The effect of using innovative technologies on the formation and development of competences of primary class students

Umidjon Khayitov[1], *Rustambek* Qo'ldoshev[1,2,*], *Firuz* Nurulloyev[1], and *Umida* Xalikova[1]

[1]Bukhara State University, Bukhara City, M. Iqbol, 11, 200100, Uzbekistan
[2]Bukhara State Pedagogical Institute, Bukhara, Uzbekistan

Abstract: The article presents the analysis and effectiveness of the research carried out in Uzbekistan on the improvement of the methodology of teaching using innovative technologies in the formation and development of the competencies of elementary school students. Key words: competence, innovative technology, evaluation criteria, teaching effectiveness.

1 Introduction

In the course of the research, special attention was paid to conducting experiments based on the didactic foundations of the teaching process using innovative technologies in the formation and development of the competencies of students in primary classes.

The purpose of the experimental work is to determine the level of effective use of innovative technologies in the formation and development of basic and science-related competencies of elementary school students.

The process of experience and testing is aimed at forming knowledge, skills and abilities of the student, improving their functionality and development.

The purpose of the experiment is to organize the teaching process based on modern requirements and analyze the pedagogical process using innovative technologies in the formation and development of the competencies of primary school students. The range of pedagogical tasks to be solved during its organization is determined as follows[1]:

- Studying and summarizing theoretical information on teaching elementary subjects using innovative technologies based on the study of educational normative documents (state education standard, curriculum, science program, etc.) covering the content of primary education subjects of general secondary schools;
- selection of experimental areas that allow for the preparation of the test-testing base and to start the test-testing works;
- to determine the staff of professors and teachers who are responsible for the perfect, high-quality and objective conduct of experimental work, as well as the direct, consistent, continuous and purposeful conduct of experimental work, and to explain to them the content of their duties;

* Corresponding author: quldoshevrustambek@buxdpi.uz

- to determine the number of respondent youth participating as the main subject in experimental schools, as well as to divide them into experimental and control groups;
- to study the conditions of the educational environment for the formation and development of the competences of primary school students (based on observation, information, questionnaires) and to determine the social and personal causes of some problems encountered in education;
- theoretical and methodological justification of the need to use innovative technologies in the teaching of primary education subjects;
- to determine the level of students' use of innovative technologies in the teaching of primary education subjects and test their independent use in practice;
- determining the development of students' creative activity;
- development of the structure of research processes, forms of observation and criteria for evaluating the knowledge of primary school students on mastering primary education subjects;
- determination of initial literacy levels of primary school students in primary education subjects (mother tongue, mathematics and science) and innovative technologies;
- to study the effectiveness of the proposed methodology of teaching primary education and the program of experimental work;
- trial-testing of training manuals and recommendations;
- collecting data at the end of experimental work and monitoring the obtained results;
- draw conclusions based on the comparison and analysis of experimental test results;
- legal guarantee and formalization of experimental works.

2 Materials and methods

The research object and its structure, size, collected materials were arranged and systematized and analyzed and studied based on relevant criteria. The materials related to the basics of the formation and development of students' competence were summarized in a way intended for primary school students, and it was determined which materials should be provided. The need to use innovative technologies in the teaching of primary education subjects was scientifically determined and working hypotheses were formulated.

A study guide, educational platform, computer and mobile applications designed for primary education classes serving the formation and development of the competence of primary school students have been created.

The smart mobile application, educational platforms, "Best Assistant Teacher", "Plickers", "Kahoot" innovative technologies developed in order to improve educational efficiency were tested. The results of the use of innovative technologies in primary education were summarized and tested in the conducted pedagogical experiments and tests, and were analyzed and concluded using mathematical and statistical methods[2; p 240-247].

In order to determine the competence of primary school students and to determine the effectiveness of teaching primary education subjects, experimental tests were carried out in Bukhara city IDUM No. 7, IDUM No. 19, IDUM No. 39, Bukhara District, IDUM No. 1 and No. 48, Shafirkon District, No. 55 No. IDUM, general secondary schools No. 6, 18, 49 and IATChOIT No. 8 in Navoi, AFChOIM No. 11, IDUM No. 12, IDUM No. 19 named after Alisher Navoi, general secondary schools No. 3 and Kashkadarya It was carried out in the 41st IDUM in the city of Karshi, Koson District No. 9, 39th general secondary schools with a total of 844 students and 28 teachers.

