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The Role of Modern Information and Communication Technologies in the Organization of Distance Education

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Abstract. This article discusses the opportunities of using information and communication technologies (ICTs) in the organization of distance learning at higher education institutions. The article covers the content and essence of the distance-adapted version of such methods as "Impulse-poster" and "Express-tests" on the example of some topics of "Discrete mathematics and mathematical logic". There is a statistical analysis of the effectiveness of innovative technologies proposed in the process of distance learning.

INTRODUCTION

It is known that distance education is becoming one of the important elements of modern education. This form of education is getting closer in content to the traditional form of education. At present, distance learning is becoming the main form of education in many higher education institutions. This means that the "remote" and "traditional" forms are almost indistinguishable. The development of pedagogical and modern telecommunication technologies gives way to rise of new forms of distance education.

There is a rich experience in distance learning in foreign countries. Observations show that the cost of distance learning is 8-10 times cheaper than traditional education. This is because the costs for building maintenance, equipment and laboratory, teacher, administration and maintenance staff will be reduced.

In distance learning, all classes including lectures, seminars or training courses can be broadcasted on telecommunication channels implementing synchronous television, video conferencing or radio broadcasting to deliver lessons to targeted remote classrooms. This in turn makes it possible for one teacher to work with a large number of students concurrently. Wisconsin University, USA and the Central Radio and Television University of China have been successful using above mentioned model in organized distance learning.

Thus, the introduction and application of new pedagogical technologies in the distance learning process is directly related to the time's demands. Many advantages of distance education can be seen. In this article, we have found it necessary to list some of them in the example of teaching Discrete Mathematics. In this regard, the development of pedagogical technologies used in distance learning and their implementation in practice is an actual problem.

The advantage of distance learning is that everyone can learn in a convenient time, place, and environment. Due to this, this system is gaining popularity in the world today. If we look at the positive aspects of distance education, today many universities and large enterprises around the world use this method to improve the skills of specialists, saving millions of dollars a year.

Naturally, with those who live far from the university, do not have suitable conditions for visiting or have a disability, the demand for distance learning will increase.

The use of traditional methods of distance learning creates a comfortable environment for people unable to study in a stable environment, for people with disabilities due to medical conditions, as well as for students of retraining and advanced training courses and applicants wishing to study in foreign educational institutions.

There are also organizational and financial benefits of distance learning, such as the fact that rooms, boards, desks and other learning tools are not required for teaching. The financial costs are mainly spent on the preparation of teaching materials and Internet traffic. It is advisable to direct the saved funds to the preparation of modern teaching materials that are understandable and detailed for students.

A number of Uzbek and foreign scholars have conducted research on the effective organization of distance and traditional education. Let's dwell on some of them. In the textbook [1] it was studied the definition, essence, content and current trends of distance education. A specific example shows the effectiveness and implementation mechanisms of distance learning programs at the current stage of development of educational technologies. [2] focuses on methodological issues in establishing a distance learning course for master's degree students who study linguistics. The research significance of the study is that the designed e-course is an innovative representation of the outcomes of accumulative research conducted by teachers and students. The main idea within the framework of the project is to put into practice the concept of communicative activity of education in remote forms for students' independent work and in doing so to come up with a innovative educational product with subsequent application in the educational processes.

The paper [3] addresses the difficulties and opportunities created by information and communication technologies (ICTs) pertinent to education. From covering innovative educational models paradigms resulting from ICTs to handling imminent student needs and general issues, this paper provides a thorough breakdown of the model, technology, teaching and other variables that tend to be vital for universities to be successful in the latest competitive marketplace of e-learning.

[4] discusses the expansion of distance education in the context of changes in general education and its use in basic and non-formal education, school education, teacher training and higher education. With its critical evaluation of the facts and performance data verification, this book provides answers to problems and raises key questions for consideration by policy makers, educators and all professionals involved in the implementation and delivery of sustainable open and distance learning.

The book [5] is written for introductory distance learning courses for prospective or current teachers, as well as for curricula that discuss teaching remote learners or managing distance education systems. It provides readers with the fundamental information they need to be knowledgeable distance educators and leaders of online learning programs. The teacher or instructor using this book will be able to determine the proper use of distance learning.

