

Mathematical statistical analysis of attainment levels of primary left handed students based on pearson's conformity criteria

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Abstract. Quantitative changes in improving the effectiveness of teaching writing and developing the skills of elementary school students were summarized in the assessment of teaching effectiveness using Student and Pearson methods. Using the χ^2 Pearson test, which is often used in statistical research, we introduce the research hypotheses of the second, third and final stages of the control and experimental class participants with the indicators of the first stage. At the end of the experimental work, it was proven that the respondent's knowledge indicators increased by 13.8% on average.

1 Introduction

The main goal of creating a methodical basis for teaching writing to left-hand writing students of primary grade is aimed at increase the efficiency and quality of education. What are the most effective ways of teaching left-hand writing students to write in primary education, and when and under what conditions will produce the desired pedagogical results? To find an answer to this question, first of all, it is necessary to separate the left-handed students from the general students, to create a unique and suitable environment for them, to provide them with methodologically and physiologically correct workplaces and writing tools so that they can learn to write well.

Creating a methodical basis for teaching writing to left-hand writing students of primary grade is a very complex and painstaking work process. The difficulty of this work is closely related to the fact that almost no serious work has been done in this regard in Uzbekistan. The first experience will certainly be challenging. Therefore, at the initial stage of our experiment - test work, we tried to determine the number of left-handed students in the experimental objects [1].

Experimental studies play an important role in all fields of science. Mathematical statistics are used in the analysis of many theoretically obtained results based on available empirical materials. Pedagogical research uses certain hypotheses and the results of theoretical research [2]. Because the absence of generally accepted axiomatics does not allow correct reasoning.

Statistical tests are important in analyzing the results of scientific and pedagogical research and evaluating their effectiveness. It should not be forgotten that the tests used in

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the study are affected by the comments related to the results of the study. The main problem is not pedagogical theory, but the variability of research results [3]. The data selection and decision-making process do not affect the analysis performed [3]. In addition to statistical tests and hypotheses, data analysis is also important in evaluating the effectiveness of the educational process, and in some cases, statistical methods are not required in the process of data analysis and processing. The article describes definitions in this field and their use in the educational process.

2 The main part

It is a very complicated and laborious work process to create a systematic basis for teaching left-hand writing students of primary grade to write. The difficulty of this work is closely related to the fact that almost no serious work has been done in this regard in Uzbekistan. The first experience will certainly be challenging. Therefore, at the initial stage of our experiment - test work, we tried to determine the number of left-handed students in the experimental objects.

The content of experimental work aimed at determining the methodical basis of teaching writing to left-hand writing students of the primary grade was revealed through statistical analysis. During the years 2017-2020, experimental and testing works were carried out in the 19th, 34th and 35th zones in the city of Bukhara, Bukhara region, the 1st, 52nd in the Shofirkon district, the 11th in the Peshku district, the 41st in the Romitan district, the 6th, 19th in the Nurota district of the Navoi region. -, was held in the 8th, 19th, 2nd, 5th, Karmana district, 9th, 30th and 31st general secondary schools in the Mubarak district of the Kashkadarya region. Model lessons were organized using modern pedagogical technologies and methodical recommendations were presented [4].

The smaller the gap between the goal set in the educational process and the achieved result, the more effective the education is.

Quality indicators of efficiency are determined according to the acquisition of knowledge and methods of activity. Quantitative indicators are determined according to the goal of education and the difference between the knowledge, skills, and qualifications achieved by students. Improving the effectiveness of teaching writing to left-hand writing students of the primary grade was tested in the following areas: proper organization of the workplace (one left-hand writing student uses a designated desk, sits by a window, sits on the left side of the desk, sit a left-handed student at the same desk as a left-handed student, sit at the desk sitting and placing educational materials correctly on the desk), using educational tools specially designed for left-handed writing (using a left-handed writing pen, a notebook and various writing devices).

The main experimental work was conducted in two academic years: 2018-2019 and 2019-2020 academic years.