Modern methods such as statistical-mathematical, questionnaire, interview, interview, analysis and observation, social surveys, sociometric, test, modeling were used in the experimental processes.

Lessons were organized for primary school students using the "Innovative technologies in primary school mathematics lessons" study guide, and the results were summarized. Based on the comparison of the results of the experimental work, a final conclusion was drawn [3; p. 200].

At the end of the experiment, tests, written and oral surveys and practical work were done. In the course of the experiment, criteria for evaluating pedagogical activity based on the principles of competences and skills of interactive management of the educational process, provided for in the state educational standards, were developed for the assessment of the knowledge of primary school students (Table 1). In order to make it easy to determine the effectiveness of the formation and development of the basic and subject-related competencies of the respondents of the experimental and control groups, the results were determined in a 100-point rating system, and the student who scored from 85.1 to 100 points was given the grade "5" for the "developed" student, who scored from 70.1 to 85 points. Efficiency was determined by replacing the grade "4" assigned to the student as a "partially developed" student, the grade "3" assigned to the student who scored from 55.1 to 70 points, the grade assigned to the "formed" student, and the grade "2" assigned to the student who scored from 0 to 55 points to the grade "partially formed" [4; pp. 21-25].

Table 1. Criteria for determining the level of competence of primary school students

Competencies	**Evaluation methods**	**Evaluation indicators**	
Core competency	Oral (interview), written, test, observation, practical assignment	Excellent (1 point); satisfactory (0.6 points); unsatisfactory (0 points); total (55 points)	85.1 points to 100 points grade "5" assigned to a "developed" student; From 70.1 points to 85 points grade "4" assigned to a "partially developed" student; From 55.1 points to 70 points grade "3" assigned to a "formed" student; From 0 points to 55 points grade "2" given to a "partially formed" student
Competence in science	Oral (interview), written, test, observation, practical assignment	Excellent (15 points (in each subject)); satisfactory (7.4 points); unsatisfactory (0 points); total (45 points)	

At the beginning of the experiment, the results of 424 students in the experimental group and 420 students (respondents) in the control groups were analyzed.

"communicative", "working with information", "self-development", "socially active citizenship", "national and general cultural", "mathematical literacy, awareness and use of science and technology news", "innovative" basic competences, and "mother tongue", "mathematics", "science" competences related to science were determined according to the following indicators (Table 2).

Table 2. Distribution of assessment of basic and subject competences of primary school students[5]

Type of competence	**Competencies that should be formed in the student**		**Evaluation form (*)**	**Excellent**	**Satisfactory**	**You are not satisfied**
Core competenc	**Communi cative competenc**	Knowledge of his native language	1-3	1	0, 6	0
		knowledge of a foreign language	1-3	1	0, 6	0
		expressing his opinion verbally	1	1	0, 6	0
		express his opinion in writing	2	1	0, 6	0
		make logical questions	2, 5	1	0, 6	0