In the paper [6] the methods of using pedagogical technologies in the effective organization of mathematical classes are described. Analysis of the organization of lectures, practical and independent training sessions in higher education institutions of developed countries and their role in the effective organization of training sessions are provided. A number of recommendations for improving the quality of education based on international experience have been developed. In [7] the theoretical foundations of the organization of independent creative works of students in the direction of Technology in Higher Education was analyzed, and the dynamics of their level of development based on the indicators of independent work of students and the skills of their independent work creativity was issued.

THE MAIN PART

According to the results of studies of distance and traditional education, discussed in the first section, the following natural questions arise: Can we use pedagogical and innovative educational technologies widely applied in traditional education in distance learning? Are there innovative technologies in distance education that serve to increase students' interest in science, increase their creativity, expand their creative activities, and develop their ability to learn independently? While research and experiments have shown that while not all innovative technologies can be used in distance learning, there are many methods that can be adapted to the distance learning process. In recent years, attention has been paid to the use of modern teaching methods in order to organize the process of distance learning on the basis of world standards. Improving the appropriate application of modern methods in asynchronous and synchronous learning modes in the context of distance learning will serve to increase the effectiveness of general education. International experience shows that interactive methods are increasingly used in distance learning.

The following are examples of the application of a number of modern methods used in the traditional educational process in distance learning "Discrete Mathematics and Mathematical Logic".

First, we describe the "Impulse-poster method".

Each participant will need Whatman sheets and markers.

1. On the tables are Whatman sheets of paper with unfinished ideas: "I am most interested in ... on this topic", "I wanted to clarify that ...", "I will apply the knowledge I have gained to ...", "In the process of studying this topic I achieved ...", "I wanted to know more about ...", "... was difficult for me", "I liked ...".
2. If possible, it is advisable to have quiet, low-pitched music during the exercise.
3. Participants are invited to go around and review all the posters, think about the ideas that have been started, and continue on these posters to the end.
4. After about 15 minutes, the posters will be hung. Opinions are read aloud and clarifying questions are asked if necessary. Participants decide for themselves whether to write their names under their comments or remain anonymous.

To get the most out of the Impulse Poster method, it will be necessary to get acquainted with the opinion of each student. But in a traditional lesson, it is impossible to include the opinion of all students on a single poster. The question arises as to whether this method can be applied in distance learning, and how it can be implemented if the method of "Impulse-poster" can be used in distance learning. Before answering this question, let's mention the areas of application, advantages and disadvantages of using the method.

Areas of application. This method is used in the teaching of natural and exact sciences to examine and determine the knowledge and interests of students.

Advantages of the Impulse-Poster method: Anonymity helps students to express their opinions, which they would prefer to remain silent in another situation. The hopes and desires expressed in this exercise will enable the teacher to adjust his efforts in planning and delivering future lessons.

Disadvantages of the "Impulse-poster" method: If students are asked to comment on their interests and challenges, we must consider this information in the future. Otherwise, they may feel like they are not taken seriously.

In the Moodle system, we will see how it is possible to organize a distance learning process using the method's



active module. To do this, let's first talk about The feedback activity module.

A teacher can use the feedback activity module to create a custom survey to collect feedback from students using a variety of question types such as multiple choice, yes/no, and text input. If desired, feedback responses can be kept anonymous, and results can be displayed to all participants or just the teachers. Non-logged-in users can participate in any feedback activities on the site's front page.

Feedback activities can be mostly applied:

- For course evaluations, which might help improve the content of the course for later participants
- To enable participants to sign up for events, course modules, etc.
- For guest surveys of school policies, course choices etc.
- For anti-bullying surveys in which students anonymously can report incidents

The use of the pulse-poster method in Moodle distance learning system in teaching the predicate calculus department can be organized as follows. In the "Add an activity or resource" section, select "Feedback". The questions are then entered in the prescribed order (Figure 1), with students having to select short answer or essay sections for them to enter their answers.

Impulse-poster method

1. I am most interested in on this topic
2. I wanted to clarify that
3. I will apply the knowledge I have gained to
4. In the process of studying this topic I achieved
5. I wanted to know more about ...
6. ... was difficult for me
7. I liked ...

