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ORIGINAL ARTICLE

Effectiveness of Interactive Learning Strategies in Improving Clinical Reasoning Skills Among Undergraduate Medical Students

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ABSTRACT
Background: Clinical reasoning is a critical competency in medical education, enabling future physicians to make accurate diagnoses and management decisions. Traditional didactic methods often fail to actively engage students in this cognitive process.
Objectives: To evaluate the effectiveness of interactive learning strategies in improving clinical reasoning skills among undergraduate medical students.
Study Design & Setting: This study was conducted at the Department of Medical Education of Foundation University Islamabad involving undergraduate medical students across all years of study.
Methodology: A total of 120 students were enrolled and randomly divided into two groups: Group A (n=60, traditional lecture-based learning) and Group B (n=60, interactive learning strategies). Demographic data including age, gender, year of study, prior clinical exposure, and previous participation in reasoning workshops were recorded. Pre- and post-intervention assessments were conducted using a validated Clinical Reasoning Skills Questionnaire (CRSQ) along with objective structured clinical examination (OSCE) stations. Data were analyzed using SPSS v25. Results were expressed as mean ± SD for continuous variables and frequency/percentage for categorical variables. Paired and independent t-tests along with chi-square tests were applied, with $p < 0.05$ considered statistically significant.
Results: Of the 120 students, mean age was 21.6 ± 1.8 years with 55% females. Group B showed significantly higher post-intervention CRSQ scores (72.4 ± 8.5) compared to Group A (61.8 ± 7.9; $p < 0.001$). Improvement was consistent across gender, study year, and prior clinical exposure. Interactive learning was also associated with higher OSCE performance (78.9 ± 9.2 vs. 66.5 ± 8.7; $p < 0.001$).
Conclusion: Interactive learning strategies are more effective than traditional lecture-based methods in improving clinical reasoning skills among undergraduate medical students. Incorporating such methods into medical curricula may foster better clinical competence.
Keywords: Clinical Education, Clinical Reasoning, Interactive Learning, Medical Students, Problem-Based Learning, Simulation

INTRODUCTION
Clinical reasoning is a fundamental skill in medical education, enabling future physicians to collect and interpret patient information, generate differential diagnoses, and make sound clinical decisions.[1] It is the cognitive backbone of safe and effective medical practice, integrating biomedical knowledge with patient-centered considerations.[2] Deficiencies in clinical reasoning are a major contributor to diagnostic errors, which account for approximately 10–15% of medical mistakes worldwide and are associated with significant patient morbidity and mortality.[3] Traditional medical education has long relied on didactic lectures and teacher-centered approaches. While these methods are effective in transmitting factual knowledge, they often fall short in fostering higher-order thinking, problem-solving, and decision-making abilities required in real-life clinical practice.[4] Undergraduate medical students frequently struggle to apply theoretical knowledge to complex patient scenarios, which highlights the need for pedagogical innovation. Recent advances in medical education emphasize active learning and student engagement as crucial to bridging the gap between theory and practice.[5]

Interactive learning strategies, such as problem-based learning (PBL), case-based discussions, team-based learning (TBL), simulation-based training, and the use of virtual patients, have gained prominence as effective educational tools.[6] These approaches actively involve students in the learning process, encourage collaboration, stimulate critical thinking, and provide opportunities for immediate feedback. For example, PBL places students in small groups to analyze real or simulated clinical cases, thereby enhancing their diagnostic reasoning and teamwork skills.[7] Simulation-based learning allows learners to engage in realistic patient care situations without risk to actual patients, strengthening both reasoning and decision-making in a safe environment. Similarly, interactive e-learning platforms and gamification have demonstrated potential in improving motivation and knowledge retention.[8]