The purpose of the initial stage of the research is to conduct experiments to determine the number of left-handed students in the elementary grades of general education schools within the framework of the study and to determine the percentage of left-handed students compared to the total number of students. was marked as In the experimental work in this process, with the help of the class leaders, we tried to determine the left-handedness of the students in the experimental classes using the left-handedness tests created by the Russian Methodist scientists M.G. Knyazeva [1] and V.Y. Wildavsky [1]. In order not to be confused with the calculation, the following protocol was drawn up [3]:

It was determined that there is the following number of left-handed students in the primary classes of the schools we selected for the experiment. A schedule of tasks was developed for the student's (table 1).

Table 1. Table of assignments for students.

Assignment	Left hand writing	Ten handwriting	Written in both hands
1.	+		
2.		+	
3.			+
and other assignments			

3 Mathematical and statistical analysis of results obtained from pedagogical experiments

The effectiveness of the proposed methodology in pedagogical research was shown by comparing the indicators recorded at the end of the experimental work. According to the ideas put forward in the mathematical-statistical methods of reanalysis of the results, repeated analysis was evaluated by determining the difference between the indicators of the control and experimental classes of students participating in the experiment at the final stage of the experiment. Table 2.

Table 2. The number of students involved in experimental work.

Provinces and districts	General education school number	Number of left-handed students in the experimental class	Left-handed students in the control class
Romitan District, Bukhara Region	41-school	17	16
	30-school	21	20
Shafirkon district, Bukhara region	1- school	18	17
	52-school	12	12
Bukhara City	19-school	20	19
	35-school	32	31
	34-school	14	14
Peshku District, Bukhara Region	11-school	16	16
Mubarak District, Kashkadarya Region	9-school	14	14
	30-school	11	11
	31-school	15	15
Nurota District, Navoi Region	6-school	17	17
	19-school	16	16
	2-school	18	18
Navoi district, Karmana district	5-school	20	19
Navoi city	8-school	19	18
	19-school	16	16
Total		296	289

The ability of independent creative work is developed in students who participated in the experimental work on the problem of improving the conditions related to the problem of providing methodical support to left-hand writing students of the primary grade compared to the students of the control class.

The statistical indicators of the scientific and research work carried out in the experimental and control groups are presented in table 3.

4 The results of the students' initial answers

Table 3. The number of students involved in experimental work (across regions).

No	Experiment - test objects	Response status and indicators							
		The total number of experimental group is 296 people				Total number of the control group is 289 people			
		«5» Excellent	«4» is good	«3» is satisfactory	«2» is not satisfied	«5» Excellent	«4» is good	«3» is satisfactory	«2» is not satisfied
1.	Bukhara region	15	19	59	57	12	21	60	52
2.	Kashkadarya region	4	11	10	15	3	9	12	16
3.	Navai region	11	14	36	45	10	11	46	37
	Total	30	44	105	117	25	41	118	105

The chart corresponding to these selections looks like this:

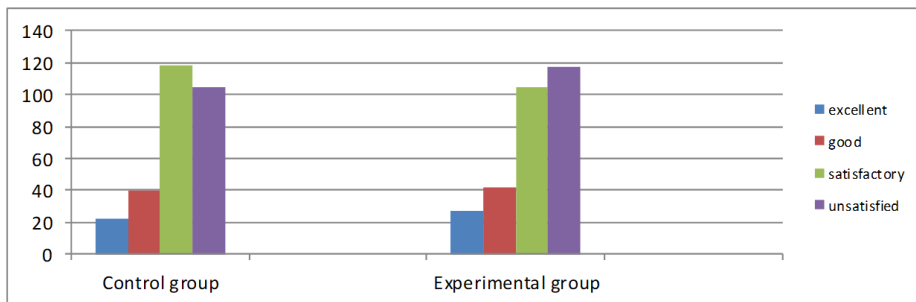


Fig. 1. Representation in a diagram of the knowledge acquired by students in connection with teaching writing to left-hand writing students of primary grade.

As can be seen from the diagram, there is almost no significant difference between the initial mastery rates of the experiment. This, in turn, shows the urgency of the problems posed in scientific-research works.

On the basis of our research work, information on the qualitative and quantitative changes in the improvement of the effectiveness of teaching left-hand writing students of the primary grade to writing and the development of their skills was summarized in table 4.

Table 4. The final distribution of the experimental test indicators was conducted in the process of providing methodical assistance to students with left hand writing who participated in the experimental work.

