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Mathematisch-statistische Analyse der Ergebnisse von pädagogischen Experimenten in medizinischen Hochschulen

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Zusammenfassung: Die pädagogische experimentelle Arbeit an Hochschulen mit dem Schwerpunkt Medizin besteht darin, den Kenntnisstand der Studierenden in den Fächern der biologischen Chemie durch die Stärkung der Zusammenarbeit medizinischer Einrichtungen zu überprüfen. Als experimentelle Methoden zur Umsetzung dieses Ziels wurden mehrere pädagogische Methoden verwendet und die Organisation experimenteller Arbeit. Es ist wichtig, pädagogische Forschungsarbeiten auf den Unterrichtsprozess anzuwenden und ihre Wirksamkeit zu bestimmen und die Ergebnisse mathematisch und statistisch zu analysieren**.**
Schlüsselwörter: klinisch-biologische Chemie, innovative Technologie, pädagogische Technologie, Varianz von Stichproben, Standardfehler der Varianz, Variationskoeffizienten, Konfidenzintervalle, Effizienzkoeffizient.

MATHEMATICAL-STATISTICAL ANALYSIS OF THE RESULTS OF PEDAGOGICAL EXPERIMENT-TESTS IN HIGHER EDUCATION INSTITUTIONS SPECIALIZING IN MEDICINE

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Abstract: Pedagogical experimental work in higher education institutions specializing in medicine consists in testing the level of students' mastery of the subjects of biological chemistry by strengthening the cooperation of medical institutions.Several pedagogical methods were used as experimental methods for the implementation of this goal and the organization of experimental work.It is important to apply pedagogical research works to the teaching process and to determine their effectiveness and to analyze the results mathematically and statistically.

Keywords: clinical biological chemistry, innovative technology, pedagogical technology, variance of samples, standard error of variance, coefficients of variation, confidence intervals, coefficient of efficiency.

Introduction. In the Republic of Uzbekistan, doctors are given great benefits for the health of the population.Therefore, it is necessary to recruit educated, spiritual and Uzbek-minded young people into the student body, equip them with knowledge and bring them to the level of qualified doctors.In doing this, the service of teachers of clinical biochemistry is great.For this, the teacher should be a well-formed

specialist in clinical biochemistry.It is necessary to know the psychology of students in addition to biological chemistry, biochemical knowledge and practical methods.He must perfectly master the methods of implementation of all stages of advance education.He should learn the didactic foundations of the subject he teaches, take into account the general methods of imparting knowledge and the behavior of students, and convey knowledge based on his life experience.

Analysis of literature on the topic (Literature review). Until the middle of the 20th century, the theoretical basis of medicine was mainly formed by morphological and physiological sciences.Now biochemistry, more precisely, clinical biochemistry (human biochemistry) has been added to these.It includes all areas of general biochemistry, but the part of them related to human health and diseases.As long as this is the case, clinical biochemistry studies the molecular basis of how a healthy human body develops and performs its functions, molecular mechanisms of diseases, biochemical methods of diagnosis and treatment (clinical biochemistry).

Many biochemists who have their own direction in the field of this science in higher educational institutions:Tashkent Medical Academies Professor R.A. Sobirova, O.A. Abrorov, F.Kh. Inoyatova, A.N. Aripov,Tashkent State Pedagogical University named after Nizomi, professor P. Mirkhamidova and associate professor N. Kamalova,from the National University of UzbekistanProfessor S. N. Dalimova, associate professor, G. B. Umarova are working on these theme.

Nowadays, obtaining a satisfactory knowledge of biochemistry requires regular study and practical training based on a certain program, as well as the creation of modern innovative pedagogical technologies, and therefore new achievements of clinical biochemistry and scientific research incorporating innovative pedagogical technologies place is very big.

Research Methodology. Clinical biochemistry, which is one of the fields forming the theoretical basis of the complex of medical sciences, is important for students of medical and pharmaceutical institutes.

