MODERN APPROACHES TO TEACHING MEDICAL STUDENTS IN THE DEPARTMENT OF PEDIATRICS: PROBLEM-BASED AND INDEPENDENT LEARNING USING SIMULATION TECHNOLOGIES

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Abstract. The aim of this study is to evaluate the effectiveness of task-based and self-directed learning among students in the Department of Pediatrics, using simulation technologies, in the development of practical skills and clinical reasoning. The study included 120 fourth- and fifth-year students from the Faculty of Pediatrics at Tashkent State Medical University. The participants were divided into a main group (n = 60), which was trained using a task-oriented and self-directed learning model incorporating simulation technologies, and a comparison group (n = 60), which was trained using traditional methods. The results showed that a high level of practical skill development, as assessed by the OSCE, was observed in 86.7% of students in the experimental group, which was significantly higher than the corresponding figure in the control group—61.7% ($p < 0.05$). The mean total score for performing a pediatric examination was 84.3 ± 6.2 points in the main group and 72.5 ± 7.1 points in the comparison group ($p < 0.01$). The number of errors in assessing vital signs was significantly lower in the main group (0.9 ± 0.3) compared with the comparison group (1.6 ± 0.4; $p < 0.05$). In addition, the proportion of students demonstrating confidence and logical consistency in their clinical decisions was 81.7% in the main group versus 58.3% in the comparison group ($p < 0.05$). The results obtained demonstrate the high effectiveness of task-oriented and independent learning using simulation technologies. This educational model contributes to improving students' practical training, developing clinical reasoning, and reducing the number of diagnostic errors, thereby enhancing the readiness of future pediatricians for professional practice.
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Introduction

Modern medical education is focused on developing a set of professional competencies in future physicians, including clinical reasoning, practical skills, and the ability to make independent decisions. In the context of the transition to a competency-based model of education, the implementation of educational technologies aimed at stimulating students' learning activities and fostering their independence has become particularly important [2; 9].

One of the promising areas for modernizing medical education is the use of simulation technologies. Simulation-based training allows for the modeling of clinical situations that closely resemble real-world practice, while providing a safe environment for honing professional skills [1; 3; 4]. This approach is particularly relevant for training students in the pediatric department, as working with children requires a high degree of responsibility, diagnostic accuracy, and the ability to make clinical decisions quickly. According to several studies, simulation-based training methods significantly improve students' clinical preparedness and help them develop lasting professional skills [5; 6; 7; 8].

Problem-based learning, combined with simulation technologies, promotes the development of analytical thinking, the formulation of clinical examination algorithms, and an increase in students' level of independence [4; 6; 8]. Within this educational model, students are actively involved in solving clinical problems, analyzing symptoms and examination findings, formulating diagnostic hypotheses, and determining patient management strategies [5; 6].

Research objective

To evaluate the effectiveness of problem-based and independent learning among students in the pediatric faculty using simulation technologies in the development of practical skills and clinical reasoning.

Materials and Methods

The study included 120 fourth- and fifth-year students from the Faculty of Pediatrics at Tashkent State Medical University. All study participants were divided into two groups: the main group (n = 60) and the comparison group (n = 60).

Students in the main group were taught using a problem-based and self-directed learning model at the university's simulation center. The presented structure of the educational process reflects a phased model of task-oriented learning for students in the Faculty of Pediatrics using simulation technologies. This model includes sequential stages of professional competency development — from the acquisition of theoretical knowledge to the comprehensive assessment of clinical skills (Table 1).

The first stage of training consists of theoretical instruction aimed at teaching students clinical algorithms for pediatric examinations, as well as the principles of diagnosis and symptom interpretation. The main objective of this stage is to build a foundation of theoretical knowledge and develop algorithmic clinical thinking. Mastery of the material is assessed through tests and oral examinations.

The next stage involves familiarizing students with simulation equipment.

Table 1

Structure of Task-Oriented Student Learning Using Simulation Technologies

Training Stage	Learning Content	Skills Developed	Form of Assessment
Theoretical Training	Study of clinical algorithms for pediatric examination, diagnosis, and interpretation of symptoms	Theoretical knowledge, algorithmic thinking	Testing, oral examination
Familiarization with simulation equipment	Working with manikins and simulators, learning to use simulation center equipment	Basic practical skills, proficiency with equipment	Instructor supervision
Practicing clinical scenarios	Simulation of typical pediatric situations (fever, respiratory disorders, dehydration, etc.)	Clinical reasoning, diagnosis, decision-making	Practical skills checklists
Independent student work	Independent completion of clinical assignments and analysis of examination results	Independence, analytical thinking	Instructor observation
Review of clinical situations (debriefing)	Analysis of errors, discussion of diagnostic and treatment algorithms	Reflection, clinical analysis	Group discussion
Final Skills Assessment	Conducting an Objective Structured Clinical Examination (OSCE)	Comprehensive Clinical Competence	OSCE

During this stage, students learn to work with manikins and simulators used in the simulation center, which helps them develop basic practical skills and proficiency in using medical equipment. The instructor monitors the correctness of the students' actions.

