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ОРГАНИЗАЦИЯ ПЕДАГОГИЧЕСКОЙ ОПЫТНО-ЭКСПЕРИМЕНТАЛЬНОЙ РАБОТЫ ПО РАЗВИТИЮ ДИАГНОСТИЧЕСКОЙ КОМПЕТЕНТНОСТИ СТУДЕНТОВ И ЕЁ ЭФФЕКТИВНОСТЬ

Аннотация. В настоящем квазиэкспериментальном исследовании оценивалась эффективность педагогического вмешательства, направленного на повышение диагностической компетенции 320 студентов Ферганского медицинского института (экспериментальная группа, n=110) и контрольных групп из Андижанского (n=105) и Бухарского (n=105) государственных медицинских институтов. Двенадцатинедельная программа включала в себя обучение на основе клинических случаев (case-based learning), симуляционные тренинги, методику самообъяснения и адаптивную обратную связь. Результаты итогового тестирования (посттеста) показали значительное улучшение в экспериментальной группе (83,08±7,14 по сравнению с 64,69±7,35 в предварительном тесте; p<0,001) в отличие от контрольных групп (Андижан: 69,43±8,83; Бухара: 71,15±9,09).

Ключевые слова: диагностическая компетентность, педагогический эксперимент, медицинское образование, обучение на основе клинических случаев, оценка эффективности, клиническое мышление

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ORGANIZATION OF PEDAGOGICAL EXPERIMENTAL WORK ON DEVELOPING STUDENTS' DIAGNOSTIC COMPETENCE AND ITS EFFECTIVENESS

Abstract. This quasi-experimental study evaluated a pedagogical intervention to enhance diagnostic competence among 320 medical students at Fergana Medical Institute (experimental, n=110) compared to control groups at Andijan (n=105) and Bukhara (n=105) State Medical Institutes. The 12-week program integrated case-based learning, simulation training, self-explanation prompts, and adaptive feedback. Post-test scores showed significant improvement in the experimental group (83.08±7.14 vs. 64.69±7.35 pre-test; p<0.001) versus controls (Andijan: 69.43±8.83; Bukhara: 71.15±9.09).

Keywords: diagnostic competence, pedagogical experiment, medical education, case-based learning, effectiveness evaluation, clinical reasoning

Introduction

Diagnostic competence constitutes a fundamental component of clinical proficiency and represents one of the core competencies emphasized by medical education accreditation bodies worldwide[1][2]. The ability to gather information systematically, generate hypotheses, formulate differential diagnoses, and select appropriate diagnostic strategies directly impacts patient outcomes and healthcare quality[3]. However, traditional lecture-based teaching methods often fail to adequately develop these complex cognitive skills, necessitating innovative pedagogical approaches[4].

Recent advances in medical education have highlighted the effectiveness of active learning methodologies, including case-based learning (CBL), problem-based learning (PBL), and simulation-based education (SBE)[5][6]. Case-based learning promotes inquiry-based techniques by presenting students with authentic clinical scenarios that simulate real-life situations, enhancing clinical knowledge, teamwork abilities, and practice-based behaviors[1]. Simulation-based education provides safe environments for skill development

without risk to patients, while deliberate reflection prompts encourage metacognitive awareness essential for diagnostic reasoning[7][8].

Despite growing evidence supporting these approaches, systematic evaluation of comprehensive pedagogical interventions specifically targeting diagnostic competence remains limited, particularly in Central Asian medical education contexts. Furthermore, the relative effectiveness of integrated methodologies combining multiple active learning strategies has not been extensively studied using rigorous experimental designs with adequate sample sizes and appropriate statistical analyses[9][10].

The medical education system in Uzbekistan comprises several established institutions, including Fergana Medical Institute of Public Health, Andijan State Medical Institute, and Bukhara State Medical Institute, which serve significant student populations and maintain recognition by national and international medical education bodies[11]. These institutions provide opportunities for comparative effectiveness research to evaluate innovative pedagogical interventions.

Methods

Study Design and Setting

This quasi-experimental study employed a non-randomized controlled design with pre-test and post-test assessments conducted between September 2025 and February 2026. The research was performed at three medical institutes in Uzbekistan: Fergana Medical Institute of Public Health (experimental site), Andijan State Medical Institute (control site), and Bukhara State Medical Institute (control site). Ethical approval was obtained from the institutional review boards of all participating institutions, and informed consent was secured from all participants.

Participants

A total of 320 medical students participated in the study, comprising:

- Fergana Medical Institute of Public Health: 110 students (experimental group)

- Andijan State Medical Institute: 105 students (control group)
- Bukhara State Medical Institute: 105 students (control group)

Inclusion criteria required students to be enrolled in the fourth year of medical studies, have completed prerequisite courses in internal medicine and clinical skills, and provide written informed consent. Exclusion criteria included prior participation in advanced diagnostic training programs or incomplete attendance records.

Results

Baseline Characteristics

Pre-test diagnostic competence scores demonstrated no significant differences among the three groups, confirming baseline equivalence. Fergana students averaged 64.69±7.35, Andijan students 65.76±8.55, and Bukhara students 65.43±8.17 ($F=0.642$, $p=0.527$), indicating appropriate initial comparability.