Nowadays, obtaining a satisfactory knowledge of biochemistry requires regular study and practical training based on a certain program, as well as the creation of modern innovative pedagogical technologies, therefore, the role of research works incorporating new achievements of clinical biochemistry and innovative pedagogical technologies is very important.

Therefore, the place and role of modern teaching methods, interactive methods, and innovative technologies in training qualified professionals in higher educational institutions and faculties is extremely important.Knowledge, experience and interactive methods of pedagogic technology and pedagogic skills ensure that pupils-students have an educated, mature qualification.

Innovative technologies are innovations and changes in the pedagogical process and teacher's and student's activities, and in its implementation mainly

interactive methods are fully used.Interactive methods are called group thinking, that is, they are methods of pedagogical influence and are a component of educational content.The uniqueness of these methods is that they are implemented only through the joint activity of pedagogues and students.Such a process of pedagogical cooperation has its own characteristics, which include:

-Force the student not to be indifferent during the lesson, think independently, create and search;

-Ensuring that pupils-students are constantly interested in knowledge during the educational process;

-Enhancing the student's interest in knowledge by independently approaching each issue creatively;

-The organization of the activity of the teacher and the student in cooperation.

Nowadays, improving the quality and efficiency of education is one of the most important tasks facing pedagogical personnel.To increase the quality and efficiency of education, it is required that teachers have good knowledge of their subject, as well as thorough mastering of computer technologies.

Description of methods. Pedagogical experimental work in higher education organizations specializing in medicine includes:It was conducted as an example of teaching "Biological chemistry" with students of Andijan State Medical Institute, Samarkand State Medical Institute and Fergana Public Health Medical Institute.

Pedagogical experiment - selected for testing Experiment - before testing, the knowledge level of students of the experimental and control groups was determined.All students of the groups were tested on the basis of oral question-and-answer and 25 test questions in the field of biological chemistry.
The results in the groups were as follows.

Table 1

O/N	Educational institutions	Groups	Number of students	Answers to oral questions		Those who answered the test questions	
				In number	In percent	In number	In percent
1.	Andijan State Medical Institute (ASMI)	Experimental group	58	31	53,4%	28	48,3%
		Control group	60	32	53,3%	29	48,3%
2.	Samarkand State Medical Institute (SamSMI	Experimental group	60	31	51,7%	30	50,0%
		Control group	61	33	54,1%	31	50,8%

	)						
3.	Fergana Public Health Medical Institute (FPHMI)	Experimental group	63	35	55,6%	32	50,8%
		Control group	62	34	54,8%	32	51,6%
4.	Total	Experimental group	181	97	53,6%	90	49,7%
		Control group	183	99	54,1%	92	50,3%

According to the initial results of the group of treatment work, the percentage of oral question answer is 53.6%, 54.1% in the control groups, test answer percents were 49.7% in the experimental groups, and 50.3% in the control groups (Figure 1).