FIGURE 1. The process of entering questions according to the Impulse poster method in the Moodle distance learning system

Impulse-poster method

[Overview](#) [Edit questions](#) [Templates](#) [Show responses](#)

Anonymous entries

Download table data as

- Comma separated values (.csv)
- Comma separated values (.csv)**
- Microsoft Excel (.xlsx)
- HTML table
- Portable Document Format (.pdf)

Response number	I am most interested in on this topic	I wanted to clarify that	I will apply the knowledge I have gained to	In the process of studying this topic I achieved	I wanted to know more about was difficult for me	I liked ...
Response number: 1							

FIGURE 2. The process of entering students' answers to questions according to the Impulse poster method in the Moodle distance learning system

Students are free to express their opinions while answering questions (Figure 2), and can also make suggestions and recommendations. For example, the answers to the given topic can be as follows:

1. On this subject I am most interested in the correct, inverse, and contradictory theorems.
2. Where else can additional information on proving sufficient and necessary conditions be obtained?
3. I will apply the knowledge I have gained to prove theorems using a method of proving by inverse assumption.
4. In the process of studying this topic, I have developed the ability to prove theorems
5. I wanted to know more about the calculation of axiomatic predicates.
6. It was difficult for me to prove sufficient and necessary conditions.
7. I liked to express mathematical considerations in the form of predicate logic formulas.


The teacher receives the answers to all the questions in tabular form. This means comparing the answers and focusing more on the same opinions, recommendations or suggestions. It is advisable to take every idea into account and eliminate problems. The application of this method in distance learning has a number of advantages: to improve the course as a result of the survey; enrich the content of the report by reviewing the proposals; elimination of corruption at the expense of students' ability to respond anonymously; the level of competence and ability of the students can be quickly assessed due to the fact that all the given answers are given in tabular form.

The next method of education is the "Express-tests" method, first of all we will describe its content and essence. It is advisable to conduct express-tests after a certain sequence of concepts (1-2 topics) to control and strengthen the knowledge of students on these topics. Express tests usually consist of 3-4 small and light exercise assignments or tests on these topics. Express tests can be conducted in a short time (5-10 minutes) during the lesson. Assignments are distributed on cards in a multi-option system. The principal objective of this test is to quickly determine whether students have mastered the minimum requirements of state educational standards. Samples of assignments should be collected from a variety of sources to monitor and assess students' mastery levels. It will be useful for teachers to be aware of these different types of assignments and apply them in practice. Nowadays, we can also create a variety of test assignments. There are 12 types of tests in traditional education, and assignments can consist of the following items:

1. Fill in the blanks with the necessary words.
2. Based on the meaning of the sentence, select the one from the words in parentheses and underline it.
3. Find the correct answer.
4. Separate the correct from the two affirmations.
5. Find the error in the definition (sentence).
6. Make logical pairs based on the meaning of the words below.
7. Continue the sentence according to the interpretation of mathematical concepts and terms.
8. Divide the following formulas into pairs according to which mathematical concept properties they belong to.
9. Match the appropriate interpretation in column B to the term given in column A.
10. Create a problem according to the pattern and solve it.
11. Numerical written work (dictation).

The teacher writes and numbers the names of several terms on the board. Then the definitions of these terms (concepts) are read in an arbitrary order without naming them. Students are asked to find out under which number the term (concept) is written. The result can be a numbered line in the form 5, 6, 10, 1, 7, 2, 3, 4, 9, 8.

12. Write an issue or question on a topic.

In the Moodle distance learning system, tests are created mainly using  Quiz. The quiz activity lets teacher to create quizzes comprising various queries, including multiple choice, blank filling, short-answer and numerical. The teacher can allow the test to be taken multiple times by shuffling the questions or choosing them randomly from the question bank. A deadline may be set.

Each attempt is assessed automatically, excluding essay questions, and the grade is recorded in the gradebook.

The teacher can choose when and if hints, feedback and correct answers are shown to students.

Quizzes may be used for the following purposes:

- Exam practice with questions from previous exams;
- Mini-tests for rereading assignments or at the conclusion of a topic;
- For self-evaluation.
- As course examinations;
- Provide immediate feedback on performance;

The tests can be reviewed in a variety of ways (Figure 3).