		answer the given questions	1-3	1	0, 6	0
		adhere to communication culture in communication	4	1	0, 6	0
		teamwork; social flexibility	4	1	0, 6	0
		able to defend his position in communication	1, 4	1	0, 6	0
		respecting the interlocutor's opinion	4	1	0, 6	0
		persuasiveness	1, 4	1	0, 6	0
		manage their passions in different situations; solving problems and disagreements.	4	1	0, 6	0
	Information competence	Ability to use TV and computer	4-5	1	0, 6	0
		being able to use a telephone	5	1	0, 6	0
		access to e-mail	5	1	0, 6	0
		able to search for the necessary information in mass media	5	1	0, 6	0
		knowledge of sorting, processing, storage, transmission	1-5	1	0, 6	0
		compliance with media culture in use	4	1	0, 6	0
		able to write simple greetings, fill out questionnaires, write information about a topic	5	1	0, 6	0
		able to use computer and mobile games	4-5	1	0, 6	0
	Self-development competence	Physical education;	4	1	0, 6	0
		independent study;	4-5	1	0, 6	0
		regularly increasing knowledge and experience;	4-5	1	0, 6	0
		evaluate his own behavior;	4	1	0, 6	0
		self-control;	4	1	0, 6	0
		to have qualities such as honesty, correctness;	4	1	0, 6	0
		knowledge of problems faced in everyday life;	4	1	0, 6	0
		be able to solve using life experience.	4-5	1	0, 6	0
	Socially active civic competence	Awareness of news in society;	1-3	1	0, 6	0
		economic, legal culture;	1-4	1	0, 6	0
		knowledge of civil duties and rights;	1-3	1	0, 6	0
		the desire to increase one's position;	4	1	0, 6	0
		civil approach to work;	1-5	1	0, 6	0
		understanding of process involvement;	1-4	1	0, 6	0
		serve the interests of society and family;	1, 4	1	0, 6	0
		to be generous to those in need.	4	1	0, 6	0
Core competencies	**National and universal competence**	Loyalty to the motherland, loyalty to the people, belief in national values;	1-4	1	0, 6	0
		understanding of art and works of art;	1-3	1	0, 6	0
		average dress and behavior;	4	1	0, 6	0
		adhere to a healthy lifestyle;	4	1	0, 6	0
		knowledge of universal values (customs);	4	1	0, 6	0
		be kind to others;	4	1	0, 6	0
		respecting other people's worldview, religious beliefs, national traditions and rituals;	1-4	1	0, 6	0
		to observe the rules of etiquette established in the society.	4	1	0, 6	0
	Mathematical litera	The student can make personal, family and economic plans based on correct calculations;	1-3	1	0, 6	0

		able to work with calculations in personal, social and economic relations;	1-5	1	0, 6	0
		be able to read various formulas, models, schemes, graphs and diagrams in daily activities;	1-3	1	0, 6	0
		to be able to use scientific and technical innovations that facilitate human labor, increase labor productivity and lead to favorable conditions;	4-5	1	0, 6	0
	Innovative competence	Manifestation of personal abilities;	1-5	1	0, 6	0
		the pursuit of mental and intellectual perfection;	1-5	1	0, 6	0
		ability to predict;	1-5	1	0, 6	0
		able to form hypotheses;	1-5	1	0, 6	0
		able to express their imagination;	1-5	1	0, 6	0
		worldview, opinions;	1-5	1	0, 6	0
		the ability to create news.	1-5	1	0, 6	0
Competencies related to science	**Mother tongue**	Speech competence (listening, speaking, reading, writing)	1-5	7, 5	3, 7	0
		Linguistic competence	1-5	7, 5	3, 7	0
	Mathematics	General competence in the content of mathematics	1-5	7, 5	3, 7	0
		Cognitive competence (a person's independent creative thinking competence)	1-5	7, 5	3, 7	0
	Science	Competence to observe, identify, understand and explain natural, socio-economic processes and events;	1-5	5	2, 2	0
		Competence to correctly use geographic objects, place names;	1-5	2, 5	1, 5	0
		Competence to use globe, geographic maps in practice;	1-5	2, 5	1, 5	0
		Competence of nature protection and ecological culture.	1-5	5	2, 1	0
Total:				**100**	**55, 1**	**0**

*1 – on the basis of oral (conversation); *2 – in written form; *3 – test form; *4 – based on observation; *5 – based on practice.

3 Analysis of results and effectiveness

The effectiveness of the methodology developed during the research was justified by mutual comparison of the values presented at the end of the experiment. The results were obtained using mathematical-statistical methods. The effectiveness of the study was determined by showing the difference between the results of the experimental and control groups of students who participated in it. K.Pearson's X^2 (xi square) test was used to show this difference. According to the X^2 criterion, the final stage result indicators of the students of the experimental and control groups are compared with the initial stage result indicators[6; p. 9-24].