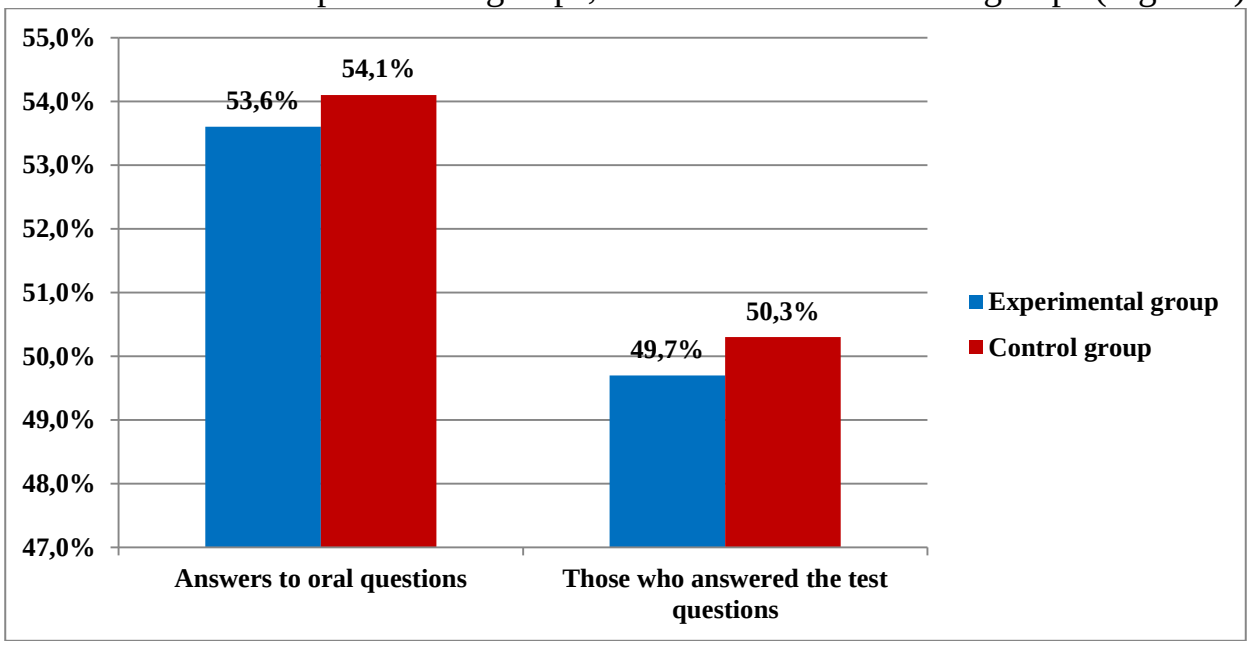

Figure 1. Students' mastery of oral and test questions

It can be seen from the obtained data that the level of mutual knowledge of the groups is almost close to each other. Therefore, it is possible to conduct pedagogical experiments in selected groups.

The level of students' knowledge and mastery of topics was initially determined through problem questions. Then a pedagogical experiment was conducted using computer technologies.Since they were selected as a control group, they were taught in the traditional way.Due to the fact that the educational field of treatment was chosen as an experimental group, they were taught through methodological developments prepared using computer technology programs.

The statistical analysis of the obtained results was checked by the χ^2 criterion. In order to check the correctness of these results and determine their effectiveness, a X^2 method was used in mathematical statistics methods.In this case, we analyzed the levels of development of the results obtained at the beginning of the experiment and at the end of the experiment using Pearson's χ^2 mathematical-statistical method.

In this case, as a hypothesis N_0, the expected probabilities for the types of evaluations at both stages are equal ($r_{11}=r_{21,}$ $r_{12}=r_{22}$, … $r_{1s}=r_{2s}$)as an alternative hypothesis N_1 ($r_{11}=r_{21,}$ $r_{12}=r_{22}$, … $r_{1s}=r_{2s}$) taken. A criterion was used to test this statistical hypothesis. That is,

$$\chi^2_{\text{observation}} = \frac{1}{n_1 n_2} \sum_{i=1}^{C} \frac{(n_1 O_{2i} - n_2 O_{1i})^2}{O_{1i} + O_{2i}}$$

we use the formula. Here, χ^2 the statistical value, N_1 and N_2, is the number of students in the groups that participated in the results of the experiment, N_1 is the number of students in the experimental group, N_2 is the number of students in the control group, O_{1i} and O_{2i} are, respectively, the number of grades obtained compared to the experimental group and the control group.

The value is comparable to χ^2_{kr}. If $\chi^2_{observation} > \chi^2_{kr}$, hypothesis N_0 is rejected and hypothesis N_1 is accepted.

Here χ^2_{kr} is the normalized deviation confidence probability *p*. The degree of freedom is found by the formula $\nu = S - 1$, types of S-estimation.

We introduce hypotheses N_0 and N_1 as follows:

N_0: the experimental group and the control group do not differ significantly in the statistical value of the obtained results of the students.

N_1: the experimental group and control group students' results are significantly different.

Since the development of the concept of self-development in experimental tests is evaluated at excellent, good, satisfactory and unsatisfactory levels, the number of evaluation types is equal to 4, i.e. if we take $C = 4$, $\alpha = 0.05$, $n=4–1=3$, which is equal to $kr = 7.81$ obtained on the basis of table G of the χ^2 criterion.

