MATHEMATICAL AND STATISTICAL ANALYSIS OF EXPERIMENTAL WORK AIMED AT DEVELOPING STUDENTS' UROLOGICAL DIAGNOSTIC AND TREATMENT SKILLS USING INTERACTIVE EDUCATIONAL TECHNOLOGIES

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Abstract

This article highlights the mathematical and statistical analysis of experimental work aimed at developing students' urological diagnostic and treatment skills based on interactive educational technologies.

Keywords: *mathematical-statistical analysis, pedagogical experiment, interactive education, urology, clinical competence, Student's t-test, descriptive statistics, effectiveness index, assessment criteria, simulation-based training.*

Annotatsiya

Mazkur maqolada talabalarni interaktiv ta’lim texnologiyalari asosida urologik diagnostika va muolaja ko‘nikmalarini rivojlantirishga yo‘naltirilgan tajriba-sinov ishlarining matematik-statistik tahlili yoritiladi.

Kalit so‘zlar:*matematik-statistik tahlil, pedagogik eksperiment, interaktiv ta’lim, urologiya, klinik kompetensiya, Student t-testi, deskriptiv statistika, samaradorlik indeksi, baholash mezonlari, simulyatsion ta’lim.*

Аннотация

В данной статье освещается математико-статистический анализ опытно-экспериментальной работы, направленной на развитие у студентов навыков урологической диагностики и лечения на основе интерактивных образовательных технологий.

Ключевые слова: *математико-статистический анализ, педагогический эксперимент, интерактивное обучение, урология, клиническая компетентность, t-критерий Стьюдента, описательная статистика, индекс эффективности, критерии оценивания, симуляционное обучение.*

INTRODUCTION

In modern pedagogical research, merely describing the effectiveness of a developed methodology in qualitative terms is insufficient; substantiating the obtained results with mathematical-statistical methods is a crucial scientific requirement [1-3]. Particularly when evaluating a complex and multi-component pedagogical process such as developing urological diagnostic and treatment skills, it is necessary to ensure the reliability, accuracy, and objectivity of the results [4]. For this reason, this section provides a thorough study of the results from the experimental work, which was organized based on interactive technologies, through mathematical-statistical analysis [5].

Preliminary and final results were obtained from the students who participated in the experimental work, which was organized to determine the in-process effectiveness of the pedagogical technology and teaching methodology for developing urological diagnostic and treatment skills among students in the General Medicine program.

Research Methodology. The primary objective of this analysis was to determine the non-random nature of changes in students' preparedness for clinical processes within the experimental and control groups. It also aimed to substantiate the practical effectiveness of the methodology, which is based on interactive technologies, using quantitative indicators. A statistical approach enhances the scientific validity of pedagogical conclusions, expanding the potential for their generalization and practical implementation.

The initial and final control results from the experimental work conducted in 2022, 2023, and 2024 at the Fergana Medical Institute of Public Health, Andijan State Medical Institute, and Bukhara State Medical Institute were summarized. The effectiveness of the educational-methodological approach was then determined through mathematical-statistical analysis. These results were achieved by applying recommendations for developing urological diagnostic and treatment skills in future doctors.

Table 1.

Distribution of Respondents into Experimental and Control Groups at Selected Institutions

Higher Education Institution	Groups	Number
Fergana Medical Institute of Public Health	EG	80
	CG	82
Andijan State Medical Institute	EG	83
	CG	81
Bukhara State Medical Institute	EG	79
	CG	80
Total	EG	242
	CG	243

In the initial stage, a comprehensive pedagogical diagnostic was conducted to determine the students' level of development in urological diagnostic and treatment skills, as well as the effectiveness of the educational process's practical orientation. The main objective of this stage was to objectively assess the formation of students' clinical thinking, diagnostic analysis abilities, treatment decision-making capacity, and procedural-practical preparedness. It also aimed to identify the pedagogical potential of the Scenario-Based Decision Technology methodology to be used in subsequent stages.

Results and Discussion. The analysis revealed that although most students had sufficient theoretical knowledge, they faced difficulties in its systematic application, prioritization, and independent decision-making in complex clinical situations. This scientifically substantiated the

insufficiency of the traditional lecture-practical approach in teaching urology and the need to introduce interactive, scenario-based, and simulation methods [6].

Table 2.

Students' knowledge levels at the beginning of the experiment, based on criteria for assessing urological diagnostic and treatment skills