In making this comparison, the hypothesis H_0 is assumed to be equal to the expected probability for the types of evaluations during the observation period in the experimental and control groups. It is assumed that H_1 is not equal to the alternative hypothesis. That is, H_0 - there are no significant changes in the students' knowledge level after the experiment in the

experimental and control groups. H_1 – significant changes are observed in experimental and control groups [7-13].

Before starting the comparison, the level of significance (the level of significance is denoted by α) is determined, and then the empirical value is compared with the critical value. Usually α is 0.001; 0.01; It is taken as 0.05. In pedagogical research, they are usually limited to 0.05, which means that the probability of error does not exceed 5%. The reliability difference or variance is then calculated as 1- α. In this case, 1-0.05=0.95 (ie 95% confidence level). We present the critical value of X^2 when α =0.05 (Table 3).

Table 3. Table of critical performance values

f	1	2	3	4	5	6	7
$X^2{}_{0.05}$	3.841	5.991	7.815	9.488	11.07	12.592	14.067

Here f defines the number of degrees of freedom.

We determine the number of degrees of freedom by the formula f=(r-1)*(c-1). Here, r is the number of table rows, c is the number of table columns. In the experiment, the number of degrees of freedom for an eight-field table 3 with 2 rows (r=2) and 4 columns (c = 4) is $f_{2*4} = (2-1)*(4-1) = 3$. It follows that the number of degrees of freedom is f(3)=7.815. Preliminary data on the students who participated in the pilot study are presented in Table 4 below.

Table 4. Preliminary results of students who participated in the experiment

Experimental object	**Groups**	**Number of students**	**Grades**			
			Partially formed 2	**Formed 3**	**Partially developed 4**	**Developed 5**
Bukhara	Experience	151	33	48	54	16
	Control	147	29	56	47	15
Navoi	Experience	137	28	42	53	14
	Control	141	27	53	49	12
Kashkadarya	Experience	136	24	45	56	11
	Control	132	23	50	47	12
Total:	Experience	**424**	**85**	**135**	**163**	**41**
	Control	**420**	**79**	**159**	**143**	**39**

According to the preliminary results of the pilot study, the acquisition of traditional lessons by primary school students is 80%, and the quality is 46%.

At the end of the study, the effectiveness of teaching primary education subjects using innovative technologies, the level of formation and development of students' competencies was determined in the selected groups (Table 5). Various innovative methods (verbal, written and computerized assignments, tests) were used to determine the effectiveness of experimental groups.

Table 5 . Results of the students at the end of the experiment

Experimental object	Groups	Number of students	Grades			
			Partially formed 2	Formed 3	Partially developed 4	Developed 5
Bukhara	Experience	151	16	46	68	21
	Control	147	26	58	47	16
Navoi	Experience	137	12	39	63	23
	Control	141	24	54	51	12
Kashkadarya	Experience	136	8	46	64	18
	Control	132	21	49	50	12
Total:	**Experience**	**424**	**36**	**131**	**195**	**62**
	Control	**420**	**71**	**161**	**148**	**40**

Analysis of the combined results of the indicators collected from these experimental-control groups (Figure 1).