We also use formulas for finding confidence intervals to determine the efficiency of the evaluation. That is, the confidence interval of the experimental group is the confidence deviation.

$$\Delta_x = t_\gamma \cdot \frac{S_x}{\sqrt{n}}$$

equal to, and in the control group:

$$\Delta_y = t_\gamma \cdot \frac{S_y}{\sqrt{n}}$$

is equal. Here ty is the critical value, and its critical value is equal to 1.96. sx sy is the sample variance, and it is found by the following formula.

$$S_x = \sum_{i=3}^{n=3} \frac{n_i (x_i - x)^2}{m-1} \quad , \quad S_y = \sum_{i=3}^{n=3} \frac{n_i (y_i - y)^2}{n-1}$$

From the results found, the confidence interval at the end of the experiment:

$$\overline{X} - t_{kr} \cdot \frac{S_x}{\sqrt{n}} \le a_x \le \overline{X} + t_{kr} \cdot \frac{S_x}{\sqrt{n}}$$

Confidence interval at the beginning of the experiment:

$$\overline{Y} - t_{kr} \cdot \frac{S_y}{\sqrt{n}} \le a_y \le \overline{Y} + t_{kr} \cdot \frac{S_y}{\sqrt{n}}$$ is calculated through formulas.

Confidence interval limit values overlap or intersect with each other, making the results unreliable.Therefore, it is necessary to assume that the confidence intervals in each group do not intersect with each other.

In order to determine the effectiveness of experimental tests, the efficiency coefficient is determined. This coefficient is the quality of the ratio of the average values of the experimental group and the control group. $\eta = \frac{\overline{X}}{\overline{Y}}$

On the basis of these formulas, we present statistical calculations of the results obtained at the various stages mentioned above.

Statistical analysis of the results obtained on the basis of students' learning indicators in the 2019-2020 academic year

Table 2

o/n	Educational institutions	Groups	Average grade	Efficiency	X^2	Critical value	Selection variance	Standard error	Confidenceint erval		The conclusion
1.	Andijan State Medical Institute	Experimental group	3,29	1,00	0,16	7,81	0,44	0,67	3,12	3,46	N_0
		Control group	3,28						3,11	3,45	

	(ASMI)										
2.	**Samarkand State Medical Institute (SamSMI)**	**Experimental group**	**3,28**	**1,00**	**0,13**	**7,81**	**0,44**	**0,66**	**3,12**	**3,45**	**N_0**
		Control group	**3,30**						**3,13**	**3,46**	
3.	**Fergana Public Health Medical Institute (FPHMI)**	**Experimental group**	**3,32**	**1,00**	**0,13**	**7,81**	**0,47**	**0,68**	**3,15**	**3,49**	**N_0**
		Control group	**3,31**						**3,14**	**3,48**	
4.	**Total**	**Experimental group**	**3,30**	**1,00**	**0,05**	**7,81**	**0,45**	**0,67**	**3,20**	**3,40**	**N_0**
		Control group	**3,30**						**3,20**	**3,39**	

According to the results of the experience acquisition levels and the values of the statistical calculation table, there is no reason to reject the null hypothesis because $\chi^2_{observation} < \chi^2_{kr} = 7.81$, and the null hypothesis is accepted.At the initial stage of the experiment, when the results of the experimental and control groups are compared with each other, the equality of students means that there is no effect at the initial stage, the level of knowledge of the selected groups is the same.