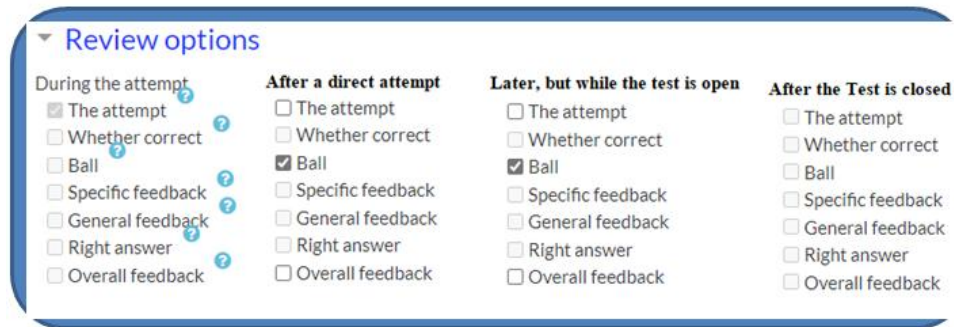


FIGURE 3. Types of test views

So, when using the method of "Express tests" in the distance learning system Moodle, we can use the following types of tests:

- Simple Calculated
- Calculated
- Drag and drop onto image
- Drag and drop markers
- Drag and drop into text
- Calculated Multichoice
- Essay
- Description
- Embedded Answers (Cloze)
- Matching
- Random Short Answer Matching
- Multiple Choice
- Short-Answer
- Select missing words
- True/False
- Numerical
- Third-party question types

In short, it is possible to organize a lesson-rich learning process for all students studying in the distance education system using interactive teaching methods. It will be a big step towards achieving the goal if they develop skills such as commenting on interesting (voluntarily, because of interest in science) questions (formed using the pulse-poster method) and taking tests (different types of tests based on the method of express tests to test their knowledge) after each lesson.

Statistical tests are important in analyzing the results of scientific and pedagogical studies and appraisal of their efficacy. It worth noting that the study tests are influenced by the comments related to the research results. [8] In the article, the compatibility, homogeneity, and Chi square tests are collated. The research results are illustrated in the method of verification using 3 types of statistical tests. Definitions in this area and their applications in the educational process are described.

During the research, special attention was paid to the organization of experimental work of higher education institutions for statistical analysis of the effectiveness of innovative technologies recommended in the process of distance learning. The purpose of the experimental work is to develop scientific and methodological recommendations for the organization of effective courses, depending on the mastery of students, by organizing two different distance learning courses in two groups studying - 5330100 - in the field of computer science and programming technology.

For the first group (control group), the distance learning process is simple (traditional), i.e., downloading a lecture element and completing the given assignments. An educational process consisting of elementary resources such as intermediate and final control by test or by writing and sending a response to the ticket is organized. For the second group (experimental group), the distance learning process was organized using innovative pedagogical

technologies (multimedia, express tests, impulse-poster, forum, chat, seminar, Venn diagrams, cluster, etc.) and students' results were analyzed.

The effectiveness of the proposed methodology in the study is comparative analysis of the indicators noted at the end of the experimental work. In mathematical-statistical methods for re-analysis of the results, the effectiveness of the study was assessed by identifying the difference between the end-of-experiment performance of the students participating in the re-analysis and the experimental and control groups. For this purpose, using the criterion χ^2 of K. Pearson, the mastery indicators of experimental and control groups' participants at the beginning and end of the experiment were compared.

K. Pearson's criterion χ^2 is a non-parametric method that allows to evaluate the significance of the dissimilarities between the actual (qualitatively determined) results or qualitative indicators and the expected theoretical number of the sample belonging to each category. In the study groups, if the zero hypothesis is correct, in other words, the method allows to assess the statistical significance of the differences between two or more relative indicators (frequencies, proportions). The H_0 hypothesis is assumed to be equal to the expected probability for the types of assessments during the observation period in the experimental and control groups, while the alternative H_1 is assumed to be unequal in the hypothesis.

H_0 - No significant change in students' knowledge levels was observed after the experimental work in the experimental and control groups.

H_1 - Significant changes are observed in the experimental and control groups.

To test this statistical hypothesis, the significance level α is first determined to compare the empirical value with the critical value. In pedagogical research, the value of (α) is assumed to be 0.05. In this situation, it was found that the reliability difference $1 - \alpha$ is equal to $1 - 0.05 = 0.95$ (i.e. 95% confidence level).

The critical value of χ_i^2 when $\alpha = 0,05$ (Table 1) is given.