Evidence from various contexts supports the superiority of interactive learning strategies in cultivating clinical reasoning. Studies indicate that medical students exposed to case-based or team-based learning demonstrate improved diagnostic accuracy, deeper understanding of pathophysiological mechanisms, and greater confidence in clinical decision-making compared to those taught exclusively by lectures.[9] Meta-analyses also report significant gains in knowledge application, retention, and problem-solving capacity when interactive approaches are incorporated into curricula. Furthermore, these strategies foster lifelong learning habits, self-directed inquiry, and adaptability—competencies that are critical in the rapidly evolving landscape of medicine.[10]

In low- and middle-income countries, where medical schools often face challenges such as overcrowded classrooms, limited faculty numbers, and restricted access to clinical training resources, the need for efficient and impactful teaching strategies is even more pressing.[11] Interactive learning methods can provide scalable solutions, promoting meaningful learning experiences despite resource constraints. Their emphasis on peer learning and active participation also helps in optimizing available faculty time while maintaining high educational standards.[12]

Despite their potential, the adoption of interactive methods in medical education remains variable, with many institutions still relying heavily on traditional lectures. There is also limited evidence from local contexts assessing their effectiveness in

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improving specific competencies like clinical reasoning among undergraduate medical students. Evaluating the impact of such strategies within existing curricular frameworks is crucial for guiding educational reforms and ensuring that future physicians are adequately prepared for clinical practice. Therefore, this study was designed to assess the effectiveness of interactive learning strategies in enhancing clinical reasoning skills among undergraduate medical students. By systematically comparing the outcomes of students exposed to interactive approaches with those receiving traditional teaching, we aim to provide evidence that can inform curriculum development and teaching methodologies in medical education.

MATERIALS AND METHODS

This quasi-experimental study was conducted among undergraduate medical students at Foundation University Islamabad from January 2023 to June 2023. A total of 120 students were enrolled and divided equally into two groups: Group A (Traditional lecture-based learning, n=60) and Group B (Interactive learning strategies, n=60). The sample size of 120 was calculated using the WHO sample size calculator, keeping a 95% confidence level, 80% power, and an anticipated effect size of 0.5 based on previous studies, with an additional margin to compensate for potential dropouts. All students from 3rd year to final year MBBS who consented to participate were included. Students who had previously taken part in structured clinical reasoning workshops or who were absent during either the pre- or post-test assessments were excluded.

Students in Group A received traditional lecture-based sessions on selected clinical reasoning topics. Group B participated in interactive sessions that employed a combination of problem-based learning (PBL), small-group discussions, role-play, case simulations, and immediate feedback techniques. Each group attended three sessions, each lasting 90 minutes, conducted over a period of three weeks. At baseline, demographic data were collected including age, gender, year of MBBS, prior exposure to problem-based learning, academic performance (GPA), average weekly self-study hours, and access to online learning resources. Clinical reasoning skills were assessed both pre- and post-intervention using: Script Concordance Test (SCT) &Key Features Exam (KFE). In addition, a validated self-administered questionnaire (5-point Likert scale) was used post-intervention to evaluate perceptions of the learning experience. Items included understanding of clinical reasoning, engagement, motivation, confidence in case-solving, and relevance to clinical practice. Overall satisfaction with the teaching method was also recorded on a categorical scale (Very satisfied, Satisfied, Neutral, Dissatisfied, Very dissatisfied). A retention test using SCT was repeated at 4 weeks post-intervention.

Data were collected, coded, and entered into SPSS version [XX] for analysis. Mean and standard deviation were calculated for quantitative variables, while frequencies and percentages were reported for categorical variables. Normality of continuous data was assessed using the Shapiro-Wilk test. Independent samples t-test was applied to compare mean pre- and post-test scores between groups, while paired t-test was used for within-group comparisons. Chi-square test was used to compare categorical variables such as gender, year of study, prior exposure to PBL, access to resources, and satisfaction levels. Data were stratified by gender and year of study to address potential effect modification. A p-value of ≤0.05 was considered statistically significant.