Statistical analysis of the results obtained on the basis of students' learning indicators in the 2020-2021 academic year

Table 3

o/n	**Educational institutions**	**Groups**	**Average grade**	**Efficiency**	**X^2**	**Critical value**	**Selection variance**	**Standard error**	**Confidenceint erval**		**The conclusion**
1.	**Andijan State Medical Institute (ASMI)**	**Experimental group**	**3,88**	**1,12**	**9,40**	**7,81**	**0,48**	**0,69**	**3,71**	**4,06**	**N_1**
		Control group	**3,47**						**3,30**	**3,65**	
2.	**Samarkand State Medical Institute (SamSMI)**	**Experimental group**	**3,87**	**1,13**	**10,02**	**7,81**	**0,49**	**0,70**	**3,69**	**4,04**	**N_1**
		Control group	**3,43**						**3,26**	**3,61**	
3.	**Fergana Public**	**Experimental group**	**3,82**	**1,12**	**7,97**	**7,81**	**0,52**	**0,72**	**3,63**	**4,00**	**N_1**

	Health Medical Institute (FPHMI)	**Control group**	**3,40**						**3,22**	**3,58**	
4.	**Total**	**Experimental group**	**3,86**	**1,12**	**27,20**	**7,81**	**0,50**	**0,70**	**3,75**	**3,96**	**N_1**
		Control group	**3,44**						**3,33**	**3,54**	

According to the calculation of mastery levels and the values of the statistical table of experimental test works in the 2020-2021 academic year, the null hypothesis is rejected because $\chi^2_{observation} > \chi^2_{kr} = 7.81$, and the first hypothesis is accepted.In the 2020-2021 academic year of the experiment, when comparing the results of the experimental and control groups with each other, the effectiveness increased by 1.12 times (on average 12%), the confidence interval did not overlap (intersect) with each other, in the obtained results of the conducted research leads to the acceptance of hypothesis N1 that there is a difference.

