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ADVANCING INSTRUCTIONAL METHODOLOGIES IN HIGHER EDUCATION VIA INFORMATION AND COMMUNICATION TECHNOLOGIES

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Abstract: The paper explores the benefits of applying information and communication technologies in subject instruction, such as fostering students' knowledge and competencies, increasing instructional efficiency, personalizing training activities, and strengthening student motivation.
Keywords: information and communication technologies, didactic system, multimedia, problem-based principle.

Introduction. Programs aimed at the informatization of education, including chemistry instruction, have been consistently reflected in official documents at various levels. Moreover, numerous studies focusing on the modernization of chemistry education invariably emphasize the principle of informatization. However, in many of these studies, the extensive potential of modern information and communication technologies (ICT) is largely limited to the use of office software for processing experimental data, specialized ChemOffice packages for molecular structure modeling, and recommendations related to computer-based testing.

Main Part. This situation can be explained by both objective and subjective factors. Objective reasons include the insufficient availability of computer laboratories in higher education institutions, limited network bandwidth, and the lack of adequate software and methodological support. Subjective factors, according to several researchers, are associated with the conservatism of educators and the education system as a whole, as well as the insufficient professional readiness of teaching staff.

One of the main reasons for the limited use of ICT in higher education lies in the reluctance of experienced educators to replace well-established and familiar teaching methods with new approaches. As a result, many teachers are not yet prepared to integrate computers into the instructional process. On the other hand, a significant drawback of multimedia educational resources is the weak methodological design of learning courses, since most such software products are not developed by specialists in the relevant academic fields.

However, the most critical problem, as emphasized by many scholars, is the absence of pedagogically grounded principles for computer-assisted learning recognized by educational science. Consequently, there is an urgent need to develop innovative approaches and methodologies aimed at integrating computer technologies into chemistry education and at enhancing the information culture of chemistry teachers.

Numerous studies by various scholars have been devoted to different aspects of the use of computer and telecommunication tools and technologies. Depending on the way the research problems are formulated and the specific issues addressed, noticeable differences can be observed in the terminology employed by the authors. At present, pedagogical literature widely uses such terms as computer technologies, information technologies, modern information

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technologies, information technologies in teaching, new information technologies, and information technologies in education [1].

Some researchers interpret information technologies in teaching as the application of computer networks, including the global Internet, within the instructional process. According to their views, the Internet can compete with the teacher by delivering course content to learners in a rapid and engaging manner. Moreover, it is capable not only of providing answers to learners' questions, but also of supporting the formulation of these questions in an appropriate and meaningful way [2].

Indeed, computer networks represent an enormous information space. However, while the Internet offers access to answers to a wide range of questions, concerns regarding the reliability and accuracy of the available information remain. For example, the well-known World Wide Web service of the Internet integrates web pages that can be created using software such as MS Word and MS Excel. As a result, the number of such pages reaches hundreds of millions, and no guarantee can be given regarding the credibility of the information stored on them [3].

Nevertheless, educational objectives such as professional competence, a modern worldview, and creative thinking can be effectively achieved only through the systematic use of information resources. At this stage, global networks provide access to scientific and instructional–methodological databases, enable information exchange among educational institutions, teachers, and students, and support the organization of teleconferences. In other words, they make it possible to obtain relevant information on specific issues within a short time and without significant financial costs.

As is well known, a network represents an integrated system of computers, communication links, and software resources. The integration of intelligent computer systems with telecommunication networks should be reflected in educational processes. Therefore, it is appropriate to define such integration as information and communication technologies (ICT). Accordingly, ICT can be understood as a set of pedagogical techniques, teaching methods, and educational technologies based on the use of computer and communication tools.

In other words, information and communication technologies in education constitute a combination of organizational forms, pedagogical technologies, and learning management tools that rely on modern computer and communication resources and ensure the achievement of educational standards.

The significance of ICT in modernizing chemistry teaching and teacher training systems necessitates an analysis of the principles governing their application in the educational process, particularly didactic principles. At the current stage of development of higher education pedagogy, the methodological requirements for implementing ICT in teaching do not imply replacing traditional didactic principles with new ones. Instead, these principles should be reconsidered, enriched with content relevant to contemporary conditions, and applied in a well-founded and systematic manner [4].

One of the key conditions for integrating ICT into higher education practices is the readiness of both teachers and students to use these technologies. Currently, unfortunately, many educators perceive the introduction of ICT into the learning process merely as the implementation of computers within the higher education system. This is likely an oversimplified and one-sided understanding of the issue. In reality, it encompasses processes aimed at reorganizing the learning experience at a higher level, as well as creating a new

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didactic model of teaching that ensures optimal interaction between humans and computers across all areas of higher education.

In the modern rapidly changing environment, several trends can be identified: teachers become partially freed from some didactic functions, especially control-related tasks, and focus more on creative approaches; their roles shift, providing broader opportunities for guiding students' learning activities; and the requirements for teachers' computer literacy increase. According to S.I. Arkhangelsky, "the nature of teachers' activities changes, taking on a 'creative-consultative' form."

