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**EFFECTIVENESS OF CHEMISTRY TEACHING PROCESS IN**  
**HIGHER EDUCATION INSTITUTION**

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**Abstract**

The article provides a comparative analysis of distance and traditional forms of education at a university in the direction of implementing didactic conditions for mastering chemical knowledge. It is indicated that the most important condition determining the effectiveness of distance learning is adequate assessment of students' own educational process. Obviously, the student's ability and desire to independently determine his own course of learning implies a corresponding decrease in the degree of teacher control over the process. The dependence of the distance learning format on the level of development of skills and abilities of independent work, the readiness of students to independently master subject knowledge is shown. Particular attention is paid to the need and importance of knowledge about the mechanism of independent activity in mastering the content of training courses. Problems of students' activities in a distance format are discussed based on basic psychological and didactic theories. It is shown that distance education should be focused on the student, on studying the problem of his cooperation with the teacher and technology in order to obtain and assimilate knowledge.

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## 1. Introduction

The international environment in which our country lives today is characterised by high tension and military confrontation with Western countries. Modern foreign policy challenges place a high degree of responsibility on higher education for solving the tasks set before the Russian society.

The requirements for university graduates that are mandatory for the implementation of basic educational programmes have increased. Accordingly, the issues of the efficiency of the learning process remain extremely relevant (Ilchenko, 2021).

In higher education today, various psychological and pedagogical concepts are used; innovative models and types of learning activities are introduced. In order to master innovative technologies, it is necessary to have a full understanding of them and to identify their characteristic features (Stikhova, Novikova, et al., 2021).

The article provides a comparative analysis of distance and traditional forms of learning in higher education in the direction of the implementation of didactic conditions of chemical knowledge assimilation. The problems of students' activity in the distance format are discussed on the basis of basic psychological and didactic theories (Stikhova, Trudnikova, et al., 2021).

Distance or structured learning, in which the student and the teacher are separated by place and sometimes by time, is currently a demanded form of subject learning. Distance learning places specific demands on both the instructor and the student, and the labour input of both is increased rather than alleviated (Ahmad et al., 2024; Singh et al., 2024; Waite, 2024).

While the first studies of the distance format dealt mainly with the organisational and technological aspects of the learning process, the focus has since shifted to educational issues related to effective teaching and student learning. In particular, problems are related to real, sustained communication, as well as new communication technologies to support the process of learning subject knowledge. Therefore, issues that affect the student, the instructor, the technology and the process of teaching and learning have become increasingly important (Inglehart & Welzel, 2005).

In order to understand the challenges facing the subject learning system today, it is necessary to consider previous educational constructs in development. Research work in the field of distance education has traditionally been viewed in terms of a complete abandonment of the standard classical classroom-based learning model (Petrova, 2016).

## 2. Problem Statement

It is the classroom-lesson form that distinguishes traditional education from distance education, and the digital environment is considered the most effective means of independent and self-determined learning for students.

The main key elements of distance learning are:

- i. spatial separation of an instructor and a student;
- ii. the object of learning is an individual, not a group of students;
- iii. using information technology to link a teacher and a student;
- iv. two-way messaging;

- v. an industrialised form of the learning process.

The term "industrialisation" has more than just an economic and technological meaning. Industrialisation is a lifestyle encompassing economic, social, cultural and educational change. It is a forced industrial transformation of the learning process (Kanaeva, 2015).

Distance education has moved from the so-called teaching industry to student-centred learning, to the exploration of the problem of the student's collaboration with the teacher and technology in order to acquire and assimilate knowledge (Kanaeva, 2015).

Distance education is a complex system consisting of many subsystems that interact with each other over time. The distance learning process in higher education is the result of a combination of three main factors: student independence (the ability to make choices), student competence (abilities, skills and motivation) and support (information resources).

In distance education of students, all inherent components of the educational process (content, means of learning, objectives, organisational forms, methods) are preserved, which, in turn, should be provided with modern information technologies.

### **3. Research Questions**

With the introduction of distance education technologies, the role of the teacher increases and changes. This is the creation of video lectures, video experiments, test materials, control-practical tasks, etc., as well as the organisation of feedback from students and solving the problem of quality control of distance learning. This is the organisation of feedback with students, and the solution of the problem of quality control of distance learning. In essence, the teacher is a link between the student and the source of learning (computer).

