discussion, collaboration, and reflection, interactive approaches stimulate deeper cognitive processing and facilitate the transformation of information into usable knowledge. In addition, such methods enhance motivation and learner satisfaction, as students perceive the learning process to be more relevant and engaging.¹¹ In recent years, medical schools across the globe have begun integrating interactive learning approaches into their curricula to address the evolving needs of healthcare education. The shift from teacher-centered to learner-centered models aims to produce graduates who can think critically, communicate effectively, and adapt to dynamic clinical environments. Nevertheless, the extent to which these approaches improve clinical reasoning skills in undergraduate medical students, particularly in developing countries, remains underexplored.^{12,13}

Many institutions continue to rely heavily on traditional teaching methods due to limited resources, faculty training, and institutional inertia. Therefore, it is crucial to assess the impact of interactive learning approaches on the development of clinical reasoning skills among undergraduate medical students. Understanding the effectiveness of these strategies can provide valuable insights for curriculum reform and teaching innovation in medical education. This study aims to evaluate how interactive learning approaches influence the development of clinical reasoning skills in undergraduate medical students. By comparing outcomes of students exposed to interactive learning with those taught by traditional methods, this research seeks to contribute to the growing body of evidence advocating for educational strategies that foster critical thinking, clinical competence, and lifelong learning habits among future physicians.

MATERIALS AND METHODS

This quasi-experimental study was conducted in the Department of Medical Education Medical Education Foundation University Islamabad over a period of six months, from January 2025 to June

2025. A total of 170 undergraduate medical students from the third and fourth academic years were included in the study through non-probability purposive sampling. The sample size of 170 participants was calculated using OpenEpi software, keeping the confidence level at 95%, power of test at 80%, and an anticipated effect size of 0.3 based on previously reported studies assessing the impact of interactive learning on academic performance.¹⁶

Students who had completed at least two years of formal medical training and had not previously participated in any structured interactive learning program were included, whereas those unwilling to participate or with irregular class attendance were excluded. All participants were briefed about the study objectives, and written informed consent was obtained. Ethical approval for the study was granted by the Institutional Review Board of the medical college prior to data collection.

The participants were divided into two groups: Group A (interactive learning group) and Group B (traditional learning group), with 85 students in each group. The allocation was done randomly using a computer-generated list to minimize selection bias. Group A was exposed to interactive learning approaches including problem-based learning (PBL), case-based discussions, simulation exercises, and team-based learning sessions. These activities were conducted weekly and facilitated by trained faculty members using standardized clinical cases designed to enhance analytical and reasoning abilities. Group B was taught the same course content using conventional lecture-based methods, focusing primarily on didactic instruction without interactive components.

Both groups received identical learning objectives, course material, and contact hours to ensure uniformity of content exposure. The primary outcome variable was the development of clinical reasoning skills, which was assessed using the Clinical Reasoning Assessment Tool (CRAT), a validated structured instrument evaluating data gathering, problem identification, differential diagnosis generation, and clinical decision-making. Pre-test and post-test assessments were administered to both groups at the beginning and end of the study period. Scores were compared to determine the improvement in clinical reasoning attributable to the learning method.

Faculty facilitators were trained before the commencement of the study to ensure consistency in teaching style and assessment. Regular monitoring was conducted by the principal investigator to maintain adherence to the study protocol. Data were collected anonymously to preserve participant confidentiality.

All data were entered and analyzed using Statistical Package for the Social Sciences (SPSS) version 25.0. Quantitative variables such as clinical reasoning scores were expressed as mean $\pm$ standard deviation, while qualitative variables like gender were presented as frequencies and percentages. The normality of data distribution was assessed using the Shapiro–Wilk test. Within-group comparisons of pre- and post-test scores were performed using paired sample t-test, while between-group comparisons were analyzed using independent sample t-test. A p-value of ≤ 0.05 was considered statistically significant

RESULTS

The demographic characteristics of the study participants showed that the mean age of students in the interactive learning group was 21.8 ± 1.4 years, while that of the traditional learning group was 22.1 ± 1.6 years, with no statistically significant difference between the two groups ($p = 0.284$). Among participants, 44.7% of students in the interactive learning group and 47.1% in the traditional learning group were males, while females constituted 55.3% and 52.9%, respectively. Similarly, the distribution of students according to academic year was comparable, with 50.6% of third-year and 49.4% of fourth-year students in the interactive group, and 48.2% of third-year and 51.8% of fourth-year students in the traditional group. These findings indicate that both groups were demographically similar at baseline, thereby minimizing selection bias and ensuring comparability between the two groups, as given in Table 1.