Experimental group	Experiment - test objects	«5»	«4»	«3»	«2»	Total
	Bukhara region	78	44	21	7	150
Kashkadarya region	16	13	8	3	40	
Navai region	42	38	18	8	106	
Total	136	95	47	18	296	
Control group	Experiment - test objects	5	4	3	2	Total
	Bukhara region	13	55	64	13	145
Kashkadarya region	3	17	16	4	40	
Navai region	10	52	24	18	104	
Total	26	124	104	35	289	

In order to compare the data of the above table, we create the following table. Table 5.

Table 5. Comparison table of the statistical values of experimental tests conducted in the process of providing methodological assistance to students with left hand writing who participated in experimental works.

Stages of experience	The number of students in the experimental group is 296				The number of students in the control group is 289			
	«5»	«4»	«3»	«2»	«5»	«4»	«3»	«2»
At the end of the experiment	136	95	47	18	26	124	104	35
In percentages:	46	32	16	06	9	43	36	12

According to the analysis of the results of the experiment, it was found that the students in the experimental group involved in the research process have developed knowledge, skills and abilities compared to the students in the control group. Statistical analysis is carried out to objectively assess this situation, and only the clarified conclusion confirms that the scientific, pedagogical, technological and methodical experimental work was carried out correctly and efficiently. Student's and Pearson's methods were chosen to perform statistical analysis during the experimental test period. This method can determine and objectively evaluate the indicators recorded in two groups. According to the essence of the mathematical-statistical method, the statistical indicators recorded in the experimental and control groups at the initial stage were selected as «5» (excellent), «4» (good), «3» (satisfactory) and 2 (unsatisfactory) levels. It was necessary to create variation series according to [5].

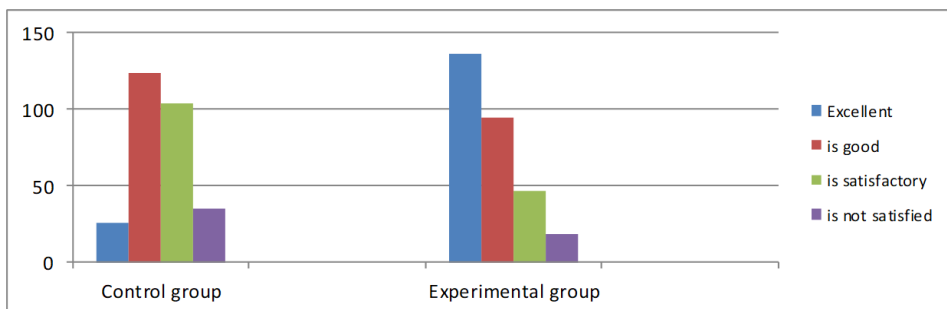


Fig. 2. Diagram of the statistical analysis at the end of the pedagogical experiment-test.

As can be seen from the diagram, the high and medium scores of the experimental

group are higher than those of the control group. Now we will analyze the data of table 6 mathematically and statistically.

We denote the acquisition rates in the experimental and control groups as and, respectively. These are random quantities and can take values such as «5» (excellent), «4» (good), «3» (satisfactory), and «2» (unsatisfactory). n_i and m_i are the numbers of respondents who scored «5», «4», «3» and «2» in the experimental and control groups, respectively.

In addition, X_i and the repetitions of n_i and m_i we define with. The number of students before the experimental work $n=296$, number of students in control groups $m=289$, we count these numbers X_i and Y_i we consider options as appropriate statistical sample sizes. So, from tables 3, we can make the following two variation series: ($n = n_1 + n_2 + n_3 + n_4$ and $m = m_1 + m_2 + m_3 + m_4$):

In addition, we X_i denote the repetitions of n_i and by and m_i . The number of pre-test students is $n=296$, and the number of students in the control groups is $m=289$, and we consider these numbers as statistical sample sizes appropriate X_i for the Y_i options. So, from we can construct the following two variation series: ($n = n_1 + n_2 + n_3 + n_4$ and $m = m_1 + m_2 + m_3 + m_4$):