During the clinical scenario training phase, typical pediatric situations are simulated, such as febrile episodes, respiratory distress, dehydration, and other clinical conditions. This phase is designed to develop clinical reasoning and build diagnostic and clinical decision-making skills. Task performance is assessed using practical skills checklists.

The stage of independent student work plays a particularly important role in the educational process. During this period, students independently complete clinical assignments, analyze examination results, and formulate diagnostic conclusions. This approach fosters the development of independence, analytical thinking, and the ability to make clinical decisions. Supervision takes the form of observation by the instructor.

An important element of the training is the review of clinical scenarios (debriefing), during which mistakes are analyzed, diagnostic and treatment algorithms are discussed, and students' actions are evaluated. This stage helps students develop reflective thinking and deepen their clinical analysis.

The final stage is a summative assessment of the skills acquired, which takes the form of an Objective Structured Clinical Examination (OSCE). This assessment format allows for a comprehensive evaluation of students' practical skills, clinical reasoning, and readiness for professional practice.

Thus, the presented structure of simulation-based education ensures the sequential development of theoretical knowledge, practical skills, and clinical competencies among students in the pediatric department. This approach is widely used in international medical education and has proven effective in developing clinical competencies [5; 9].

Students in the comparison group were trained using a traditional educational model based on lectures and practical sessions without the use of simulation technologies.

The effectiveness of the training was assessed using:

- an objective structured clinical examination (OSCE);
- checklists for assessing practical skills;
- a final theoretical and practical assessment.

Statistical analysis of the data was performed using standard methods of variational statistics. The statistical significance of differences between groups was assessed at a significance level of $p < 0.05$.

Study Results

Analysis of the presented data reveals statistically significant differences between the main group and the comparison group for most of the studied indicators of learning effectiveness.

A high level of practical skills, as assessed by the Objective Structured Clinical Examination (OSCE), was observed in 52 students in the main group, accounting for 86.7%. In the comparison group, this figure was significantly lower, at 61.7% (37 students). The differences between the groups are statistically significant ($p < 0.05$), indicating the greater effectiveness of the educational model used in the main group (Table 2).

The mean total score for the pediatric examination was also significantly higher among students in the main group, at 84.3 ± 6.2 points, whereas in the comparison group this score was 72.5 ± 7.1 points. The observed differences are statistically significant ($p < 0.01$) and indicate a higher level of clinical skill development and the ability to interpret clinical data among students in the main group.

Table 2

Comparative Assessment of Student Learning Outcomes

Indicator	Main group (n = 60)	Comparison group (n = 60)	p
High level of practical skills on the OSCE	52 (86.7%)	37 (61.7%)	< 0.05
Average score for pediatric examination (points)	84.3 ± 6.2	72.5 ± 7.1	< 0.01
Number of errors in assessing vital signs	0.9 ± 0.3	1.6 ± 0.4	< 0.05
Students demonstrating confidence and logical consistency in clinical decision-making	49 (81.7%)	35 (58.3%)	< 0.05

An analysis of the error rate in assessing vital signs revealed that in the main group, this rate was significantly lower, at 0.9 ± 0.3 errors per student, whereas in the comparison group it reached 1.6 ± 0.4. The differences between the groups are statistically significant ($p < 0.05$), reflecting more accurate performance of diagnostic procedures by students in the main group.

In addition, students in the main group demonstrated confidence and logical consistency in clinical decision-making significantly more often. This indicator was observed in 49 students (81.7%), whereas in the comparison group, it was observed in 35 students (58.3%). The differences between the groups are also statistically significant ($p < 0.05$).

During the error analysis, it was found that students in the main group made significantly fewer errors when assessing vital signs and interpreting physical examination data. The frequency of such errors decreased by a factor of 1.8 compared to students in the comparison group.

Thus, the results indicate that the use of task-oriented and independent learning with simulation technologies contributes to a higher level of practical skill development, a reduction in the number of diagnostic errors, and the development of clinical reasoning among students in the pediatric faculty.

Discussion

The results confirm the high effectiveness of simulation technologies in the educational process at a medical university. The use of a task-oriented approach significantly increases student engagement in the learning process and contributes to the development of lasting practical skills [6; 8]. Simulation technologies create conditions for repeated practice of clinical procedures, which is particularly important when training students in the pediatric department, where many procedures require a high degree of precision and accuracy [7]. The ability to simulate various clinical situations contributes to the development of clinical reasoning and the formation of diagnostic and treatment algorithms [9]. In addition, students' independent work in a simulation center stimulates their cognitive activity, promotes the development of self-control skills, and increases their motivation to learn.

Conclusion

The results of this study showed that task-oriented and independent learning among students in the pediatric faculty, using simulation technologies, is an effective educational tool. The application of this learning model contributes to a significant improvement in students' practical training, the development of clinical reasoning, and a reduction in the number of diagnostic errors. The use of simulation technologies creates a safe educational environment for developing professional skills and enhances the readiness of future pediatricians for clinical practice within the modern healthcare system.

Authors' Contributions:

M. M. Tadzhiev — development of the study concept and design, scientific supervision, preparation, and final editing of the manuscript; H. M. Mirkhoshimova — data collection and processing, statistical analysis, and formatting of the article; Z. R. Kholmirzaev — participation in the analysis and interpretation of the results.

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