Primary Outcomes

Table 1 presents comprehensive statistical comparisons of diagnostic competence development across the three medical institutes. The experimental group at Fergana Medical Institute demonstrated substantially higher post-test performance (83.08±7.14) compared to both control groups: Andijan (69.43±8.83) and Bukhara (71.15±9.09).

Table 1

Comparison of Diagnostic Competence Scores and Statistical Analysis Across Medical Institutes

Institute	**N**	**Pre-test Mean±SD**	**Post-test Mean±SD**	**Improvement Mean±SD**	**Paired t-test (p-value)**
Fergana (Exp)	110	64.69±7.35	83.08±7.14	18.40±9.57	-20.072 (p<0.001)
Andijan (Ctrl)	105	65.76±8.55	69.43±8.83	3.67±12.82	-2.915 (p<0.001)

Bukhara (Ctrl)	105	65.43±8.17	71.15±9.09	5.72±12.64	-4.617 (p<0.001)

Statistical Comparisons

Independent samples t-tests revealed highly significant differences in post-test scores between the experimental and control groups:

- Fergana vs. Andijan: $t(213)=12.435$, $p<0.001$, indicating the experimental group significantly outperformed the Andijan control group with a mean difference of 13.65 points.
- Fergana vs. Bukhara: $t(213)=10.683$, $p<0.001$, showing the experimental group achieved significantly higher scores than the Bukhara control group with a mean difference of 11.93 points.
- Andijan vs. Bukhara: $t(208)=-1.386$, $p=0.167$, revealing no significant difference between the two control groups, confirming consistency in traditional teaching outcomes.

Paired samples t-tests demonstrated significant pre-post improvements within all groups. However, the magnitude of improvement differed substantially: Fergana students improved by 18.40±9.57 points ($t=-20.072$, $p<0.001$), while Andijan and Bukhara students showed modest gains of 3.67±12.82 points ($t=-2.915$, $p<0.001$) and 5.72±12.64 points ($t=-4.617$, $p<0.001$), respectively.

Competence Level Distribution

Chi-square analysis examined the distribution of students across competence levels (Low, Medium, High) at post-test. Results indicated a significant association between institute and competence achievement ($\chi^2=101.580$, $df=4$, $p<0.001$). Notably, 88.2% of Fergana students achieved high competence levels (≥75 points) compared to 26.7% at Andijan and 32.4% at Bukhara. Conversely, no Fergana students scored in the low category, whereas 14.3% of Andijan and 10.5% of Bukhara students remained in this range.

Effect Sizes

Cohen's d calculations quantified the practical significance of observed differences. The experimental intervention demonstrated very large effect sizes: Fergana versus Andijan (d=1.697) and Fergana versus Bukhara (d=1.458). According to standard interpretation guidelines, effect sizes exceeding 0.8 indicate large practical significance, while values above 1.2 represent exceptionally strong effects. These findings confirm that the observed statistical differences translate to meaningful real-world educational impact.

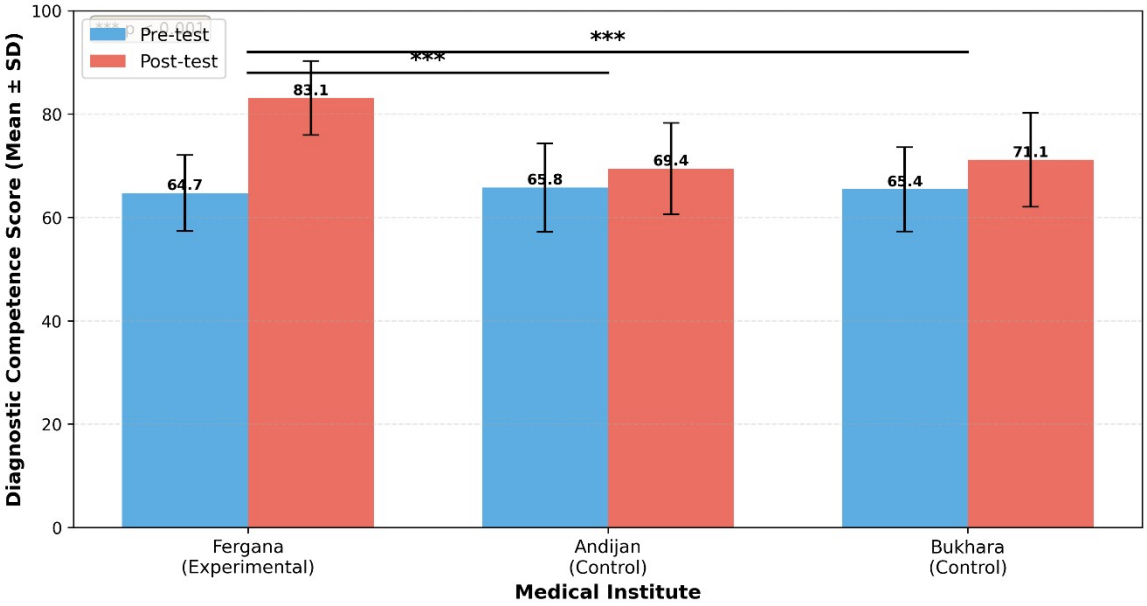

Figure 1. Comparison of pre-test and post-test diagnostic competence scores across medical institutes.