Performance indicators of the experimental group:

$$(1) \begin{cases} X_i & 5 & 4 & 3 & 2 \\ n_i & 136 & 95 & 47 & 18 \end{cases} \quad n = \sum_{i=1}^4 n_i = 296$$

Control group mastery rates:

$$(2) \begin{cases} Y_j & 5 & 4 & 3 & 2 \\ m_j & 26 & 124 & 104 & 35 \end{cases} \quad m = \sum_{j=1}^4 m_j = 289$$

In order to facilitate the statistical analysis, we calculate n_i and m_j repetitions (frequency) from the above variation series on the basis of appropriate statistical probability

formulas $p_i = \frac{n_i}{n}$ and $q_j = \frac{m_j}{m}$.

$$(3) \begin{cases} X_i & 5 & 4 & 3 & 2 \\ p_i & 0,46 & 0,32 & 0,16 & 0,08 \end{cases} \quad \sum_{i=1}^4 p_i = 1$$

$$(4) \begin{cases} Y_j & 5 & 4 & 3 & 2 \\ q_j & 0,09 & 0,43 & 0,36 & 0,12 \end{cases} \quad \sum_{j=1}^4 q_j = 1$$

We begin the statistical analysis by calculating and comparing the average acquisitions of both groups. Average mastery rates yielded the following results:

$$\bar{X} = \sum_{i=1}^4 p_i X_i = 0,46 \cdot 5 + 0,32 \cdot 4 + 0,16 \cdot 3 + 0,06 \cdot 2 = 4,18$$

In percent $\bar{X}\% = \frac{4,18}{5} \cdot 100\% = 83,6\%$

$$\bar{Y} = \sum_{i=1}^4 q_i Y_i = 0,09 \cdot 5 + 0,43 \cdot 4 + 0,36 \cdot 3 + 0,12 \cdot 2 = 3,49$$

In percent $\bar{Y}\% = \frac{3,49}{5} \cdot 100\% = 69,8\%$.

Hence, the acquisition in the experimental groups is greater than the average acquisition in the control groups $(83,6 - 69,8)\% = 13,8\%$ is higher. And this in turn $\frac{83,6\%}{69,8\%} = 1,19$ means double excess.

So, at the end of the experimental work, the respondent's knowledge indicators increased by 13.8% on average.

Now let's move on to the evaluation of the errors of experimental work. First, we calculate the sample variances:

$$S_X^2 = \sum_{i=1}^4 p_i \cdot X_i^2 - (\bar{X})^2 = 0,46 \cdot 25 + 0,32 \cdot 16 + 0,16 \cdot 9 + 0,06 \cdot 4 - (4,18)^2 = 0,8276$$

Standard error: $S_X = \sqrt{0,8276} = 0,91$.

$$S_Y^2 = \sum_{i=1}^4 p_i \cdot Y_i^2 - (\bar{Y})^2 = 0,09 \cdot 25 + 0,43 \cdot 16 + 0,36 \cdot 9 + 0,12 \cdot 4 - (3,49)^2 = 0,6699$$

Standard error: $S_Y = \sqrt{0,6699} = 0,81$.

We calculate the deviation percentages of these errors with respect to the average values by means of coefficients of variation. In order to make it more clear, we calculate the mean value accuracies for both statistical samples through the coefficients of variation, that is, C_x and C_y we calculate using the formula:

$$C_x = \frac{S_x}{\sqrt{n} \cdot \bar{X}} \cdot 100\% = \frac{0,91 \cdot 100\%}{\sqrt{296} \cdot 4,18} = \frac{91\%}{17,2 \cdot 4,18} = \frac{91\%}{71,896} \approx 1,26\%,$$

$$C_y = \frac{S_y}{\sqrt{m} \cdot \bar{Y}} \cdot 100\% = \frac{0,81 \cdot 100\%}{\sqrt{289} \cdot 3,49} = \frac{81\%}{17,0 \cdot 3,49} = \frac{81\%}{59,33} \approx 1,36\%.$$

Both error rates are well below the 5% margin considered possible. This means that the experimental work has been completed satisfactorily.

hypothesis that the theoretical means of the two statistical samples are equal using Student's test. $H_0 : a_X = a_Y$ For this purpose, we calculate the appropriate statistics:

$$T_{n,m} = \frac{|\bar{X} - \bar{Y}|}{\sqrt{\frac{S_X^2}{n} + \frac{S_Y^2}{m}}} = \frac{|4,18 - 3,49|}{\sqrt{\frac{0,8276}{296} + \frac{0,6699}{289}}} = \frac{0,69}{0,07} \approx 9,85.$$

The 95% critical point $t_{kp}(0,95) = 1,96$ of Student's criterion is the value of the statistic sufficiently greater than: $T_{n,m} = 9,85 > 1,96 = t_{kp}(0,95)$.

