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BIOSTATISTICAL EVALUATION OF THE EFFECTIVENESS OF PERSONALIZED LEARNING SYSTEMS IN TEACHING "INFORMATION TECHNOLOGIES" IN MEDICAL HIGHER EDUCATION INSTITUTIONS

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Abstract This study investigates the effectiveness of personalized electronic learning systems in teaching the "Information Technologies in Medicine" course to first-year pharmacy students at a medical higher education institution. The results of the pedagogical experiment were evaluated within the Microsoft Excel environment using biostatistical methods, specifically analysis of variance and Student's t-test. The empirical findings demonstrated that the academic performance of students in the experimental group, who were taught via the personalized e-system, was statistically significantly higher ($p < 0.05$) compared to the control group taught through traditional methods.

Keywords: medical informatics, personalized learning, biostatistics, Student's t-test, Microsoft Excel, digital medicine, pedagogical assessment.

INTRODUCTION

The rapid digitization of the modern healthcare system places a significant responsibility on future physicians and pharmacists, requiring them not only to acquire clinical knowledge but also to possess a high level of proficiency in managing medical data and information technologies (ICT). The integration of Hospital Information Systems (HIS), Electronic Health Records (EHR), and artificial intelligence components into clinical practice necessitates a fundamental reform in the quality of teaching "Information Technologies in Medicine" at medical universities.

However, the traditional group-based instructional methodology fails to fully account for each student's baseline IT literacy, cognitive processing speed, and individual learning trajectories. This limitation induces a sharp stratification within student cohorts, particularly when first-year students encounter complex practical skills such as the statistical analysis of medical data—for instance, calculating clinical parameters and variables using Microsoft Excel.

As a contemporary solution to this challenge, the integration of Personalized Learning Systems (PLS) has been increasingly advocated. These adaptive digital environments dynamically align with the student's individual progress, progressively calibrating the complexity of practical tasks, laboratory assignments, and methodological guidance based on real-time performance.

The objective of this study: To evaluate and empirically validate the effectiveness of a personalized electronic learning system in teaching the biostatistics module of the "Information Technologies" course in a medical university using pedagogical experimentation and objective mathematical-statistical methods (Student's t-test).

METHODS

A combination of a controlled pedagogical experiment and biostatistical analysis was deployed in this study. The experimental trial was conducted among first-year undergraduate students majoring in Pharmacy.

1. Experimental Design

A sample size of 50 students was recruited and randomly assigned into two parallel groups:

- **Control Group ($n_1 = 25$):** Attended standard sessions conducted via traditional methodologies, consisting of conventional lectures and uniform laboratory tasks.
- **Experimental Group ($n_2 = 25$):** Engaged in sessions supported by a personalized electronic learning platform that adaptively calibrated tasks based on individual mastery levels.

The core subject of the experiment was the instructional module: *"Biostatistical Calculations in Microsoft Excel (Descriptive statistics, variance analysis, correlation, and t-tests)"*. Objective baseline (pre-test) and final (post-test) assessments were administered to both groups using a 100-point scale comprising theoretical tests and practical laboratory assignments.

2. Biostatistical Analysis Methodology

To evaluate the statistical reliability of the collected data, **Microsoft Excel**—the most pragmatic and widely accessible tool in medical and pharmaceutical academic settings—was utilized along with its *"Data Analysis"* toolpak.

To compare the mean scores between the two independent samples (control and experimental groups), a **two-sample Student's t-test assuming unequal variances** was conducted.

The calculations were executed based on the following mathematical formula:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

Where:

- $\bar{X}_1$ and $\bar{X}_2$ represent the sample mean scores of the respective groups;
- S_1^2 and S_2^2 signify the sample variances;
- n_1 and n_2 denote the number of observations per group ($n_1 = n_2 = 25$).

The level of statistical significance for the pedagogical evaluation was established at a standard threshold of $\alpha = 0.05$ ($p < 0.05$).

RESULTS

Prior to the commencement of the educational intervention, a baseline assessment was administered. The pre-test results indicated no statistically significant difference between the control group ($\bar{X} = 66.4$ points) and the experimental group ($\bar{X} = 65.8$ points) with $p > 0.05$, confirming that both cohorts possessed homogenous baseline ICT literacy.

Upon completion of the academic module, the post-test results revealed a positive upward trend in both groups, with a remarkably higher growth trajectory observed within the experimental group. The biostatistical analysis report generated in Microsoft Excel comparing the final post-test scores of the two groups is summarized in Table 1.