Assessment Criteria	HEI	Groups	Number	High		Medium		Low	
				Number	Percent	Number	Percent	Number	Percent
Analytical	Fergana Medical stitute of Public Health	EG	**80**	6	7.5%	18	22.5%	56	70.0%
		CG	**82**	7	8.5%	17	20.7%	58	70.7%
	Andijan State Medical Institute	EG	83	7	8.4%	19	22.9%	57	68.7%
		CG	81	7	8.6%	18	22.2%	56	69.1%
	Bukhara State Medical Institute	EG	79	6	7.6%	18	22.8%	55	69.6%
		CG	80	7	8.8%	17	21.3%	56	70.0%
	Total	EG	242	19	7.9%	55	22.7%	168	69.4%
		CG	243	21	8.6%	52	21.4%	170	70,0%
Evidence-Based Reasoning	Fergana Medical stitute of Public Health	TG	**80**	7	8.8%	19	23.8%	54	67.5%
		NG	**82**	7	8.5%	20	24.4%	55	67.1%
	Andijan State Medical Institute	TG	83	6	7.2%	21	25.3%	56	67.5%
		NG	81	6	7.4%	20	24.7%	55	67.9%
	Bukhara State Medical Institute	TG	79	6	7.6%	18	22.8%	55	69.6%
		NG	80	7	8.8%	17	21.3%	56	70.0%
	Total	TG	242	19	7.9%	58	24.0%	165	68.2%
		NG	243	20	8.2%	57	23.5%	166	68.3%
Comparison	Fergana Medical stitute of Public Health	TG	**80**	6	7.5%	18	22.5%	56	70.0%
		NG	**82**	6	7.3%	19	23.2%	57	69.5%
	Andijan State Medical Institute	TG	83	5	6.0%	19	22.9%	59	71.1%
		NG	81	5	6.2%	19	23.5%	57	70.4%
	Bukhara State Medical Institute	TG	79	6	7.6%	17	21.5%	56	70.9%
		NG	80	5	6.3%	19	23.8%	56	70.0%

Reflective Thinking	Total	TG	242	17	7.0%	54	22.3%	171	70.7%
		NG	243	16	6.6%	57	23.5%	170	70.0%
	Fergana Medical stitute of Public Health	TG	**80**	6	7.5%	19	23.8%	55	68.8%
		NG	**82**	7	8.5%	17	20.7%	58	70.7%
	Andijan State Medical Institute	TG	83	6	7.2%	18	21.7%	59	71.1%
		NG	81	6	7.4%	17	21.0%	58	71.6%
	Bukhara State Medical Institute	TG	79	7	8.9%	16	20.3%	56	70.9%
		NG	80	7	8.8%	17	21.3%	56	70.0%
	Total	TG	242	19	7.9%	53	21.9%	170	70.2%
		NG	243	20	8.2%	51	21.0%	172	70.8%

According to the criteria for the development level of urological diagnostic and treatment skills in students during the initial experimental tests at the beginning of the experiment:

According to the analytical criterion, the high level of mastery in the experimental and control groups was 7.9% and 8.6% respectively, showing a decrease of 0.8% in the experimental groups compared to the control groups. The medium level of mastery was 22.7% and 21.4%, an increase of 1.3% in the experimental groups compared to the control groups. The low level of mastery was 69.4% and 70.0%, and a decrease of 0.5% was observed in the experimental groups compared to the control groups.

To assess the ideas put forward in the research and determine the students' level of developed skills in urological diagnostics and procedures, the final stage of the experimental work was conducted, and the students' level of developed skills in urological diagnostics and procedures was determined.

Table 3.

The level of development of students' skills in urological diagnostics and procedures at the end of the experiment, based on assessment criteria

Assessment Criteria	HEI	Groups	Number	High		Medium		Low	
				Number	Incent	Number	Incent	Number	Incent
Analytical	Fergana Medical Institute of Public Health	EG	80	19	23.8	43	53.8	18	22.
		CG	82	10	12.2	20	24.4	52	63.

	Andijan State Medical Institute	EG	83	18	21.7	47	56.6	18	21.
		CG	81	9	11.1	21	25.9	51	63.
	Bukhara State Medical Institute	EG	79	20	25.3	41	51.9	18	22.
		CG	80	10	12.5	21	26.3	49	61.
	Total	EG	242	57	23.6	131	54.1	54	22.
		CG	243	29	11.9	62	25.5	152	62.
	Fergana Medical Institute of Public Health	EG	80	21	26.3	39	48.8	20	25.
		CG	82	10	12.2	25	30.5	47	57.
	Andijan State Medical Institute	EG	83	19	22.9	40	48.2	24	28.
Evidence-based reasoning		NG	81	9	11.1	22	27.2	50	61.
	Bukhara State Medical Institute	TG	79	20	25.3	38	48.1	21	26.
		NG	80	10	12.5	23	28.8	47	58.
	Total	TG	242	60	24.8	117	48.3	65	26.
		NG	243	29	11.9	70	28.8	144	59.
	Fergana Medical Institute of Public Health	TG	80	18	22.5	43	53.8	19	23.
		NG	82	9	11.0	24	29.3	49	59.
	Andijan State Medical Institute	TG	83	17	20.5	44	53.0	22	26.
Comparison		NG	81	8	9.9	22	27.2	51	63.