So, we H_0 reject the hypothesis, $\bar{X} > \bar{Y}$ and (1) taking into account the relationship $a_x > a_y$, we can conclude that the average mastery of the experimental group will be greater than the mastery of the control group.

Based on the Student's criterion, we calculate the degree of freedom using the following formula:

$$K = \frac{\left(\frac{S_x^2}{n} + \frac{S_y^2}{m}\right)^2}{\frac{\left(\frac{S_x^2}{n}\right)^2}{n-1} + \frac{\left(\frac{S_y^2}{m}\right)^2}{m-1}} = \frac{\left(\frac{0,8276}{296} + \frac{0,6699}{289}\right)^2}{\frac{\left(\frac{0,8276}{296}\right)^2}{295} + \frac{\left(\frac{0,6699}{289}\right)^2}{288}} = \frac{(0,002795 + 0,002318)^2}{\frac{(0,002795)^2}{295} + \frac{(0,002318)^2}{288}} = 579,17$$

The degree of significance of the statistical sign for this probability $\alpha = 0,05$ if we say, then $p=1-\alpha=0,95$ and degrees of freedom $k=579,17$ is equal to. The critical point of the binomial criterion from the Student's function distribution table:

$$T_{1-\frac{(1-p)}{2}}(k) = T_{1-\frac{(1-0,95)}{2}}(579,17) = T_{0,975}(579,17) = 1,96.$$

So, according to the above calculations $T = 9,85 > T_{0,975}(579,17) = 1,96$ for being H_0 therefore, there is no reason to accept the hypothesis H_1 the hypothesis is accepted. It can be seen that our experimental group studies were statistically more effective than the control group studies.

Finally, we X_i and Y_i about equality of distribution laws of statistical samples $K : F_x = F_y$ we use the Pearson test to test the hypothesis:

$$X_{n,m}^2 = \frac{1}{N \cdot M} \cdot \sum_{i=1}^k \frac{(n_i M - m_i N)^2}{n_i + m_i}.$$

For this purpose, we will make the following table (Table 6).

Table 6. Levels of acquisition indicating writing instruction in experimental left-handed learners.

Groups \ Grades	5	4	3	2
Experimental group	136	95	47	18
Control group	26	124	104	35

We calculate the Pearson statistic:

$$X_{n,m}^2 = \frac{1}{296 \cdot 289} \cdot \left(\frac{(136 \cdot 289 - 26 \cdot 296)^2}{136 + 26} + \frac{(95 \cdot 289 - 124 \cdot 296)^2}{95 + 124} + \frac{(47 \cdot 289 - 104 \cdot 296)^2}{47 + 104} + \frac{(18 \cdot 289 - 35 \cdot 296)^2}{18 + 35} \right) \approx 105,43$$

The degree of freedom of the Pearson criterion is 1 less than the number of points: $k=4-1=3$, which is the 95% critical point corresponding to $k=3$ $Z_{kp}(0,95) = 7,82$.

But,

$$X_{n,m}^2 = 105,43 > 7,82 = Z_{k,p}(0,95).$$

Therefore, hypothesis K is also rejected. This is because the difference between teaching methods before and after experimental work is not accidental, but legal, and always leads to an increase in mastery rates [4].

Now we find reliable deviations to determine the performance indicator of the evaluation:

$$\Delta_x = t_\gamma \cdot \frac{S_x}{\sqrt{n}} = 1,96 \cdot \frac{0,91}{\sqrt{296}} = 1,96 \cdot \frac{0,91}{17,2} = \frac{1,7836}{17,2} \approx 0,10$$

is equal to, and in the control group:

$$\Delta_y = t_\gamma \cdot \frac{S_y}{\sqrt{m}} = 1,96 \cdot \frac{0,81}{\sqrt{289}} = 1,96 \cdot \frac{0,81}{17,0} = \frac{1,5876}{17,0} \approx 0,09$$

is equal to.