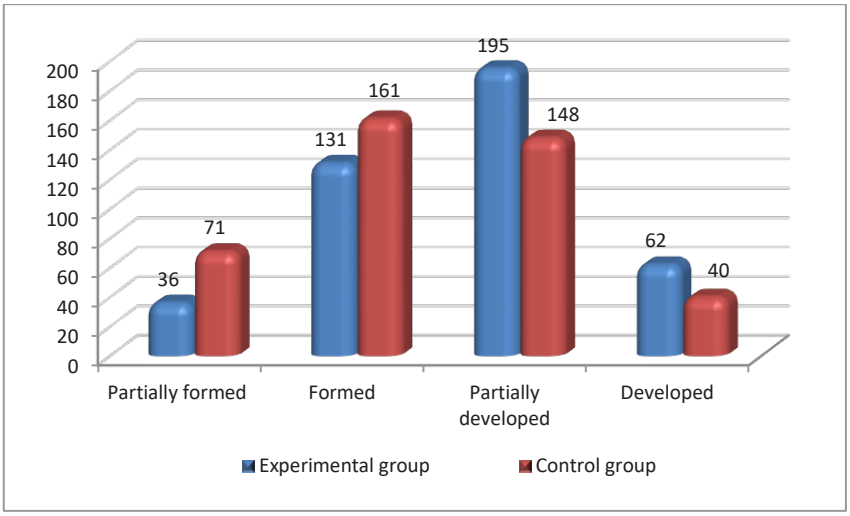

Fig. 1. Summary diagram of experimental results

Summarizing the results of the experiment, the overall average learning of the experimental and control groups was analyzed based on K.Pearson's X^2 (xi square) criterion. In this case, $\bar{x}$ and $\bar{y}$ are the arithmetic mean of mastery grades, M and N are the number of respondents, M_i and N_i are the group indicators, m_i and n_i are the number of students corresponding to the indicator.

$$\bar{x} = \frac{1}{M} \cdot \sum_{i=1}^{4} M_i \cdot m_i = \frac{1}{424} \cdot [2 \cdot 36 + 3 \cdot 131 + 4 \cdot 195 + 5 \cdot 62] = \frac{1555}{424} = 3,667$$

$$\bar{y} = \frac{1}{N} \cdot \sum_{i=1}^{4} N_i \cdot n_i = \frac{1}{420} \cdot [2 \cdot 71 + 3 \cdot 161 + 4 \cdot 148 + 5 \cdot 40] = \frac{1417}{420} = 3,374$$

Samaradorlyk indicators:

$$\eta = \frac{\bar{x}}{\bar{y}} = \frac{3,667}{3,374} = 1,087$$

From the statistical analysis of the results of the experiment, it was found that the efficiency of the experimental group was 8.7% higher than that of the control group.

The variability of the results (coefficient of variation) is determined by the accuracy of the results of the experimental work. Therefore, when determining the variability of the results of experimental tests, we identify possible errors in the assessment of student knowledge.

We find the statistical variance differences of the experimental and control groups:

$$S_x^2 = \frac{1}{M} \cdot \sum_{i=1}^{4} {m_i}^2 \cdot M_i - \bar{x}^2 = \frac{1}{424} \cdot [2^2 \cdot 36 + 3^2 \cdot 131 + 4^2 \cdot 195 + 5^2 \cdot 62] -$$

$$-3,667^2 = \frac{1}{424} \cdot 5993 - 13,447 = 14,135 - 13,447 = 0,688$$

$$S_y^2 = \frac{1}{N} \cdot \sum_{i=1}^{4} {n_i}^2 \cdot N_i - \bar{y}^2 = \frac{1}{420} \cdot [2^2 \cdot 71 + 3^2 \cdot 161 + 4^2 \cdot 148 + 5^2 \cdot 40] -$$

$$-3,374^2 = \frac{1}{420} \cdot 5101 - 11,384 = 12,145 - 11,384 = 0,761$$

Now we find the coefficients of variation for the experimental and control groups:

$$V_x = \frac{S_x}{\bar{x}} \cdot 100\% = \frac{\sqrt{0,688}}{3,667} \cdot 100\% = 0.226 \cdot 100\% \approx 22,6\%$$

$$V_y = \frac{S_y}{\bar{y}} \cdot 100\% = \frac{\sqrt{0,761}}{3,374} \cdot 100\% = 0.258 \cdot 100\% \approx 25,8\%$$

The coefficients of variation in the experimental and control groups did not exceed 30%. It can be seen that the experimentally determined $\bar{x}$ and $\bar{y}$ average absorbance indicators completely cover the theoretical average values (ie a_x, a_y). $\bar{x} = a_x$ and $\bar{y} = a_y$.

