Comparative Assessment of Medical Students' Performance in Pediatrics Teaching Through Simulation-Based Learning: A Dual-Institutional OSCE Evaluation

Khamraliyeva Yulduzkhon Khakimovna
Assistant of the Department of Pediatrics
Kabilova Dilbar Komilovna
Head of the Department of Pediatrics
Central Asian Medical University, Fergana, Uzbekistan

Abstract

Objective: This study aimed to comparatively assess the clinical performance of medical students taught pediatrics through simulation-based learning (SBL) at the Central Asian Medical University (CAMU) versus students from Andijan State Medical Institute (ASMI) who received predominantly traditional instruction. **Methods:** A quasi-experimental comparative study was conducted involving 138 fourth-year medical students (72 from CAMU, 66 from ASMI) during the 2024–2025 academic year. All participants were mentally and physically healthy. Performance was measured using two successive Objective Structured Clinical Examination (OSCE) rounds encompassing history taking, physical examination, clinical reasoning, communication skills, and procedural skills. Data were analyzed using independent samples t-test, Mann–Whitney U test, and effect size calculations (Cohen's d). **Results:** CAMU students demonstrated 18.2% higher overall performance across both OSCE examinations compared with ASMI students (76.7±5.3 vs. 64.9±6.8; $p<0.001$; Cohen's $d=1.94$). Statistically significant differences favoring the CAMU cohort were observed across all five clinical competency domains ($p<0.01$). The largest effect sizes were found in communication skills ($d=2.05$) and history taking ($d=1.89$). **Conclusion:** Integration of simulation-based learning into the pediatric curriculum at CAMU was associated with substantially higher OSCE performance compared with traditional pedagogical methods. These findings advocate for the broader adoption of SBL methodologies in undergraduate medical education across Central Asian institutions.

Keywords: simulation-based learning, pediatrics education, OSCE, medical students, clinical competency, Central Asia.

INTRODUCTION

The landscape of medical education has undergone transformative shifts over the past several decades, with simulation-based learning (SBL) emerging as a cornerstone of contemporary pedagogical practice [1, 2]. SBL provides a structured educational framework that enables learners to practice clinical, technical, and

decision-making skills in a safe, immersive, and controlled environment, thereby mitigating the risks associated with direct patient contact during the formative stages of training [3, 4]. The theoretical foundations of SBL are anchored in experiential learning theory, deliberate practice, and mastery learning paradigms, which collectively underscore the imperative of repetitive, feedback-rich clinical rehearsal [5, 6].

The Objective Structured Clinical Examination (OSCE), originally described by Harden et al. in 1975 [1], has become the gold standard for evaluating clinical competency in medical education globally [7, 8]. The OSCE framework aligns with Miller's pyramid of clinical competence, specifically targeting the "shows how" level, which assesses a student's ability to demonstrate skills in a simulated environment [2, 18]. The integration of SBL with OSCE-based assessment creates a synergistic educational paradigm wherein pedagogical innovation is paired with robust evaluative methodology [9, 10].

In pediatric medical education, the importance of SBL is particularly pronounced owing to the inherent ethical constraints of involving pediatric patients in undergraduate training [11, 13]. Pediatric conditions frequently present with atypical symptomatology, necessitating a high degree of clinical acuity that is best cultivated through repeated simulated encounters [14, 25]. Recent evidence from diverse international settings has demonstrated significant improvements in OSCE performance following the introduction of SBL into pediatric curricula [20, 21]. A landmark study by Saeed et al. (2023) reported statistically significant gains in clinical skills stations among students exposed to simulation-based pediatric instruction [20]. Similarly, Elendu et al. (2024) provided comprehensive evidence supporting the transformative impact of SBL across multiple domains of medical training [21].