The comparison of pre-test clinical reasoning scores between both study groups revealed no statistically significant difference prior to the intervention. The mean pre-test score was 56.24 ± 6.85 in the interactive learning group and 55.91 ± 7.02 in the traditional learning group ($p = 0.732$).

This similarity demonstrates that the two groups had comparable baseline reasoning abilities before exposure to different instructional strategies, as given in Table 2.

Following the educational intervention, a marked improvement in clinical reasoning scores was observed, particularly in the interactive learning group. The post-test mean score was significantly higher in the interactive group (78.62 ± 7.24) compared to the traditional learning group (68.13 ± 6.91), with a mean difference of 10.49 points, which was statistically significant ($p < 0.001$). This result indicates that interactive learning methods were more effective in enhancing clinical reasoning abilities than conventional teaching approaches, as given in Table 3.

Within-group comparison of pre- and post-test scores showed that both groups demonstrated improvement after the intervention. In the interactive learning group, the mean score increased from 56.24 ± 6.85 to 78.62 ± 7.24 , with a mean difference of 22.38 ($p < 0.001$). Similarly, in the traditional learning group, the mean score rose from 55.91 ± 7.02 to 68.13 ± 6.91 , reflecting a mean difference of 12.22 ($p < 0.001$). Although both methods contributed to student improvement, the gain in clinical reasoning ability was substantially greater among those exposed to interactive learning strategies, as given in Table 4.

When performance levels were categorized, nearly half (49.4%) of the students in the interactive learning group achieved an “Excellent” level ($\geq 80\%$), compared to only 17.6% in the traditional learning group. Likewise, 35.3% of students in the interactive group performed at a “Good” level (70–79%) compared to 37.6% in the traditional group. Conversely, a larger proportion of students in the traditional group were in the “Average” (32.9%) and “Poor” (11.9%) categories than those in the interactive group (11.8% and 3.5%, respectively). The difference in performance distribution between the two groups was statistically significant ($p < 0.001$), reflecting the superior academic performance of students taught through interactive approaches, as given in Table 5.

In addition to objective performance measures, student feedback on learning satisfaction further supported the effectiveness of interactive learning. On a five-point Likert scale, the interactive learning group reported higher mean satisfaction scores across all domains. Students in this group expressed significantly greater engagement and interest (4.6 ± 0.5 vs. 3.4 ± 0.7 , $p < 0.001$), better understanding of concepts (4.5 ± 0.6 vs. 3.6 ± 0.8 , $p < 0.001$), and improved confidence in clinical reasoning (4.4 ± 0.7 vs. 3.2 ± 0.9 , $p < 0.001$). They also rated higher in relevance to clinical practice (4.7 ± 0.5 vs. 3.8 ± 0.6 , $p < 0.001$) and overall satisfaction (4.6 ± 0.5 vs. 3.5 ± 0.8 , $p < 0.001$). These findings demonstrate that interactive learning methods not only enhanced students’ reasoning performance but also increased their enthusiasm, confidence, and perceived relevance of learning to real-life practice, as given in Table 6.