From findings to research If we find a confidence interval for school students:

$$\bar{X} - t_{kp} \cdot \frac{S_x}{\sqrt{n}} \leq a_x \leq \bar{X} + t_{kp} \cdot \frac{S_x}{\sqrt{n}}$$

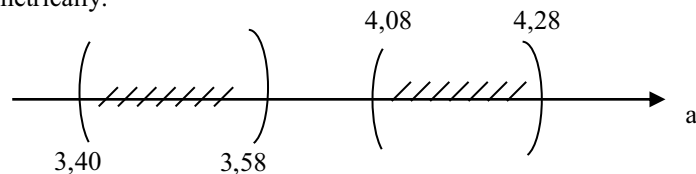
$$4,18 - 0,10 \leq a_x \leq 4,18 + 0,10, \quad 4,08 \leq a_x \leq 4,28.$$

Confidence interval for high school students from our research work:

$$\bar{Y} - t_{kp} \cdot \frac{S_y}{\sqrt{n}} \leq a_y \leq \bar{Y} + t_{kp} \cdot \frac{S_y}{\sqrt{n}}$$

$$3,49 - 0,09 \leq a_y \leq 3,49 + 0,09 \quad 3,40 \leq a_y \leq 3,58.$$

Let's put it geometrically:



of $\alpha = 0.05$ that the post-study mean is higher than the pre-study mean and the intervals do not overlap. So, it turned out that the mathematical-statistical analysis has achieved a good result.

Based on the above calculations, a mathematical-statistical analysis was performed for

the state at the end of the experiment, the average mastery indicators, sample dispersion, variation indicators, Student's sample criterion, degree of freedom based on Student's criterion, Pearson's consistency criterion and reliable deviations shown in the table below [4].

Based on the above results, mathematical statistical analysis was performed and the following results were found for the condition at the end of the experiment (table 7).

The average value of statistical indicators at the end of the experiment, mean square deviation, sample dispersion, variation indicators, Student's selection criterion, degree of freedom based on Student's criterion, Pearson's compatibility criterion and reliable deviations are shown in the following table (table 7).

Table 7. Based on Pearson's goodness-of-fit and reliable deviations. An analysis of mastery levels showing how to teach writing to left-handed learners.

\bar{X}	\bar{Y}	S_x^2	S_y^2	C_x	C_y	$T_{x,y}$	K	$X_{n,m}^2$	Δ_x	Δ_y
4.18	3.49	0.8276	0.6699	1.26	1.36	9.85	579.17	105.43	0.10	0.09

We calculate the quality indicators of experimental work from the obtained results. We know $\bar{X}=4,18$; $\bar{Y}=3,49$ $\Delta_x = 0,10$, $\Delta_y = 0,09$ is equal to.

Quality indicators from this:

$$K_{yeb} = \frac{(\bar{X} - \Delta_x)}{(\bar{Y} + \Delta_y)} = \frac{4,18 - 0,10}{3,49 + 0,09} = \frac{4,08}{3,58} \approx 1,14 > 1;$$

$$K_{bdb} = (\bar{X} - \Delta_x) - (\bar{Y} - \Delta_y) = (4,18 - 0,10) - (3,49 - 0,09) = 4,08 - 3,40 = 0,68 > 0;$$

From the obtained results, it can be seen that the criterion for evaluating the effectiveness of teaching primary grade left-hand writing students to write is greater than one, and the level of learning is greater than zero. So, the mastery rate in the experimental group is higher than the mastery in the control group [4].

5 Conclusion

The pedagogical experiment was conducted to create a methodical basis for teaching left-hand writing students of primary grade. Having collected the results related to the proof of the research concept, they were processed based on mathematical-statistical methods.

All forms of experimental work were implemented in practice.

The results of the control work were analyzed quantitatively and qualitatively.

The results of the pedagogical experiment to create a methodical basis for teaching elementary school left-handed students to write have been proven to be effective.

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