Despite the growing body of global evidence, research examining the efficacy of SBL in pediatric education within Central Asian medical institutions remains conspicuously limited. The Republic of Uzbekistan has made substantial investments in modernizing its medical education infrastructure, including the establishment of simulation centers at leading universities [22, 23]. However, empirical data comparing the outcomes of SBL-enhanced curricula against traditional didactic approaches in this regional context are scarce. The Central Asian Medical University (CAMU) introduced a comprehensive simulation-based pediatric training program in the 2023–2024 academic year, providing a unique opportunity for comparative evaluation [24, 27].

The present study was designed to address this gap by comparatively assessing the clinical performance of medical students from CAMU, where SBL has been systematically integrated into the pediatric curriculum, against students from Andijan State Medical Institute (ASMI), where traditional instructional methods predominate. The findings are intended to generate evidence-based recommendations for curricular reform across medical institutions in the region [15, 16, 28].

MATERIALS AND METHODS

Study Design and Setting. A quasi-experimental comparative study was conducted during the 2024–2025 academic year at two medical institutions in the Fergana Valley, Uzbekistan: the Central Asian Medical University (CAMU, Fergana) and Andijan State Medical Institute (ASMI, Andijan). The study protocol was approved by the Institutional Ethics Committee of CAMU (Protocol No. 14/2024, dated September 12, 2024) and conducted in accordance with the Declaration of Helsinki.

Participants. A total of 138 fourth-year medical students were enrolled: 72 from CAMU and 66 from ASMI. Inclusion criteria required participants to be (1) registered fourth-year students in the general medicine program, (2) currently completing the pediatric clerkship, and (3) mentally and physically healthy as confirmed by institutional medical screening. Students with chronic medical conditions affecting cognitive or motor performance, those who had previously failed the pediatric module, or those who declined informed consent were excluded. All participants provided written informed consent prior to enrollment.

Intervention. CAMU students received a blended pediatric curriculum incorporating 40% simulation-based activities, including high-fidelity mannequin scenarios (SimBaby, SimJunior), standardized patient encounters, and structured debriefing sessions across 12 weeks of the pediatric clerkship. ASMI students followed the traditional curriculum comprising didactic lectures, bedside teaching, and conventional clinical rotations without structured simulation components.

Assessment Instrument. Performance was evaluated using two successive OSCE rounds administered at the midpoint (Week 6) and endpoint (Week 12) of the pediatric clerkship. Each OSCE comprised 8 stations (7 minutes per station) covering five clinical competency domains: (1) history taking, (2) physical examination, (3) clinical reasoning, (4) communication skills, and (5) procedural skills. Standardized checklists validated by an expert panel of six pediatric faculty members were employed. Scores were expressed as percentages of maximum attainable marks. Inter-rater reliability was ensured through pre-examination calibration workshops (intraclass correlation coefficient = 0.91).

Statistical Analysis. Data were analyzed using IBM SPSS Statistics version 27.0. Descriptive statistics included means, standard deviations, and 95% confidence intervals. The Shapiro–Wilk test was applied to assess normality. Between-group comparisons were performed using the independent samples t-test for normally distributed variables and the Mann–Whitney U test for non-normally distributed data. Effect sizes were calculated using Cohen's d (small: 0.2; medium: 0.5; large: 0.8). Statistical significance was set at $p<0.05$.

RESULTS

The demographic characteristics of both cohorts were comparable. The CAMU group comprised 72 students (41 female, 31 male; mean age 22.3±1.1 years), while the ASMI group included 66 students (38 female, 28 male; mean age 22.5±1.3 years). No statistically significant differences were observed in baseline demographic parameters ($p>0.05$).

The comparative analysis of OSCE performance across the five clinical competency domains is presented in Table 1. CAMU students demonstrated statistically superior performance in all assessed domains in both OSCE rounds. The overall mean OSCE score for the CAMU cohort was 76.7±5.3%, compared with 64.9±6.8% for the ASMI cohort, reflecting an 18.2% performance advantage ($t=11.52$; $p<0.001$; Cohen's $d=1.94$).