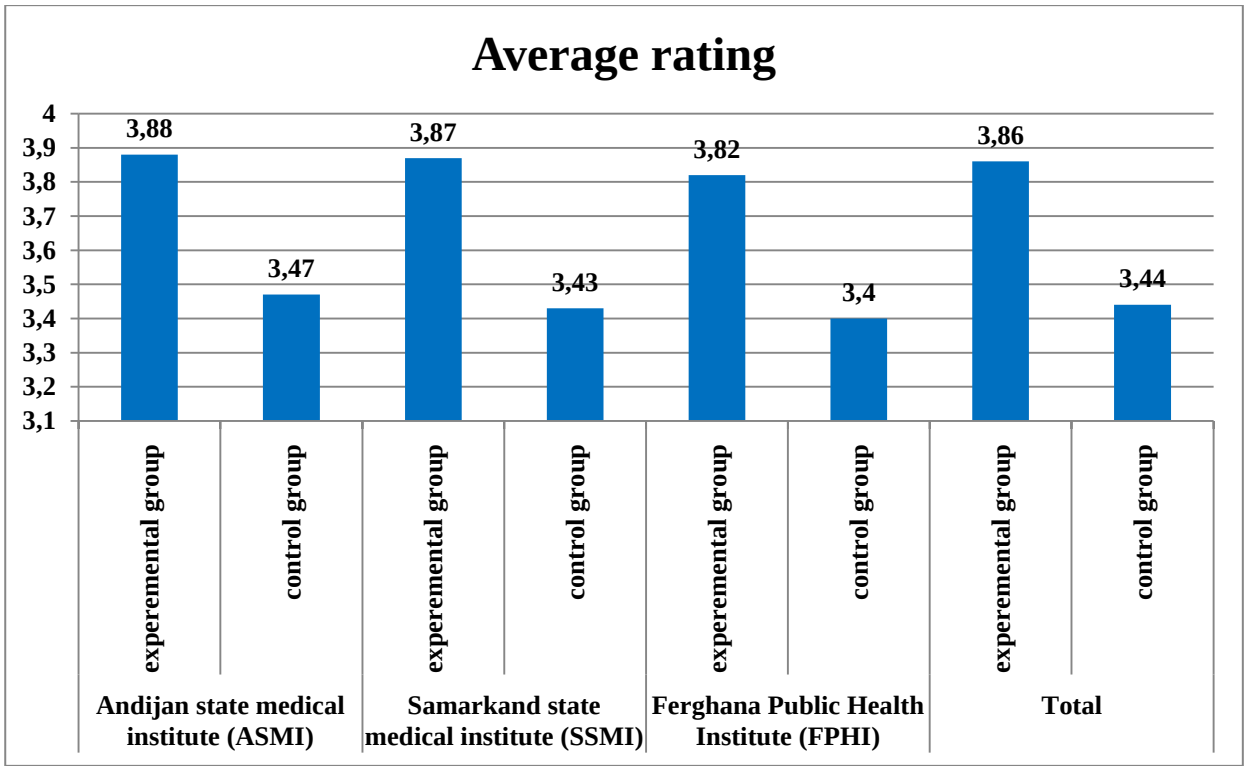

Figure 2. Average learning indicators in the 2020-2021 academic year

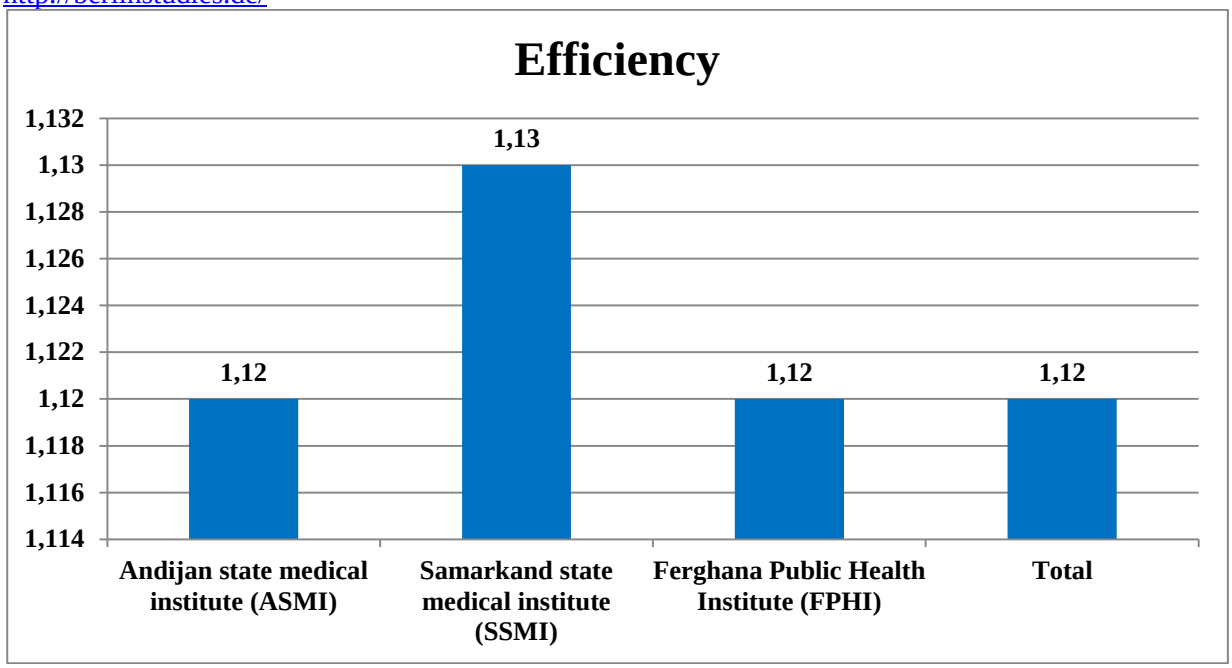

Figure 3. Performance indicators in the 2020-2021 academic year

Statistical analysis of the results obtained on the basis of students' learning indicators in the 2021-2022 academic year

Table 4

o/n	Educational institutions	Groups	Average grade	Efficiency	X^2	Critical value	Selection variance	Standard error	Confidenceint erval		The conclusion
1	Andijan State Medical Institute (ASMI)	Experimental group	3,98	1,15	15,22	7,81	0,48	0,69	3,81	4,16	N_1
		Control group	3,48						3,31	3,65	
2	Samarkand State Medical Institute (SamSMI)	Experimental group	4,00	1,15	16,81	7,81	0,42	0,65	3,84	4,16	N_1
		Control group	3,49						3,33	3,66	
3	Fergana Public Health	Experimental group	3,98	1,14	15,24	7,81	0,45	0,67	3,82	4,15	N_1
		Control group	3,48						3,31	3,65	