TABLE 1. The critical value χ_i^2 when $\alpha = 0,05$

$M-1$	1	2	3	4	5
χ_i^2	3,84	5,99	7,81	9,49	11,07

As noted above, students' initial mastery levels were studied. Experimental and control groups were determined by the test results and assignments obtained to define the efficacy level of training in experimental disciplines, and the results of the final analysis of the level of knowledge of students were expressed as follows (see Table 2).

TABLE 2. Preliminary and final results of students who participated in the experimental work in distance learning in the direction of "Computer Science and Programming Technologies (by direction)"

Groups	Number of students	Marks							
		I.S.	F.S.	I.S.	F.S.	I.S.	F.S.	I.S.	F.S.
		"2"		"3"		"4"		"5"	
Experiment	39	1	0	18	13	19	21	1	5
Control	35	0	1	20	22	14	11	1	1

Based on these results, separate empirical values for each group were examined and mathematical-statistical analysis was performed. The results of assignments and tests conducted by the control and experimental groups of students of Bukhara State University in the system of distance education are formed in Table 2.

In calculating the empirical values for the experimental and control groups, the indicators of the experimental group were denoted by M_i , the corresponding number of students by m_i , and the same quantities by N_i, n_i for the control groups, using formula 1.

$$\chi_{emp}^2 = T \cdot N \cdot \sum_{i=1}^M \frac{\left(\frac{m_i}{T} - \frac{n_i}{N}\right)}{m_i + n_i} \quad (1)$$

The arithmetic mean values and efficiency of the experimental and control groups were calculated as follows:

$$\bar{x} = \frac{1}{T} \cdot \sum_{i=1}^M M_i \cdot m_i; \quad \bar{y} = \frac{1}{N} \cdot \sum_{i=1}^M N_i \cdot n_i; \quad \eta = \frac{\bar{x}}{\bar{y}}.$$

Since $M = 4$ in the experiment, $M - 1 = 3$, and the corresponding critical value $\chi_{0,05}^2 = 7,81$ was obtained.

TABLE 3. The values for the higher education institution were calculated using this formula. General results of experimental work of students of Bukhara State University

The name of the university	Indicator	In experimental groups				Control groups			
		The quantity of participants at the initial stage of the experiment	%	The quantity of participants at the end of the experiment	%	The quantity of participants at the initial stage of the experiment	%	The quantity of participants at the end of the experiment	%
Bukhara State University	Excellent	1	2,6	5	12,8	1	2,8	1	2,8
	Good	19	48,7	21	53,9	14	40	11	31,5
	Satisfactory	18	46,1	13	33,3	20	57,2	22	62,9
	Unsatisfactory	1	2,6	0	0	0	0	1	2,8

Results of students at the initial stage of the experiment:

$$\chi_{emp}^2 = 39 \cdot 35 \cdot \left[\frac{\left(\frac{1}{39} - \frac{0}{35}\right)^2}{1+0} + \frac{\left(\frac{18}{39} - \frac{20}{35}\right)^2}{18+20} + \frac{\left(\frac{19}{39} - \frac{14}{35}\right)^2}{19+14} + \frac{\left(\frac{1}{39} - \frac{1}{35}\right)^2}{1+1} \right] \approx 1,65;$$

$$\bar{x} = \frac{1}{39} \cdot [2 \cdot 1 + 3 \cdot 18 + 4 \cdot 19 + 5 \cdot 1] \approx 3,51; \quad \bar{y} = \frac{1}{35} \cdot [2 \cdot 0 + 3 \cdot 20 + 4 \cdot 14 + 5 \cdot 1] \approx 3,46;$$

$$\eta = \frac{3,51}{3,46} \approx 1,02.$$

The empirical value obtained is smaller than the critical value, i.e. $1.65 < 7.81$. This suggests that the H_0 conjecture can be applied for the beginning of the experiment. That is, there was not any noteworthy change in students' knowledge levels prior to the experiment in the experimental and control groups.