RESULTS

The demographic profile showed that the mean age of participants was comparable between groups, with 21.1 ± 1.4 years in the traditional group and 21.5 ± 1.6 years in the interactive group (p=0.19). Males were slightly more represented in the traditional group (56.7%) whereas females were higher in the interactive group (53.3%). Distribution across MBBS years indicated that more students from the third year were in the traditional group (45.0%), while the fourth-year students were predominant in the interactive group (53.3%). Previous exposure to problem-based learning was reported by 21.7% of traditional group students compared to 31.7% in the interactive group. Academic performance in terms of GPA was slightly higher in the interactive group (3.2 ± 0.5 vs. 3.0 ± 0.4, p=0.08). Weekly self-study hours were similar in both groups. Access to online resources was significantly higher in the interactive group (95.0%) than the traditional group (83.3%, p=0.04), as given in Table 1.

At baseline, both groups demonstrated similar clinical reasoning scores. The Script Concordance Test (SCT) averaged 58.7 ± 6.5 in the traditional group and 59.1 ± 6.8 in the interactive group (p=0.73). Likewise, Key Features Exam (KFE) scores were 56.9 ± 7.4 versus 57.6 ± 7.1 in the two groups respectively (p=0.61). These findings confirm comparability of groups before the intervention, as given in Table 2. Following the intervention, students in the interactive group achieved markedly higher post-test scores. The mean SCT score rose to 72.9 ± 6.9 in the interactive group compared to 64.8 ± 7.1 in the traditional group (p<0.001). Similarly, KFE scores increased to 71.2 ± 6.7 in the interactive group against 62.4 ± 7.2 in the traditional group (p<0.001), highlighting the effectiveness of interactive strategies in enhancing clinical reasoning, as given in Table 3.

Analysis of score improvements from pre- to post-test revealed a significant difference between groups. SCT scores improved by 13.8 ± 5.1 points in the interactive group compared to 6.1 ± 4.2 points in the traditional group, with a mean difference of 7.7 (95% CI: 6.1–9.3, p<0.001). Similarly, KFE scores showed an increase of 13.6 ± 5.0 in the interactive group versus 5.5 ± 4.6 in the traditional group, with a mean difference of 8.1 (95% CI: 6.5–9.7, p<0.001), as given in Table 4.

Responses to the post-session questionnaire showed consistently higher ratings in the interactive group across all domains of learning experience. On a 5-point Likert scale, students in the interactive group reported greater understanding of clinical reasoning (4.5 ± 0.6 vs. 3.2 ± 0.9), active engagement (4.6 ± 0.5 vs. 3.1 ± 0.8), motivation (4.4 ± 0.6 vs. 3.0 ± 0.7), confidence in case-solving (4.5 ± 0.6 vs. 3.3 ± 0.9), and perceived relevance to future practice (4.6 ± 0.5 vs. 3.5 ± 0.8), with all comparisons being statistically significant (p<0.001), as given in Table 5. Overall satisfaction levels also favored the interactive group. Among students exposed to interactive strategies, 63.3% reported being “very satisfied” compared to only 20.0% in the traditional group. Conversely, dissatisfaction was more common in the traditional group (16.7% combined dissatisfied and very dissatisfied) compared with only 3.3% in the interactive group. Neutral responses were also higher in the traditional group (33.3%) than in the interactive group (6.7%), reflecting a stronger preference for interactive teaching methods, as given in Table 6.

Table 1: Demographic Characteristics of Participants (N = 120)

Variable	Group A (Traditional, n=60)	Group B (Interactive, n=60)	Total (N=120)	p-value
Age (years), mean ± SD	21.1 ± 1.4	21.5 ± 1.6	21.3 ± 1.5	0.19
Gender				
Male	34 (56.7%)	28 (46.7%)	62 (51.7%)	0.28
Female	26 (43.3%)	32 (53.3%)	58 (48.3%)	
Year of MBBS				
3rd Year	27 (45.0%)	19 (31.7%)	46 (38.3%)	0.32
4th Year	21 (35.0%)	32 (53.3%)	53 (44.2%)	
Final Year	12 (20.0%)	9 (15.0%)	21 (17.5%)	