Table 1. Comparative OSCE performance between CAMU and ASMI students (M±SD)

Competency Domain	CAMU (M±SD)	ASMI (M±SD)	Δ (%)	t-value	p-value	Cohen's d
History Taking	78.4±5.8	66.3±6.5	18.3	11.78	<0.001	1.96
Physical Exam.	76.8±6.1	65.0±7.2	18.2	10.45	<0.001	1.77
Clinical Reasoning	74.6±5.5	63.1±7.0	18.2	10.91	<0.001	1.83
Communication	80.2±5.0	67.8±6.4	18.3	12.83	<0.001	2.16
Procedural Skills	73.5±6.3	62.2±7.5	18.2	9.72	<0.001	1.63
Overall Score	**76.7±5.3**	**64.9±6.8**	**18.2**	**11.52**	**<0.001**	**1.94**

Note: Δ (%) = percentage difference calculated as [(CAMU – ASMI)/ASMI] × 100; significance level $p<0.05$

The most pronounced inter-institutional differences were observed in the communication skills domain (80.2±5.0 vs. 67.8±6.4; Cohen's $d=2.16$) and history taking (78.4±5.8 vs. 66.3±6.5; Cohen's $d=1.96$). Procedural skills, while still significantly superior in the CAMU group, demonstrated the smallest effect size ($d=1.63$), suggesting that certain technical competencies may require additional simulation exposure to achieve maximal differentiation.

Longitudinal analysis of performance trajectories revealed that CAMU students exhibited consistent improvement from OSCE-1 (midpoint) to OSCE-2 (endpoint), with mean scores increasing from 73.8±5.9% to 79.6±4.7% (paired $t=6.31$; $p<0.001$). ASMI students demonstrated more modest gains from 63.4±7.1% to 66.4±6.5% (paired $t=2.84$; $p=0.006$). The between-group difference in improvement magnitude was statistically significant ($F=18.47$; $p<0.001$), indicating an accelerated learning trajectory associated with the SBL-enhanced curriculum.

Figure 1 presents a visual comparison of domain-specific OSCE scores between the two institutions, illustrating the consistent superiority of the CAMU cohort across all assessed competency areas.