Distance learning is a concept that encompasses teaching and learning activities in the cognitive, psychomotor and affective domains of the individual student. It is characterised by continuous communication and can be carried out anywhere and at any time, which makes it attractive especially for teaching more professionally motivated adults (Mau, 2016).

The ability and desire of the student to determine his/her own course of study imply a corresponding decrease in the degree of instructor's control over the process. As a consequence, the most important problem in distance learning is students' self-organisation. In the absence of real control over class attendance and the monitoring of independent activity, not all students are ready to organise their academic work properly.

One of the conditions determining the effectiveness of distance learning is adequate assessment of students' own learning process. It is obvious that most students find it difficult to assess their own capabilities of independent activity. At the same time, without students' independent work skills and readiness to independently assimilate subject knowledge, the effectiveness of distance learning is significantly reduced. And also, students should be motivated to develop their own independent work. The knowledge of the mechanism of independent activity to assimilate the content of educational courses is equally important. There is no point in giving students autonomy in choosing learning objectives and assessment procedures if they do not have the competence to use this autonomy (Okhotsky, 2016).

Motives of learning should be considered in connection with skills of independent activity. The motivational component should be expressed quite strongly, as the distance form implies students' understanding of the need to work hard on their own. The rivalry shown by students at the blackboard, in oral reports, independent fulfilment of creative tasks, etc., which traditionally increase motivation, do not work in the distance mode.

#### **4. Purpose of the Study**

I will dwell on some disadvantages of distance learning in the issue of formation of independent work skills. For example, a traditional lecture stimulates independent search for knowledge, including through the charisma of the teacher and his involvement in the subject. In the electronic course, there are no facial expressions and gestures, pauses, changes in the tone of voice, i.e. all those means that emotionally colour knowledge and traditionally contribute to more effective perception of the material, focus students on their independent work. Emotions are an integral part of cognition. As a consequence, old forms and methods that activate students' independent work do not fit into the distance format.

Today students know where and on which website to find the necessary information, but they are unable to independently assimilate educational and scientific text, which leads to a decrease in the level of system-forming knowledge. That is why, it is so important to know about the mechanism of independent activity to assimilate the content of the training course, the formation of skills to use this mechanism in the learning process. This mechanism can be created only on the basis of the methodology of interrelation of integrative and differentiated approaches to independent work. The task is to develop a theory explaining how a new construction of knowledge occurs in a new format of learning.

When conducting classes, there is no confidence that students are actually present in the class, listen, and, most importantly, understand what is being discussed. The modern student has a great temptation and enough ways of "non-self-study", and the instructor has little opportunity for quality control of such costs of distance technologies.

Lack of full-fledged practical and laboratory classes, a real chemical experiment, in turn negatively affects the formation of skills of independent work, practical skills. As a consequence, all this affects the process of knowledge assimilation, development of thinking, thought processes, memory (a person remembers not only image and sound, but also odours, sensations). This is not the case in distance learning. On the basis of sensations, a more meaningful perception is created, and this is the first condition for achieving correct, conscious and solid knowledge.

In the distance format, video experiments involve only the distance senses (vision, hearing), which perceive stimuli at a distance. The contact senses (taste and touch) and the sense of smell, which perceive stimuli only by direct contact, are not involved in distance learning.

Therefore, it is necessary to provide didactic techniques to compensate for them.

#### **5. Research Methods**

One of such techniques can be considered a detailed verbal description of the chemical experiment, involvement in the observation of the chemical process in all details. However, this does not

solve the problem of development of independent work in comparison with individual experimentation. In order to increase the share of independent work, let us divide video experiments into fragments, in intervals between which there is an opportunity to summarise observation data, conduct mathematical and statistical processing of measurement results, explain results of the chemical experiment, and formulate conclusions.

The effectiveness of the process of knowledge assimilation is directly related to the control procedures. Of the proposed forms of intermediate and current control, the most preferred ones were testing, performance of control and practical tasks in a written form and in an online format of a sample survey of the group. Individual oral questioning and video recordings of answers to control questions were less favoured. However, according to the basic laws of knowledge assimilation, the share of oral forms of control in the distance format should be higher (Lipich & Balahura, 2024; Regnerová et al., 2024; Shumilina & Antsiferova, 2024).