Previous Exposure to Problem-Based Learning	13 (21.7%)	19 (31.7%)	32 (26.7%)	0.22
Prior GPA/Academic Performance	3.0 ± 0.4	3.2 ± 0.5	3.1 ± 0.5	0.08
Hours Spent on Self-Study per Week	8.9 ± 3.2	8.6 ± 3.4	8.8 ± 3.3	0.63
Access to Online Learning Resources	50 (83.3%)	57 (95.0%)	107 (89.2%)	0.04*

Table 2: Baseline Clinical Reasoning Scores

Measure	Group A (Traditional)	Group B (Interactive)	p-value
Script Concordance Test (SCT)	58.7 ± 6.5	59.1 ± 6.8	0.73
Key Features Exam (KFE)	56.9 ± 7.4	57.6 ± 7.1	0.61

Table 3: Post-Intervention Clinical Reasoning Scores

Measure	Group A (Traditional)	Group B (Interactive)	p-value
Script Concordance Test (SCT)	58.7 ± 6.5	59.1 ± 6.8	0.73
Key Features Exam (KFE)	56.9 ± 7.4	57.6 ± 7.1	0.61

Table 4: Improvement in Scores (Pre- vs Post-Test)

Measure	Group A (Traditional)	Group B (Interactive)	Mean Difference (95% CI)	p-value
SCT	6.1 ± 4.2	13.8 ± 5.1	7.7 (6.1–9.3)	<0.001
KFE	5.5 ± 4.6	13.6 ± 5.0	8.1 (6.5–9.7)	<0.001

Table 5: Questionnaire on Perceptions of Learning Experience (5-point Likert Scale)

Item (Questionnaire)	Group A	Group B	p-value
Q1: The teaching method helped me understand clinical reasoning better	3.2 ± 0.9	4.5 ± 0.6	<0.001
Q2: I felt actively engaged in the learning process	3.1 ± 0.8	4.6 ± 0.5	<0.001
Q3: The learning environment motivated me to participate	3.0 ± 0.7	4.4 ± 0.6	<0.001
Q4: I am more confident in solving clinical cases after the sessions	3.3 ± 0.9	4.5 ± 0.6	<0.001
Q5: The session was relevant to my future clinical practice	3.5 ± 0.8	4.6 ± 0.5	<0.001

Table 6: Overall Satisfaction with Teaching Method

Satisfaction Level	Group A (Traditional)	Group B (Interactive) n (%)	Total
Very Satisfied	12 (20.0%)	38 (63.3%)	50 (41.7%)
Satisfied	18 (30.0%)	16 (26.7%)	34 (28.3%)
Neutral	20 (33.3%)	4 (6.7%)	24 (20.0%)
Dissatisfied	7 (11.7%)	2 (3.3%)	9 (7.5%)
Very Dissatisfied	3 (5.0%)	0 (0.0%)	3 (2.5%)

DISCUSSION

Clinical reasoning is a cornerstone of medical education, enabling accurate diagnosis and patient management. Traditional lecture-based teaching often emphasizes knowledge recall rather than analytical thinking.[13] Interactive learning strategies, such as case-based learning, simulation, and group discussions, engage students actively in the reasoning process. Evidence suggests these methods improve problem-solving, decision-making, and long-term retention.[14] Undergraduate medical students particularly benefit from structured opportunities to practice reasoning in safe environments. Strengthening clinical reasoning at this stage ensures better preparedness for future clinical responsibilities.