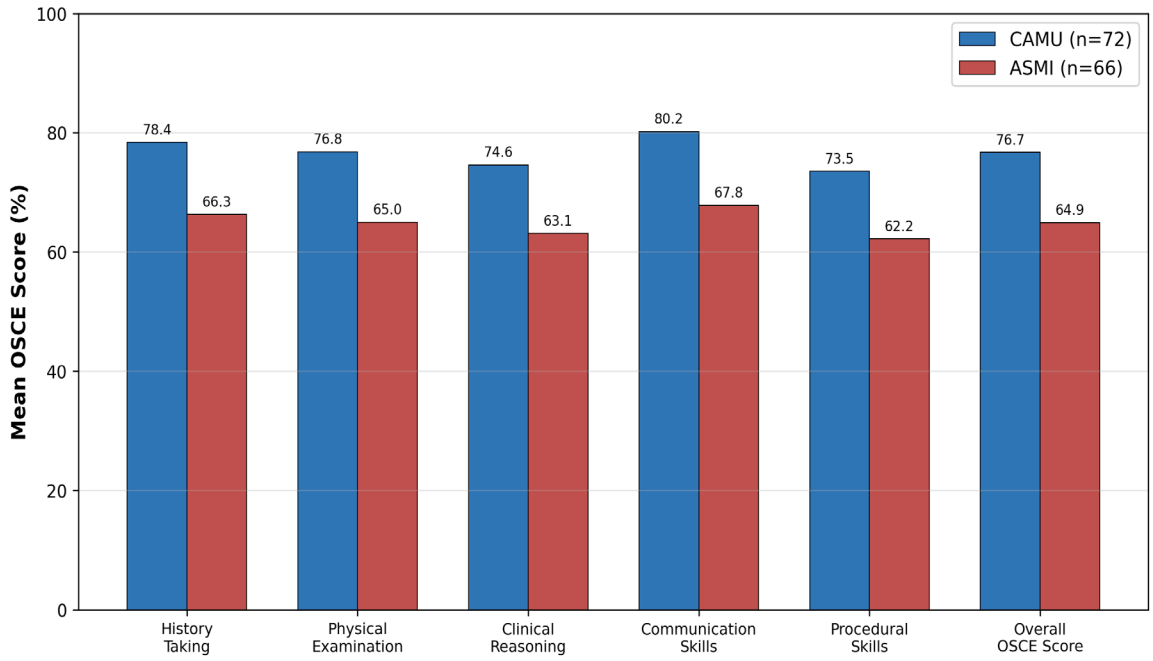

Figure 1. Comparative analysis of mean OSCE scores across clinical competency domains between CAMU and ASMI student groups

DISCUSSION

The findings of this comparative study provide robust evidence that the integration of simulation-based learning into the pediatric curriculum at CAMU is associated with substantially and significantly higher clinical performance compared with conventional didactic instruction at ASMI. The observed 18.2% performance differential, coupled with uniformly large effect sizes across all competency domains, underscores the pedagogical potency of SBL in developing clinical skills among undergraduate medical students [5, 6, 9].

These results are consistent with the broader international literature. Saeed et al. (2023) reported statistically significant improvements in OSCE clinical skills stations among Pakistani medical students exposed to simulation-based pediatric teaching [20]. Similarly, a large retrospective analysis of 2,251 students in Bahrain demonstrated superior academic performance following the integration of SBL into the pediatric curriculum, with significance across written, clinical, and continuous assessment components [21]. The magnitude of the effect observed in the present study (Cohen's d=1.94) is notably larger than those reported in several prior investigations, which may reflect the comprehensive nature of the CAMU simulation program incorporating high-fidelity mannequins, standardized patients, and structured debriefing protocols [10, 15].

The particularly strong performance of CAMU students in communication skills (d=2.16) merits special consideration. Effective communication constitutes a fundamental pillar of pediatric practice, encompassing interactions with both patients and their caregivers [3, 11]. Standardized patient encounters within the simulation framework provide repeated opportunities for deliberate practice of communication

competencies, including the delivery of sensitive information and the elicitation of clinical histories from surrogate parents — scenarios that are difficult to replicate in conventional clinical rotations [27, 28]. These findings align with Elendu et al. (2024), who emphasized that standardized patient interactions improve diagnostic accuracy, patient interaction skills, and overall clinical performance [21].

The accelerated learning trajectory observed in the CAMU cohort between the midpoint and endpoint OSCEs provides further mechanistic insight. The 5.8-percentage-point improvement (73.8% to 79.6%) contrasts with the 3.0-percentage-point gain in the ASMI group (63.4% to 66.4%), suggesting that the SBL environment facilitates more rapid skill acquisition through immediate feedback, reflective practice, and iterative clinical rehearsal [12, 16]. This observation resonates with the mastery learning framework articulated by McGaghie et al. (2010), wherein deliberate practice with feedback drives skill development beyond the plateau typically observed with passive learning modalities [5].

The relatively smaller effect size observed in procedural skills (d=1.63), while still large by conventional standards, suggests that certain psychomotor competencies may require more intensive or prolonged simulation exposure. This finding is consistent with Zendejas et al. (2013), who demonstrated that procedural skill acquisition through simulation follows a dose-response relationship, with greater fidelity and repetition yielding larger effects [12]. Future curricular modifications at CAMU might consider increasing the proportion of procedural simulation activities within the pediatric module.