	Medical Institute (FPHMI)										
4	**Total**	**Experimental group**	**3,99**	**1,15**	**47,12**	**7,81**	**0,45**	**0,67**	**3,89**	**4,09**	**N_1**
		Control group	**3,48**						**3,39**	**3,58**	

According to the calculation of mastery levels and the values of the statistical calculation table of the experimental test work in the 2021-2022 academic year, the null hypothesis is rejected, the first hypothesis is accepted, because the general results obtained in the context of $\chi^2_{observation} > \chi^2_{kr} = 7.81$. In the 2021-2021 academic year of the experiment, when comparing the results of the experimental and control groups with each other, the efficiency increased by 1.15 times (on average 15%), the confidence interval did not overlap (intersect) with each other, in the obtained results of the conducted research leads to the acceptance of hypothesis N_1 that there is a difference.

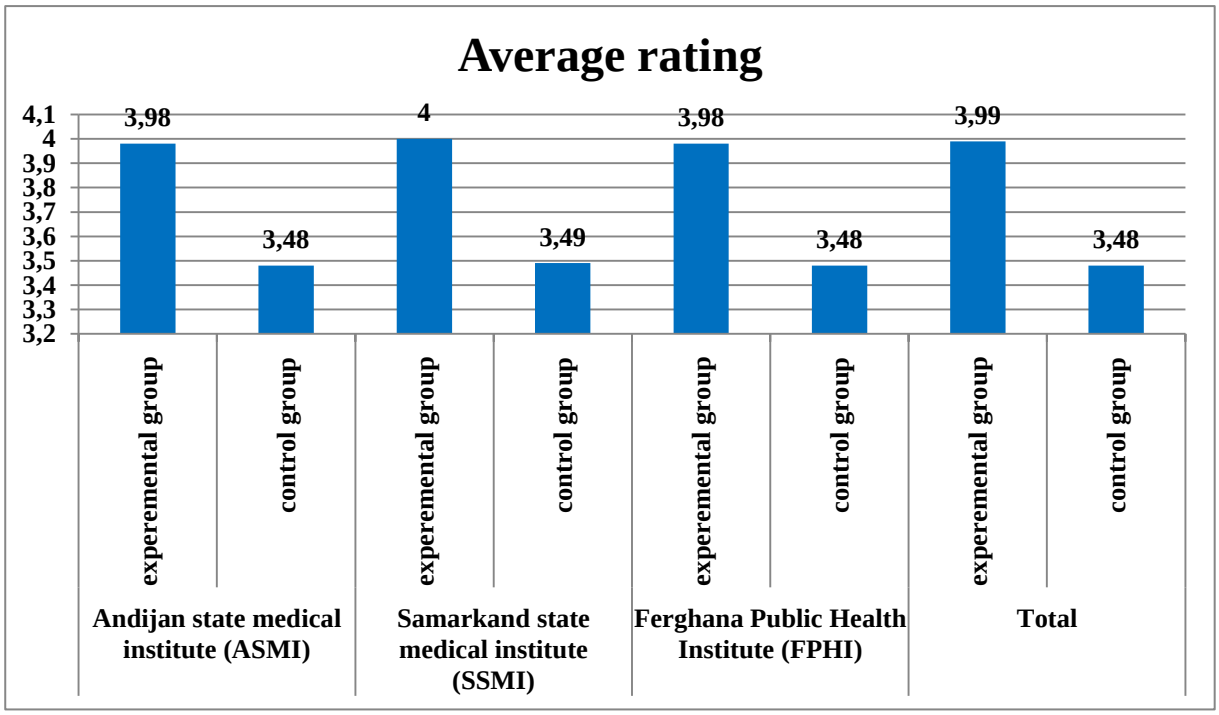

Figure 4. Average learning indicators in the 2021-2022 academic year

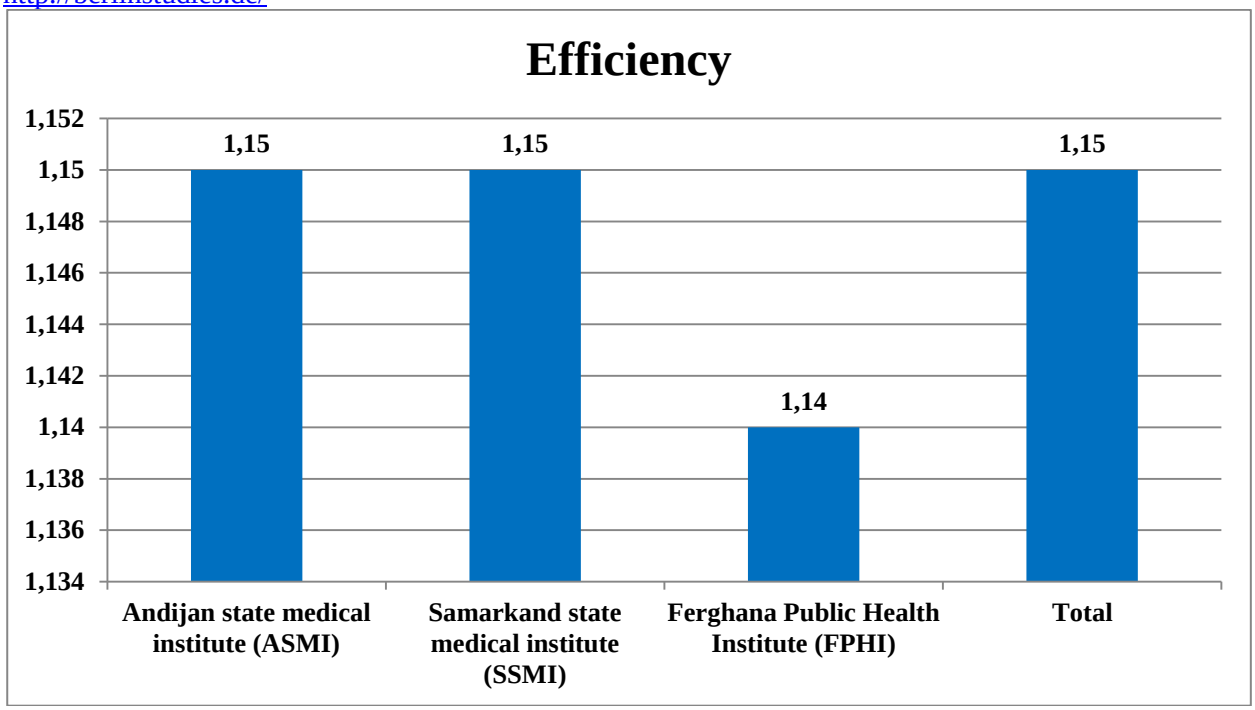

Figure 5. Performance indicators in the 2021-2022 academic year

After the experiment, the results of the groups were compared.It can be seen that the mastery rate between the control and experimental groups differs by 15% on average.

In conclusion, the use of innovative pedagogical technologies and computer technologies in the course of the lesson makes it easier to master the topics of biological chemistry in medical institutions, and it makes the work of professors and teachers easier.In the research work, appropriate research was conducted using computer technologies in medical higher education organizations, and their results were directly related to practice.

Discussion.

1. At the end of the pedagogical experiment, it was found that there is a statistical difference in the study of the results of the use of innovative technologies in the theoretical knowledge, practical skills and qualifications of the students in the test groups.The results obtained after the experiment were proven to be higher in the experimental group and the effectiveness was 15% higher on the basis of mathematical and statistical methods.
2. The accepted research hypothesis on improving the methodical support of teaching biological chemistry subjects to students based on innovative technologies through mathematical-statistical processing of pedagogical experiment-test results was fully confirmed.

Conclusion

In conclusion, the use of innovative pedagogical technologies and computer technologies in the course of the lesson makes it easier to master the topics of biological chemistry in medical institutions, and it makes the work of professors and teachers easier.In the research work, appropriate research was conducted using

computer technologies in medical higher education organizations, and their results were directly related to practice.

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