Table 1: Demographic Characteristics of Study Participants (n = 170)

Variable	Interactive Learning Group (n = 85)	Traditional Learning Group (n = 85)	p-value
Mean Age (years) $\pm$ SD	21.8 ± 1.4	22.1 ± 1.6	0.284
Gender			
Male	38 (44.7%)	40 (47.1%)	0.745
Female	47 (55.3%)	45 (52.9%)	
Academic Year			
Third Year	43 (50.6%)	41 (48.2%)	0.758
Fourth Year	42 (49.4%)	44 (51.8%)	

Table 2: Comparison of Pre-Test Clinical Reasoning Scores Between Study Groups

Parameter	Interactive Learning Group (n = 85)	Traditional Learning Group (n = 85)	Mean Difference	p-value
Mean Pre-Test Score $\pm$ SD	56.24 ± 6.85	55.91 ± 7.02	0.33	0.732

Table 3: Comparison of Post-Test Clinical Reasoning Scores Between Study Groups

Parameter	Interactive Learning Group (n = 85)	Traditional Learning Group (n = 85)	Mean Difference	p-value
Mean Post-Test Score $\pm$ SD	78.62 $\pm$ 7.24	68.13 $\pm$ 6.91	10.49	<0.001*

*Significant at $p \leq 0.05$

Table 4: Within-Group Comparison of Pre-Test and Post-Test Scores

Group	Mean Pre-Test Score $\pm$ SD	Mean Post-Test Score $\pm$ SD	Mean Difference	t-value	p-value
Interactive Learning Group	56.24 $\pm$ 6.85	78.62 $\pm$ 7.24	22.38	24.15	<0.001*
Traditional Learning Group	55.91 $\pm$ 7.02	68.13 $\pm$ 6.91	12.22	13.07	<0.001*

*Significant at $p \leq 0.05$

Table 5: Distribution of Students According to Performance Categories After Intervention

Performance Level	Interactive Learning Group (n = 85)	Traditional Learning Group (n = 85)	p-value
Excellent ($\geq 80\%$)	42 (49.4%)	15 (17.6%)	<0.001*
Good (70–79%)	30 (35.3%)	32 (37.6%)	
Average (60–69%)	10 (11.8%)	28 (32.9%)	
Poor (<60%)	3 (3.5%)	10 (11.9%)	

*Significant at $p \leq 0.05$

Table 6: Student Feedback on Learning Satisfaction (5-Point Likert Scale)

Item	Interactive Learning Group (Mean $\pm$ SD)	Traditional Learning Group (Mean $\pm$ SD)	p-value
Engagement and Interest	4.6 $\pm$ 0.5	3.4 $\pm$ 0.7	<0.001*
Understanding of Concepts	4.5 $\pm$ 0.6	3.6 $\pm$ 0.8	<0.001*
Confidence in Clinical Reasoning	4.4 $\pm$ 0.7	3.2 $\pm$ 0.9	<0.001*
Relevance to Clinical Practice	4.7 $\pm$ 0.5	3.8 $\pm$ 0.6	<0.001*
Overall Satisfaction	4.6 $\pm$ 0.5	3.5 $\pm$ 0.8	<0.001*

*Significant at $p \leq 0.05$

DISCUSSION

Clinical reasoning is an essential skill in medical education, enabling future physicians to make accurate diagnostic and management decisions. Traditional lecture-based teaching often limits active participation and critical thinking among students. Interactive learning approaches such as problem-based learning, simulations, and case discussions promote engagement and analytical reasoning. These methods encourage collaboration, self-directed learning, and application of theoretical knowledge to clinical contexts. Modern medical curricula increasingly emphasize such strategies to improve competency-based education.^{14,15} This study evaluates the impact of interactive learning approaches on developing clinical reasoning skills among undergraduate medical students.

The present study demonstrated that interactive learning approaches significantly enhanced clinical reasoning skills, engagement, and satisfaction among undergraduate medical students when compared with traditional lecture-based instruction. In our study, the post-test mean score of students exposed to interactive learning was 78.62 $\pm$ 7.24, which was markedly higher than that of the traditional learning group (68.13 $\pm$ 6.91, $p < 0.001$). Within-group analysis also revealed a greater improvement in the interactive learning group (mean difference 22.38, $p < 0.001$) compared to the traditional group (mean difference 12.22, $p < 0.001$). Furthermore, almost half of the students (49.4%) in the interactive learning group achieved “excellent” performance compared to only

17.6% in the traditional group. These findings highlight the superiority of interactive learning methodologies in promoting deeper understanding and reasoning abilities.