One of the conditions that determine the effectiveness of distance learning is adequate evaluation of students' own learning process. Factors that may influence the concept of control should be studied in order to accurately reflect the complex interaction between an instructor and students in a distance-learning environment.

Subject learning is both an individual process and part of a wider activity involving teachers and students. The interaction between them provides both dialogue and feedback, as well as motivation for learning. With the development of two-way interactive technologies (e.g. videoconferencing), there are more opportunities for interaction between the main actors in the learning process. A survey of 1st year students was conducted on the results of learning chemistry in a distance learning format. To the question "Your attitude towards distance learning", 56% of respondents answered positively, 32% responded neutrally, and only 12% of the total number of students expressed a negative attitude towards distance learning.

One of the questions in the questionnaire asked to assess the level of independent work skills developed at previous levels of education. Only 4% rated the developed level of independent work as low, 31% as high, and 65% of respondents indicated an average level of their own independent work skills.

Analysis of the survey data confirms the inability of students to adequately assess their own level of independent work; most students find it difficult to assess their own capabilities for independent work.

## 6. Findings

As a result of the survey, the most sensitive problems that students encountered during distance learning were identified. These include difficulties with self-organization in educational activities, subject to an increase in the share of independent work (Dokuchayeva et al., 2024; Tang & Yang, 2024).

Students noted difficulties in independently comprehending chemical content; they had difficulty maintaining attention while listening to online lectures. About 80% of respondents experienced psychological problems due to the lack of live contact with the teacher and classmates.

The advantages of distance learning over traditional learning were also noted: individual pace of learning; use of modern educational technologies; the ability to re-watch videos; visualization of

educational information; more time and opportunities for independent study of educational material; development of independence and responsibility in educational activities, etc.

Distance learning is a complex system consisting of subsystems interacting with each other.

In modern research on distance education, the emphasis has shifted from the technological side to problems associated with teaching and student learning. Therefore, issues that affect the student, the teacher, the technology and the teaching and learning process are becoming increasingly important.

One of the most important conditions that determine the effectiveness of distance learning is adequate assessment of students' own educational process, as well as the developed level of skills and abilities of independent work, the readiness of students to independently master subject knowledge.

No less important is knowledge about the mechanism of independent activity in mastering the content of training courses. There is no point in giving a student autonomy in choosing learning objectives and assessment procedures if he does not have the competence to exercise this autonomy.

## 7. Conclusion

Distance learning is a complex system consisting of many subsystems that interact with each other. The first studies of the distance format touched mainly on the organisational and technological aspects of the learning process. Later the focus shifted to educational problems related to effective teaching and learning of students.

Distance education has moved from the so-called teaching industry to student-centred learning, to the exploration of the problem of the student's collaboration with the teacher and technology in order to acquire and assimilate knowledge.

The distance learning format depends on the level of formation of students' independent work skills, assumes their further development and formation of independence as a personality trait.

When discussing distance learning, it is necessary to talk not only about the technology of the learning process, but also to correctly formulate the system of didactic tasks. This is, first of all, the creation of a new model of student's activity based on the basic psychological theories of knowledge assimilation.

It was believed that the distance learning format could completely replace the traditional learning model. However, as a result of the study, significant shortcomings were identified, especially related to the teaching of natural sciences, including chemistry.

This is, first of all, the lack of full-fledged practical and laboratory classes, a real chemical experiment, which in turn negatively affects the formation of independent work skills and practical skills. As a result, all this affects the process of acquiring knowledge, the development of thinking, thought processes and the functioning of memory.

Subject learning is both an individual process and part of a broader activity in which teachers and students participate. The interaction between them provides both dialogue and feedback, as well as motivation for the learning process. Motives for learning should be considered in conjunction with skills and abilities of independent activity.

The effectiveness of the knowledge acquisition process is directly related to control procedures. in accordance with the basic laws of knowledge acquisition, the proportion of oral forms of control in a

remote format should be higher. And here, direct contact with the teacher, the psychological aspects of this contact, including empathy and emotional responsiveness to the students' experiences, are important.

As a consequence, when discussing distance learning, one should talk not only about the technology of the educational process, but also correctly formulate a system of didactic tasks. This is, first of all, the creation of a new model of student activity based on basic psychological theories of knowledge acquisition.

Distance education should be focused on the student, on exploring the problem of his cooperation with the teacher and technology in order to obtain and assimilate knowledge.

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