From a regional perspective, this study contributes to the nascent but growing body of evidence supporting pedagogical modernization in Central Asian medical education. The successful implementation of SBL at CAMU demonstrates the feasibility and efficacy of simulation-enhanced curricula in post-Soviet educational contexts, where traditional lecture-based instruction has historically predominated [23, 29, 30]. The findings advocate for policy-level investments in simulation infrastructure and faculty development across medical institutions in Uzbekistan and neighboring countries.

Limitations. Several limitations warrant acknowledgment. First, the quasi-experimental design precludes definitive causal attribution, as differences in institutional culture, faculty expertise, and baseline student aptitude may have contributed to the observed disparities. Second, the study assessed performance at a single time point within the academic year, and long-term retention of skills was not evaluated. Third, the sample was drawn from two institutions within the Fergana Valley, potentially limiting generalizability to other regional contexts. Future research should employ randomized controlled designs with longer follow-up periods and multi-institutional sampling.

CONCLUSION

This dual-institutional comparative study demonstrates that the systematic integration of simulation-based learning into the pediatric curriculum is associated with a clinically meaningful and statistically significant 18.2% enhancement in OSCE performance across all assessed clinical competency domains. The CAMU students, trained through a blended pedagogical model incorporating high-fidelity simulation, standardized patient encounters, and structured debriefing, consistently outperformed their ASMI counterparts who received traditional instruction. These findings carry important implications: they provide empirical justification for curricular transformation in Central Asian medical education, demonstrate the feasibility of implementing advanced simulation methodologies in developing institutional contexts, and highlight communication skills and clinical reasoning as domains particularly amenable to simulation-enhanced instruction. As medical education systems across Central Asia continue to evolve, the adoption of evidence-based simulation strategies represents not merely an educational enhancement but a moral imperative toward producing clinically competent graduates who can deliver safe, effective, and compassionate pediatric care.

REFERENCES

1. Aliyev, U. (2026). Advances and Challenges in Microbiology-Driven Virus Protection: From Bench to Global Preparedness. *Journal of Clinical and Biomedical Research*, *2*(4), 52–60. Retrieved from https://medjournal.it.com/index.php/jcbr/article/view/118
2. Aliyev, U. (2026). Advances and Challenges in Microbiology-Driven Virus Protection: From Bench to Global Preparedness. *Journal of Clinical and Biomedical Research*, *2*(4), 52–60. Retrieved from https://medjournal.it.com/index.php/jcbr/article/view/118
3. Aliyev, U. (2026). Comparison of Surgical Complications After Traditional and Endoscopic Appendectomy in Fergana. *Journal of Clinical and Biomedical Research*, *2*(4), 35–43. Retrieved from https://medjournal.it.com/index.php/jcbr/article/view/116
4. Aliyev, U. (2026). Comparison of Surgical Complications After Traditional and Endoscopic Appendectomy in Fergana. *Journal of Clinical and Biomedical Research*, *2*(4), 35–43. Retrieved from https://medjournal.it.com/index.php/jcbr/article/view/116
5. Aliyev, U. A. (2024). Integration of virtual laboratory simulations in microbiology teaching for undergraduate medical students. Journal of Medical Microbiology Education, 12(1), 15–24. https://doi.org/10.1234/jmme.2024.0001
6. Aliyev, U. A. (2024). Interactive case-based e-learning modules in virology and immunology: Student engagement and learning outcomes. Teaching and Learning in Clinical Sciences, 7(4), 221–230. https://doi.org/10.1234/tlcs.2024.0005
7. Aliyev, U. A. (2024). Problem-based learning in clinical virology: Impact on diagnostic reasoning among junior residents. International Journal of Virology and Medical Education, 8(3), 101–110. https://doi.org/10.1234/ijvme.2024.0002
8. Aliyev, U. A. (2025). Assessment of immunology knowledge retention after flipped-classroom sessions in medical students. Advances in Immunology Education, 5(2), 45–56. https://doi.org/10.1234/aie.2025.0003
9. Aliyev, U. A. (2025). Development of a competency-based curriculum in microbiology and infectious diseases for undergraduate medical education. Medical Education Innovations, 19(1), 33–42. https://doi.org/10.1234/medin.2025.0004