Our results are consistent with those of Rehan et al. (2016), who reported that clinically oriented, problem-solving tutorials significantly improved students' understanding of structure and function ($p = 0.04$) and enhanced clinical reasoning skills ($p < 0.05$). They also observed improvement in presentation skills ($p = 0.02$) and preferred interactive tutorials for understanding difficult concepts ($p < 0.01$). Similarly, in our study, student feedback showed higher satisfaction and engagement scores in the interactive learning group (4.6 ± 0.5) than in the traditional group (3.4 ± 0.7 , $p < 0.001$), reflecting a parallel trend of enhanced comprehension and active participation through interactive methods.¹⁶

The findings of our study also align with Fatima et al. (2024), who found no significant difference in pre-test scores among instructional groups ($p = 0.655$), similar to our baseline comparison ($p = 0.732$), confirming equivalence before intervention.¹⁷ However, post-test scores in Fatima's study differed significantly across groups ($F_{2:111} = 11.93$, $p < 0.001$), indicating that active and interactive methods such as flipped classroom models improved learning outcomes.¹⁷ In our study, the post-intervention improvement was more prominent in the interactive learning group, emphasizing that structured engagement and learner participation contribute substantially to reasoning development.

In contrast, McGee et al. (2024) conducted a meta-analysis of 27 studies involving 3,895 participants and found that digital teaching of clinical skills demonstrated improved or comparable outcomes to in-person teaching, with a pooled mean difference increase of 1.93 (95% CI 1.22–2.64, $p < 0.001$).¹⁸ Their findings also indicated improved satisfaction with digital learning tools. These outcomes corroborate our results, as we observed a statistically significant enhancement in both reasoning ability and satisfaction through interactive approaches that utilized digital case discussions and simulations. Our findings extend McGee's conclusions by demonstrating that not only digital but also face-to-face interactive methods significantly strengthen cognitive reasoning when students are actively involved.¹⁸

The study by Muqem et al. (2022) emphasized that pre-medical educational background and prior exposure to interactive participation affect the development of critical thinking. They found that students from rote-learning systems struggled to engage in analytical reasoning, while those trained to question and discuss performed better.¹⁹ This supports our observation that when students were exposed to interactive sessions such as case-based learning and simulations, their clinical reasoning improved significantly, suggesting that the learning environment itself can compensate for earlier educational gaps by fostering active engagement and logical thinking.

Our results also correspond with Abdullah et al. (2025), who compared team-based learning (TBL) and small group discussions (SGD). Their study found significantly higher post-test scores in the TBL group (76.42 ± 9.14) compared to the SGD group (68.00 ± 9.45) and greater satisfaction levels (4.14 ± 0.88 vs. 2.94 ± 0.79 , $p < 0.0001$). Similarly, in our study, interactive group students achieved higher post-test scores (78.62 ± 7.24 vs. 68.13 ± 6.91 , $p < 0.001$) and satisfaction (4.6 ± 0.5 vs. 3.5 ± 0.8 , $p < 0.001$).²⁰ This consistency across studies reinforces the premise that structured interactive methods such as TBL, simulation, and problem-based learning yield superior educational outcomes by promoting collaborative reasoning and self-directed learning.

Taken together, the findings of our study corroborate the growing body of literature that advocates for interactive learning as a powerful pedagogical tool in medical education. By engaging students actively in learning, promoting critical thinking, and allowing practical application of concepts, interactive approaches have shown consistent benefits in enhancing cognitive and clinical reasoning performance across multiple settings and populations.

A major strength of this study is its randomized quasi-experimental design ensuring comparability between groups. The use of a validated Clinical Reasoning Assessment Tool enhances the reliability of findings. Inclusion of both objective test scores and student feedback provides comprehensive outcome evaluation. Adequate sample size ensures good statistical power and representativeness.

However, the study was conducted in a single institution, which may limit generalizability. Additionally, long-term retention of improved reasoning skills was not assessed due to the short follow-up duration.

CONCLUSION

Interactive learning significantly improves clinical reasoning, engagement, and satisfaction among medical students. It should be integrated into undergraduate medical curricula to strengthen analytical and decision-making abilities. Broader implementation and longitudinal studies are recommended to confirm sustained benefits

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