Table 1. Student's t-test analysis of the post-test academic performance between groups (Excel output)

Statistical Parameter	Control Group	Experimental Group
Mean ($\bar{X}$)	**74.32**	**85.16**
Variance (S^2)	54.22	38.64
Observations (n)	25	25
Hypothesized Mean Difference	0	
Degrees of Freedom (df)	47	
t Stat (t_{emp})	**-5.63**	
P(T $\le$ t) two-tail (p-value)	**0.00000084**	
t Critical two-tail	**2.011**	

As illustrated by the empirical data, the post-test mean score of the experimental group reached **85.16** points, demonstrating a substantial advancement over the control group's mean score of **74.32** points.

The mathematical-statistical processing indicates that the absolute empirical value of the calculated Student's t-test ($|t_{emp}| = 5.63$) significantly exceeds its corresponding tabulated critical value ($t_{crit} = 2.011$). Concurrently, the calculated probability value ($p = 0.00000084$) is drastically lower than the predefined significance criterion $\alpha = 0.05$ ($p < 0.05$).

DISCUSSION

The obtained biostatistical metrics confirm that the divergence in academic performance between the experimental and control groups is not random or accidental. Instead, it represents a statistically rigorous regularity directly attributable to the implementation of the personalized digital learning platform.

In the control group, which received traditional instruction, the higher sample variance ($S^2 = 54.22$) indicates a persistent and strong academic stratification within the classroom. This implies that students who initially struggled with medical computing concepts remained alienated from the core learning pace. Conversely, the significantly lower variance observed in the experimental group ($S^2 = 38.64$) highlights that the personalized electronic system succeeded in narrowing the performance gap. It achieved this by auto-generating targeted visual materials, differential hints, and flexible practice quizzes tailored specifically for lower-performing students, thereby elevating their competencies toward the cohort average.

In medical and pharmaceutical curricula, teaching ICT purely through abstract lectures is inherently ineffective. Future professionals must seamlessly navigate software applications to calculate clinical standard deviations, variance parameters, and correlations. The personalized interactive platform bridges this gap by highlighting algorithmic errors in real-time, structurally reinforcing the student's practical computing competencies.

CONCLUSION

1. The deployment of personalized electronic learning systems in teaching "Information Technologies in Medicine" significantly optimizes the mastery of practical data-processing skills among first-year students.

2. Biostatistical analysis executed via Microsoft Excel verified that the mean academic performance score in the experimental group surged by 10.84 points, a result that is highly reliable and statistically sound under the condition $p < 0.05$.

3. To expand the digital learning ecosystem and bolster the biostatistical literacy of medical students, it is highly recommended to integrate adaptive, personalized IT platforms across all practical modules of the medical informatics curriculum.

REFERENCES

1. Decree of the President of the Republic of Uzbekistan dated October 5, 2020, No. UP-6079 "On Approval of the Strategy 'Digital Uzbekistan — 2030' and Measures for its Effective Implementation."

2. Ganiyev, A. K. (2022). *Innovative Approaches to Textbooks in Medical Informatics and Biostatistics*. Tashkent: Medicine Publishing.

3. Sullivan, G. M., & Feinn, R. (2012). Using Effect Size—or Why the P Value Is Not Enough. *Journal of Graduate Medical Education*, 4(3), 279-282.

4. OpenStax, *Introductory Statistics*. OpenStax CNX. (2021).

5. Kurbonovich, T. B. et al. (2025). Digital Technologies in Medicine. Telemedicine. *IMRAS*, 8(12), 39-41.

6. Kurbonovich, T. B. et al. (2026). Problems in Modern Culture: Socio-Spiritual Analysis in the Context of Globalization and Digital Transformation. *Global Science Review*, 18(1), 183-188.

7. Panji o‘g‘li, C. O. et al. (2026). Regenerative Properties and Modern Histological Analysis of Connective Tissue in the Morphofunctional System of the Organism. *American Journal of Applied Medical Science*, 4(2), 230-235.

8. Turdimuratov, B. K. (2022). *Teaching Medical Sciences Using Innovative Methods and ICT*. Tashkent: Uzbekistan Medical Publishing House.

9. Kurbonovich, T. B., & Bahodirovich, B. B. (2026). Step-by-step acquisition of practical skills in studying information technologies in medicine. *Global Science Review*, 17(1), 203–209.

10. Kurbonovich, T. B., & Nurhayat, M. (2026). Compilation and steps of the medical situational issues algorithm. *American Journal of Applied Medical Science*, 4(2), 59–63.

11. Turdimurodov, B. K., et al. The essence of electronic textbooks in medical education. *European Journal of Humanities and Educational Advancements*, 3(4), 48–50.

12. Kurbonovich T. B. et al. USE OF ICT AND SOFTWARE IN TEACHING PRACTICAL MEDICAL EXERCISES //AMERICAN JOURNAL OF APPLIED MEDICAL SCIENCE. – 2025. – Т. 3. – №. 11. – С. 1-6.