Reflective Thinking	Bukhara State Medical Institute	TG	79	16	20.3	42	53.2	21	26.
		NG	80	8	10.0	21	26.3	51	63.
	Total	TG	242	51	21.1	129	53.3	62	25.
		NG	243	25	10.3	67	27.6	151	62.
	Fergana Medical Institute of Public Health	TG	80	21	26.3	42	52.5	17	21.
		NG	82	10	12.2	22	26.8	50	61.
	Andijan State Medical Institute	TG	83	19	22.9	45	54.2	19	22.
		NG	81	9	11.1	21	25.9	51	63.
	Bukhara State Medical Institute	TG	79	20	25.3	41	51.9	18	22.
		NG	80	10	12.5	23	28.8	47	58.
	Total	TG	242	60	24.8	128	52.9	54	22.
		NG	243	29	11.9	66	27.2	148	60.

At the end of the experiment, based on the analytical criteria from the combined results of all higher education institutions, the development level of students' urological diagnostic and treatment skills was analyzed. In the experimental and control groups, the high-level assessment scores were 23.6% and 11.9% respectively, showing an 11.6% increase in the experimental groups compared to the control groups. The medium-level mastery was 54.1% and 25.5%, representing a 28.6% increase in the experimental groups. For low-level performers, the scores were 22.3% and 62.6%, which constituted a 40.2% decrease in the experimental groups compared to the control groups.

A statistical analysis of the results from the final experimental work was conducted to determine the students' level of development in urological diagnostic and treatment skills at the end of the experiment. The analysis revealed that the average values for the experimental group were higher than those for the control group, the effectiveness indicators for the experimental group were greater than one compared to the control group, the confidence intervals did not overlap, and the empirical value of

the Student's t-test was greater than the critical value. These findings indicate that the results are significant, providing the basis for accepting the H1 hypothesis [7-11]. Diagrams showing the average mastery indicators, effectiveness results, and confidence intervals for each criterion are presented.

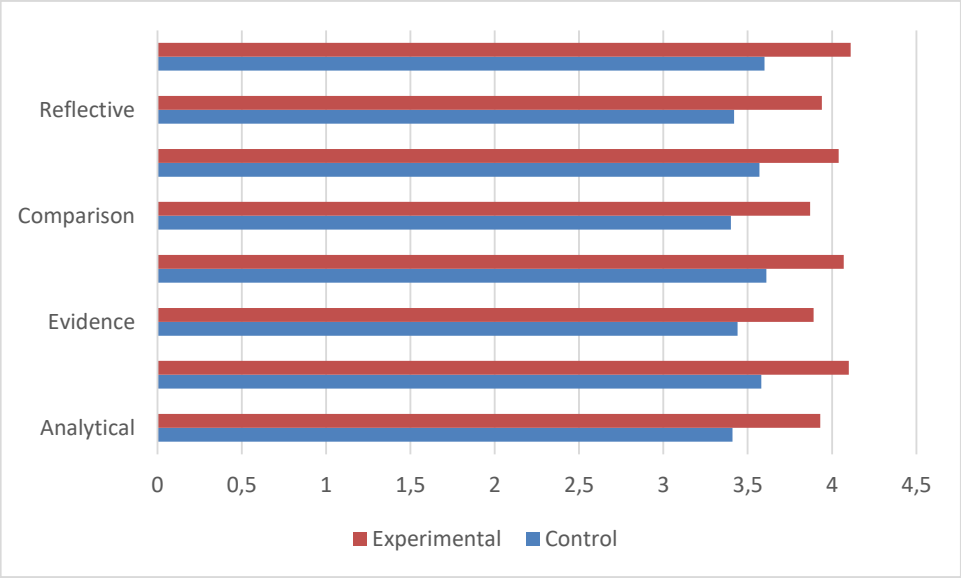

Figure 1. Confidence intervals for the experimental group versus the control group regarding the development level of students' urological diagnostic and treatment skills across all criteria at the end of the experiment.

Both the control and experimental groups demonstrated positive pre–post growth across all four cognitive domains: analytical thinking, evidence-based reasoning, comparison skills, and reflective thinking. In the control group, analytical thinking increased from 3.41 to 3.58, evidence-based reasoning from 3.44 to 3.61, comparison skills from 3.40 to 3.57, and reflective thinking from 3.42 to 3.60, indicating moderate but consistent improvement. The experimental group showed higher overall performance levels, with analytical thinking rising from 3.93 to 4.10, evidence-based reasoning from 3.89 to 4.07, comparison skills from 3.87 to 4.04, and reflective thinking from 3.94 to 4.11. Although the magnitude of growth was similar in both groups (approximately +0.17–0.18 points), the experimental group maintained consistently higher mean scores, suggesting stronger overall cognitive skill development.

CONCLUSION

According to the results of the final stage of the experiment, the development level of urological diagnostic and treatment skills in students of the experimental and control groups differed across all assessment levels. It was determined that the knowledge level was higher in the experimental groups, and the presence of effectiveness was established by substantiating the statistical hypothesis and proving the effectiveness of the final knowledge. The development level of students' urological diagnostic and treatment skills was found to be 14.8% higher by the analytical criterion, 13.6% by the comparison criterion, 14.7% by the reflexive thinking criterion, and 14% higher overall.

From this, it became clear that the development level of urological diagnostic and treatment skills in students of the experimental group is higher than that of the control group. Therefore, the results obtained regarding the development level of urological diagnostic and treatment skills in the students of the experimental groups are effective.

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