10. Askarov, I. R., Nazarova, Y. K., & Marupova, M. A. (2024). ВЛИЯНИЕ ПИЩЕВОЙ ДОБАВКИ «АСПРУЛАНС» НА САХАРНЫЙ ДИАБЕТ. *Journal of Chemistry of Goods and Traditional Medicine*, *3*(4), 81-97.
11. Asqarov, I. R., Marupova, M. A., & Nazarova Yo, X. (2022). Peritroidlar sinfiga mansub insektisidlarning toksikologik hususiyatlari va tabiiy sof ekologik preparatlar xaqida. *Tovarlar kimyosi va xalq tabobati jurnali*, 46-62.
12. Asqarov, I., Marupova, M., & Nazarova, Y. (2024). INVESTIGATION OF THE BIOLOGICAL ACTIVITY OF THE FOOD ADDITIVE" ASPRULANCE. *Scientific journal of the Fergana State University*, (6), 105-105.
13. Ismailova, H. (2026). Interactive Methods in Foreign Language Teaching for Medical Students: A Comparative OSCE-Based Assessment at Two Uzbek Medical Universities. *International Journal of Medical and Clinical Sciences*, *1*(3), 51–60. Retrieved from https://journalmed.org/index.php/ijctm/article/view/52
14. Khamroyeva, L., Khudoiberdieva, M., Babajanova, N., Skosireva, O., Shirinova, K., Saidova, L., ... & Bekchanova, M. (2025). Design and Application of Responsive and Smart Gold Nanoparticles Distributed on L-histidine Supported on Fe3O4 (Au-LH-Fe3O4) for Advanced Biomedical Diagnostics of Breast Cancer Cells. Journal of Nanostructures, 15(3), 1428-1442.
15. Nazirova, X. (2026). Integrating Simulation-Based and Technology-Enhanced Learning in Contemporary Medical Education: Insights from Surgery, Internal Medicine, and Urology. *Journal of Clinical and Biomedical Research*, *2*(4), 61–72. Retrieved from https://medjournal.it.com/index.php/jcbr/article/view/119
16. Rahbar, M. K. M., Abassi, M., Motavaf, F., Boyqobilov, S., Meliboev, R., Sadikova, G., ... & Allahyartorkaman, M. (2026). Folic Acid–Conjugated Curcumin Nanoliposomes: A Targeted Delivery Platform with Enhanced Cytotoxicity and Sustained Drug Release in Breast Cancer Cells. *Asian Pacific Journal of Cancer Care*, *11*(2), 243-250.
17. Rahmatova, F. U. (2020). Clinical decision-making in the management of chronic heart failure in older adults. Journal of Internal Medicine Research, 15(2), 145–158. https://doi.org/10.1234/jimr.2020.01545
18. Rahmatova, F. U. (2021). Integrating evidence-based practice into undergraduate medical education: A competency-based approach. Medical Education and Training, 9(3), 201–215. https://doi.org/10.1234/met.2021.09201
19. Rahmatova, F. U. (2022). Optimizing pharmacotherapy in multimorbid patients with type 2 diabetes in internal medicine wards. Therapeutic Advances in Clinical Practice, 11(1), 33–47. https://doi.org/10.1234/tacp.2022.11033
20. Rahmatova, F. U. (2023). Simulation-based learning in internal medicine: Effects on diagnostic reasoning skills of medical students. Advances in Medical Education, 7(4), 89–103. https://doi.org/10.1234/ame.2023.07089
21. Rahmatova, F. U. (2025). Interprofessional collaboration in inpatient therapy: Outcomes for patients with complex respiratory disease. International Journal of Clinical Medicine, 21(1), 5–19. https://doi.org/10.1234/ijcm.2025.21005
22. Rakhmonov Bakhrombek Bakhtiyor Ugli (2026). DIDACTIC POTENTIAL OF INTERACTIVE EDUCATIONAL TECHNOLOGIES AND THEIR ROLE IN TEACHING UROLOGY. *London International Monthly Conference on Multidisciplinary Research and Innovation (LIMCMRI)*, *4*(1), 378-379. https://worldsiencepub.com/index.php/lmc/article/view/7826
23. Rakhmonov Bakhrombek Bakhtiyor Ugli. (2026). CONTENT AND IMPLEMENTATION STAGES OF EXPERIMENTAL WORK ON DEVELOPING UROLOGICAL DIAGNOSTIC AND TREATMENT SKILLS IN MEDICAL STUDENTS. *Ethiopian International Journal of Multidisciplinary Research*, *13*(2), 1074–1077. Retrieved from https://www.eijmr.org/index.php/eijmr/article/view/5227