It is known that the confidence interval for estimating the mathematical expectations M_x and N_y with a given random x in the case of a dispersed normal distribution is determined by the inequalities:

$$\bar{x} - \frac{t_\alpha \cdot S_x}{\sqrt{M}} \le a_x = M_x \le \bar{x} + \frac{t_\alpha \cdot S_x}{\sqrt{M}}$$

$$\bar{y} - \frac{t_\alpha \cdot S_y}{\sqrt{N}} \le a_y = N_y \le \bar{y} + \frac{t_\alpha \cdot S_y}{\sqrt{N}}$$

In this formula, t is the confidence coefficient. We find the theoretical mean values of the 95% confidence interval using the standard method given below. γ is the reliability or confidence level of the estimate. Confidence level is usually 0.9; 0.95; 0.99; Accepts one of the values 0, 999. In this experiment, we will use a value of $\gamma = 0.95$. Using the empirical (statistical) distribution function, we find the confidence coefficient t:

$$\Phi_0(t) = \frac{\gamma}{2};\ =>\ \Phi_0(t) = \frac{0,95}{2};\ =>\ \Phi_0(t) = 0,475$$

This leads to $t_\alpha = 1,96$ according to the table of values of the Laplace function. Now we determine the confidence interval for the experimental and control groups:

$$3,667 - \frac{1,96 \cdot \sqrt{0,688}}{\sqrt{424}} \le a_x \le 3,667 + \frac{1,96 \cdot \sqrt{0,688}}{\sqrt{M424}}$$

$$3,374 - \frac{1,96 \cdot \sqrt{0,761}}{\sqrt{420}} \le a_y \le 3,374 + \frac{1,96 \cdot \sqrt{0,761}}{\sqrt{420}}$$

$$3,588 \le a_x \le 3,746$$

$$3,291 \le a_y \le 3,457$$

Therefore, it follows that the inequality $a_x > a_y$ is reasonable, that is, it turns out that the theoretical average learning indicators corresponding to the experimental and control groups are in a non-intersecting range.

The analysis of the results of the final stage of pedagogical experiments proved that the use of innovative technologies in teaching primary education is effective.

References

1. Resolution No. 187 of April 6, 2017 of the Cabinet of Ministers of the Republic of Uzbekistan "On approval of state educational standards of general secondary and secondary special education" (https://lex.uz/pdfs/3153714).
2. Xaitov U.X. (2021). Problemы sovremennogo obrazovaniya, **(6),** 240-247.
3. S.K. Kahhorov, U.Kh. Khaitov. "Innovative technologies in primary school mathematics lessons" study guide (Durdona publishing house. - Bukhara 2022)
4. Xaitov U.X., Vestnik nauki i obrazovaniya. «Problems nauki» **5 (125).** 21-25 (2022)
5. Xaitov U.X., Vestnik nauki i obrazovaniya. «Problems nauki» **5 (125).** 25-27 (2022)
6. Rao, C. R. (2002). *Karl Pearson chi-square test the dawn of statistical inference.* Goodness-of-fit tests and model validity, 9-24.
7. Malseva Ye.V., Kapralova A.O. *Use informatsionno-kommunikatsionnыx texnologiy na urokax matematiki v nachalnoy shkole //* Mejdunarodnoy nauchno-prakticheskoy internet-konferensii “Actual problems metodiki obucheniya informatike i matematike v sovremennoy shkole” Russia, Moskva, MPGU, 22-26 aprelya 2019. 679-683.
8. Mirzaakhmad K., Oltinboyevich J. K., Resmilitaris **13**. 1. 251-257 (2023)
9. Oltinboyevich J. K., Khudoyberdievich K. S., Journal of Survey in Fisheries Sciences **10**. 2S, 2967-2972 (2023)
10. Efendi N., Sartika S. B., Oltinboyevich J. K. *Collaborative Skills in Natural Science Practicum: A Student Perspective* //International Conference on Intellectuals’ Global Responsibility (ICIGR 2022). pp. 77-85 (Atlantis Press, 2023)
11. Kakhkhorovich K. S., Oltinboyevich J. K. A *Model for Improving Students' Technical Creative Competences Based on Robotic Elements* //Resmilitaris **13**. 1. 245-250 (2023)
12. Kuldoshev R. et al. E3S Web of Conferences **371**. 05069 (2023)
13. Hamroyev A., Jumayeva H., E3S Web of Conferences **420**. 10007 (2023)