Outcomes of students' experiments:

$$\chi_{emp}^2 = 39 \cdot 35 \cdot \left[\frac{\left(\frac{0}{39} - \frac{1}{35}\right)^2}{0+1} + \frac{\left(\frac{13}{39} - \frac{22}{35}\right)^2}{13+22} + \frac{\left(\frac{21}{39} - \frac{11}{35}\right)^2}{21+11} + \frac{\left(\frac{5}{39} - \frac{1}{35}\right)^2}{5+1} \right] \approx 8,92;$$

$$\bar{x} = \frac{1}{39} \cdot [2 \cdot 0 + 3 \cdot 13 + 4 \cdot 21 + 5 \cdot 5] \approx 3,79; \quad \bar{y} = \frac{1}{35} \cdot [2 \cdot 1 + 3 \cdot 22 + 4 \cdot 11 + 5 \cdot 1] \approx 3,34;$$

$$\eta = \frac{3,79}{3,34} \approx 1,14.$$

The empirical value obtained is greater than the critical value, i.e. $8.92 > 7.81$. Hence, the fact that the proposed methodology is effective suggests that the H_1 hypothesis can be accepted. After conducting experiments in the experimental and control groups, a significant change in the level of knowledge of students was felt.

From the above calculations, we found that the result in the experimental group was 12% ($1.14 - 1.02 = 0.12$) higher than in the control group.

- In the control groups, the rate of excellent grades at the first and final stages of the experiment was 2.8%, and in the experimental groups at the first stage of the experiment the rate was 2.6%, while at the last of the experiment - 12.8% of students got excellent grades;

- The quantity of participants who achieved a good grade was 40% in the control group at the initial stage, while the figure was 31.5% in the final stage. In the experimental groups, the rate was 48.7% at the beginning and 53.9% at the end of the experiment;

- The quantity of participants with satisfactory assessment increased from 57.2% to 62.9% in the control groups, and decreased from 46.1% to 33.3% in the experimental groups;

- The quantity of participants with unsatisfactory assessment increased from 0% to 2.8% in the control groups, and decreased from 2.6% to 0% in the experimental groups.

Based on the obtained scientific results, a comparative analysis of the indicators of the formation of the technological approach of students to the teaching process of their knowledge, skills and abilities is given in the following histograms (Figure 4).

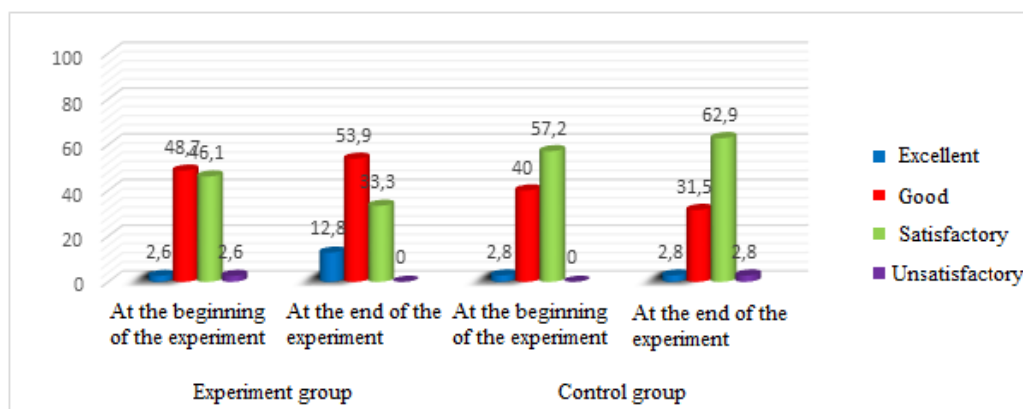


FIGURE 4. Diagram of mastering indicators of students who participated in the experimental work of Bukhara State University.

As can be seen from the diagram given above, the indicators of the formation of abilities and skills of students in distance learning in the field of "Computer Science and Programming Technology (by direction)" increased from 51.3% to 66.7% in the group "Experiment" and 42% in the group "Control". , Decreased from 8% to 34.3%. The status of the above experiments shows that the distance learning process is organized using innovative pedagogical technologies (multimedia, express tests, impulse posters, forums, chats, seminars, Venn diagrams, clusters, etc.) and not only increases the level of knowledge of students. Also guarantees the quality of course processes.

CONCLUSION

In short, the essence of pedagogical technologies in distance learning is the interaction and integral activity of science teachers and students. Conclusions were made based on a comparison of the competence of students in the experimental group to work in distance learning, which showed an increase in the competence of students in the course organized in distance learning using innovative methods in the control group compared to students studying through distance learning in the experimental group.

Application of pedagogical technologies in the process of distance learning in students

- initiative and independent thinking;
- Through mastering of knowledge;
- logical thinking;
- cultivate creative imagination allows the formation of such qualities as.

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