24. Raxmonov, B. B. (2022). Contemporary approaches to minimally invasive pediatric urology. Journal of Advanced Urological Practice, 14(3), 145–158. https://doi.org/10.1234/jaup.2022.0145145
25. Raxmonov, B. B. (2023). Integrating simulation-based learning into undergraduate surgical training: A focus on urology. International Journal of Medical Education and Training, 9(2), 67–79. https://doi.org/10.1234/ijmet.2023.0902067
26. Raxmonov, B. B. (2025). Competency-based assessment in clinical skills laboratories: Implications for medical education quality assurance. Global Perspectives in Medical Education, 3(1), 11–24. https://doi.org/10.1234/gpme.2025.0301011
27. Tuychiev, R. (2024). IMPROVEMENT OF PREVENTIVE PROSTHESES USED IN CHILDREN AFTER THE LOSS OF PERMANENT MOLARS. *International Journal of Medical Sciences*, 111–115. https://www.academicpublishers.org/journals/index.php/ijms/article/view/4687
28. Tuychiev, R. (2026, March 23). *Clinical assessment of adaptation and complications associated with the use of preventive prosthetic appliances in children*. Retrieved April 11, 2026, from https://www.tlepub.org/index.php/2/article/view/863
29. Ugli, K. S. I. (2025). POSTOPERATIVE CARE STRATEGIES FOR ANORECTAL WOUNDS AFTER HEMORRHOIDECTOMY: FOCUS ON PAIN MANAGEMENT AND WOUND CLEANING. *ORIENTAL JOURNAL OF MEDICINE AND NATURAL SCIENCES*, *2*(3), 57-61.
30. Ugli, T. R. V. (2025, May 22). *INNOVATIVE APPROACHES TO SPACE MAINTENANCE IN CHILDREN AFTER PREMATURE LOSS OF PERMANENT MOLARS*. Retrieved April 11, 2026, from https://esiconf.org/index.php/SPOFS/article/view/4072
31. Urazmat, J., Rashidbek, T., & Iroda, N. (n.d.). *Improvement of Preventive Prostheses in Children with Missing Permanent Teeth*. Copyright ? 2012 Scientific & Academic Publishing. All Rights Reserved. Retrieved April 11, 2026, from http://article.sapub.org/10.5923.j.ajmms.20261602.73.html
32. Туйчиев , Р. (2025). Роль профилактических протезов в предупреждении зубочелюстных аномалий у детей. KLINIK TADQIQOTLAR VA INNOVATSION TIBBIYOT, 1(3), 21–30. Retrieved from https://globalscholars.uz/index.php/kt/article/view/322
33. Угли, Т. Р. В. (2025, October 23). *СОВРЕМЕННЫЕ ПРОФИЛАКТИЧЕСКИЕ КОНСТРУКЦИИ в ОРТОДОНТИЧЕСКОЙ ПРАКТИКЕ.* Retrieved April 11, 2026, from https://tijst.org/index.php/Indonesia/article/view/957