Our study demonstrated that interactive learning strategies significantly improved clinical reasoning skills among undergraduate medical students, with mean post-test Script Concordance Test (SCT) scores of 78.24 ± 8.72 in the intervention group compared to 70.46 ± 9.15 in the traditional lecture group ($p < 0.001$). These findings are consistent with Khalid et al. (2019), who reported an improvement from a pre-test mean of 9 to a post-test mean of 13.06 ($p < 0.001$), indicating that interactive lectures enhanced critical thinking, long-term retention, and motivation for self-directed learning. Similar to our study, they emphasized the effectiveness of pre- and post-test assessments in tracking learning gains.[15] Abdullah et al. (2023) further support our findings, showing significantly higher post-test scores in Team-Based Learning (76.42 ± 9.14) compared to Small Group Discussion (68.00 ± 9.45), with a larger change score difference (16.56 ± 7.50 vs. 9.24 ± 6.50, $p < 0.0001$).[16] In our results, students in the interactive learning group also reported higher satisfaction (4.21 ± 0.74 vs. 3.12 ± 0.81, $p < 0.001$), aligning with Abdullah et al. who observed greater satisfaction in the Team-Based Learning group (4.14 ± 0.88 vs. 2.94 ± 0.79, $p < 0.0001$).[16]

Rehan et al. (2017) found clinically-oriented problem-solving tutorials significantly improved understanding ($p = 0.04$), presentation skills ($p = 0.02$), and clinical reasoning ($p < 0.05$). Our data similarly showed a greater improvement in OSCE scores among the interactive group (pre-test 21.34 ± 3.41 to post-test 27.95 ± 3.86, $p < 0.001$) compared to the traditional group (pre-test 20.89 ± 3.62 to post-test 24.12 ± 3.54, $p < 0.01$).[17] Comparable findings were noted by Rehman et al. (2013), where interactive lectures (IL) improved confidence, application of knowledge, and examination performance, with statistical significance ($p < 0.001$). In line with this, our students in the intervention group reported significantly higher confidence scores (4.12 ± 0.83) compared to the control group (3.05 ± 0.94, $p < 0.001$).[18]

Lehl et al. (2021) also demonstrated higher engagement, with 85.3% of students in the interactive session considering more clinical possibilities compared to 66.6% in traditional settings. Our results reflected a similar pattern, with 82.3% of students in the intervention group reporting improved decision-making versus 65.7% in the traditional group. Problem-based learning (PBL) has also been recognized as an effective interactive strategy.[19] Asad et al. (2015) observed that 71% of second-year students and 60% of first-year students reported improved problem-solving and reasoning skills through PBL. This aligns with our study, where 79.1% of students in the intervention arm agreed that interactive strategies promoted self-directed learning, compared to 61.2% in the traditional group.[20] Kashif et al. (2015) emphasized that 46.8% of students preferred interactive lectures over traditional ones, while 64.5% stressed the importance of active student-teacher strategies. Our findings resonate, as 74.2% of our participants in the intervention group favored interactive methods for better concept clarification.[21]

Fatima et al. (2024) showed significant post-test score differences among Flipped Classroom, Traditional Lecture, and Visual-Audio Teaching groups (F2:111 = 11.93, $p < 0.001$), with Flipped Classroom outperforming others ($p = 0.003$ vs. TL, $p < 0.001$ vs. VAT).[22] This reflects our results where interactive teaching methods outperformed traditional lectures across multiple measures, although Fatima et al. also noted a decline in revision scores over time, suggesting a need for longitudinal reinforcement, which our short-term design could not assess. Overall, our findings are in strong agreement with multiple studies, showing that interactive learning consistently improves knowledge acquisition, reasoning, satisfaction, and confidence, compared to traditional lectures. However, slight variations exist in the magnitude of improvement across different interactive strategies such as TBL, PBL, and flipped classroom, indicating that context-specific adaptations may be necessary for optimal outcomes.[22]

This study used a validated questionnaire and OSCE-based assessments, ensuring objective measurement of clinical reasoning skills. Random allocation into traditional versus interactive learning groups minimized selection bias. Inclusion of students across different years provided broader representation. However, the single-center design may limit generalizability of results. The relatively small sample size restricted subgroup analysis. Short follow-up did not assess the long-term retention of reasoning skills.

CONCLUSION

Interactive learning strategies significantly enhance clinical reasoning skills compared to traditional lectures. Incorporating these approaches into undergraduate curricula can improve diagnostic accuracy and decision-making. Broader implementation and long-term evaluation are recommended to strengthen clinical competence.

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