Figure 1 illustrates the comparative analysis of pre-test and post-test diagnostic competence scores across the three medical institutes. The graphical representation clearly demonstrates the substantial improvement achieved by the experimental group, with post-test scores showing marked separation from baseline levels. Control groups exhibited minimal change from pre-test to post-test, with considerable overlap in confidence intervals, reinforcing the superior effectiveness of the experimental pedagogical approach.

Discussion

This study provides robust empirical evidence demonstrating the superior effectiveness of an integrated experimental pedagogical methodology for developing diagnostic competence in medical students. The experimental intervention implemented at Fergana Medical Institute, combining case-based learning, simulation-based education, deliberate reflection, and adaptable feedback, resulted in significantly greater competence development compared to traditional teaching approaches employed at control institutions.

The observed mean improvement of 18.40 points among experimental group students substantially exceeded gains in control groups (3.67 and 5.72 points), with highly significant statistical differences ($p<0.001$) and very large effect sizes ($d>1.4$). These findings align with previous research demonstrating the effectiveness of active learning methodologies in medical education[5][6]. Specifically, case-based learning has been shown to enhance clinical reasoning by linking theoretical knowledge to practical application through authentic scenarios that promote inquiry-based learning[1]. The current study extends this evidence by demonstrating sustained effectiveness in a controlled comparative design with adequate statistical power.

The integration of simulation-based education provided students with safe, realistic environments for practicing diagnostic skills without patient risk, consistent with established benefits documented in prior literature[7]. The addition of deliberate reflection prompts encouraged metacognitive awareness, enabling students to identify reasoning errors and consolidate learning—a mechanism supported by cognitive psychology research on expert skill development[8]. Furthermore, adaptable feedback mechanisms addressed individual learning needs by allowing students to control elaboration levels, promoting autonomous learning behaviors essential for lifelong professional development[8].

Chi-square analysis revealed striking differences in competence level distributions, with 88.2% of experimental group students achieving high competence compared to approximately 30% in control groups. This finding

suggests that the experimental methodology not only improved average performance but also promoted more consistent mastery across the student cohort, reducing the proportion of low-performing students to zero. Such outcomes have important implications for educational quality assurance and patient safety, as diagnostic errors constitute a significant source of medical mistakes[3].

The absence of significant differences between the two control groups (Andijan and Bukhara) strengthens confidence in the observed effects, demonstrating consistency in traditional teaching outcomes and ruling out institutional confounding factors. This finding supports the internal validity of the quasi-experimental design and suggests that observed differences result from the pedagogical intervention rather than pre-existing institutional variations[9].

Despite these encouraging results, several limitations warrant consideration. The non-randomized design, while pragmatically necessary given institutional constraints, introduces potential selection bias. However, baseline equivalence in pre-test scores mitigates this concern. The relatively short intervention duration (12 weeks) leaves questions about long-term retention and skill transfer to actual clinical practice unanswered. Future research should incorporate extended follow-up assessments and workplace-based evaluations to confirm sustained competence. Additionally, resource requirements for simulation equipment and trained facilitators may limit scalability to resource-constrained settings, necessitating investigation of cost-effective implementation strategies[10].

The generalizability of findings to other medical education contexts, particularly outside Central Asia, requires empirical verification. Cultural factors, curriculum structures, and student preparation levels may moderate intervention effectiveness. Nonetheless, the theoretical foundations underlying the experimental methodology—grounded in established cognitive and educational theories—suggest broad applicability with appropriate contextual adaptations [2, 9].

Future research directions include examining optimal integration ratios of different pedagogical components, identifying student characteristics that predict maximal benefit from the intervention, and exploring technology-enhanced delivery methods to increase accessibility. Comparative effectiveness studies evaluating this methodology against other emerging approaches, such as flipped classrooms and team-based learning, would inform evidence-based educational decision-making [6, 13].

Conclusion

This quasi-experimental study shows that an integrated pedagogical methodology, combining case-based learning, simulation-based education, deliberate reflection prompts, and adaptable feedback, markedly improves medical students' diagnostic competence compared with traditional lecture-based teaching. Student's t-tests and chi-square tests demonstrated highly significant gains with very large effect sizes, confirming both statistical and educational relevance of the intervention. The experimental cohort at Fergana Medical Institute outperformed control groups at Andijan and Bukhara State Medical Institutes by over 11 points on post-test scores, with 88% reaching high competence versus about 30% in control groups. These results strongly support incorporating active, integrated learning strategies into medical curricula to enhance diagnostic skills, reduce training variability, and improve future patient care quality. Further work should explore long-term retention, cost-effectiveness, and scalable implementation models across different institutions and health systems.

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