It is important to emphasize that in the context of ICT usage, the teacher's role not only remains leading but also becomes more complex. The teacher prepares learning materials, develops interaction structures and algorithms with ICT, establishes criteria for managing students' activities, and more. The essence of their work changes, increasingly taking a consultative nature, which demands continuous updating not only of knowledge and professional skills but also of methodological competence.

From a psychological perspective, using ICT can present challenges for some teachers due to low computer literacy, fear of working with new technology, or lack of experience with computers. The novelty of computer-based learning processes and additional requirements can inadvertently create uncertainty and specific psychological barriers for educators.

In such conditions, a crucial factor for the effectiveness of a teacher's professional activity is computer culture. That is, a teacher using ICT in the learning process should understand the capabilities of computers in their field, be skilled in applying ICT appropriately, select and use learning materials effectively, create problem-based situations during lessons, or collaborate with programmers to develop teaching software tools.

Another crucial condition for the effective use of ICT in education is the teacher's intrinsic motivation to employ it. This implies that a teacher should recognize how these technologies can assist in solving various pedagogical tasks efficiently, such as highlighting the significance of the studied material, enhancing its assimilation, developing practical skills, managing students' learning activities, and recording learning outcomes. Moreover, ICT enables the automation of routine pedagogical processes, allowing teachers to gain more free time. Unfortunately, in many higher education institutions, ICT-related initiatives are not centralized, and the real workload of teachers is often not considered in their personal work plans.

Under ICT implementation conditions, the teacher's role becomes significantly more challenging. They are required to operate in a new pedagogical environment using modern instructional tools. Through ICT, the teacher can directly influence students via strategies implemented in this environment. Consequently, the nature of their work changes, demanding engagement in functions not typically present in traditional teaching.

It can be concluded that currently, the computer readiness of professors and lecturers lags behind the demands of the modern era. Their psychological and pedagogical preparedness for ICT use does not meet required levels. For example, 90% of technical and specialized subject teachers, and 70% of all educators, lack foundational psychological and pedagogical readiness. This situation necessitates the creation of targeted practical guidelines.

Analysis of leading universities' experiences indicates that psychological and pedagogical readiness of teaching staff is developed through various forms, such as skill enhancement centers, methodological workshops, exchanges of best practices, and young teacher schools. These programs cover all areas of pedagogy and psychology in higher education. However, the

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scope and complexity of these programs often do not allow for in-depth exploration of critical aspects of modern pedagogy within the given course timeframe. Furthermore, seminars or practical sessions addressing these issues are frequently omitted.

Another limitation of existing programs is that they are not tailored for the specific needs and readiness levels of individual departments. This results in a generalized approach to developing psychological and pedagogical preparedness, often overlooking the essential need for individualized guidance.

It is advisable to structure the preparation of professors and lecturers for ICT use into three main sections to achieve the program's objectives effectively. The first section is conducted at the level of the entire higher education institution, the second at an interdepartmental scale for related faculties, and the third directly within individual departments. For conducting sessions in the first and partly the second sections, pedagogical and psychological instructors of the university are involved. Sessions for the third section and partly the second section are led by experienced teacher-methodologists from the respective departments.

Considering the content of the subjects being taught as well as the requirements of national education standards, related faculties can be grouped as follows: Group 1 – Humanities faculties; Group 2 – Natural and scientific faculties; Group 3 – General education faculties; Group 4 – Specialized faculties. The psychological and pedagogical readiness of teachers in these groups should be developed according to the principle of differentiation, meaning that ICT-related knowledge, skills, and competencies are divided into two types: general-didactic (necessary for teaching any subject) and specialized (required for teaching specific subjects). Analysis of advanced practices in higher education, along with interviews with teachers from several institutions, indicates that for successful ICT integration, teachers must possess a set of knowledge, skills, and competencies, including the following:

General-didactic knowledge: the concept of ICT, its significance, didactic functions, and potential; types and classes of computers and information tools; principles of ICT application; the role and importance of ICT in the learning process; psychological and pedagogical conditions for ICT use; effectiveness of ICT implementation in teaching; teaching methods and forms based on ICT and their instructional design technology.

General-didactic skills and competencies: identifying the role and significance of different computer tools within ICT, utilizing their didactic potential, selecting software based on psychological and pedagogical factors, preparing necessary learning materials for ICT-based lessons, and applying them effectively in the learning process.

Specialized knowledge: The role and significance of ICT in higher education, operational and technical characteristics of the tools used, their didactic potential, specifics of integrated use of software tools, and technologies for applying ICT across various types of educational activities.

Specialized skills and competencies: Justifying the role and importance of different software tools in various learning activities across subjects; identifying appropriate learning materials (topics, laboratory work) for specific ICT applications; selecting optimal methods for conducting lessons within ICT environments; creating didactic materials, developing algorithms for practical software products, preparing methodological guidelines, and acquiring skills to work with communication tools and their software support; evaluating and analyzing the effectiveness of ICT-based learning activities.

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Thus, in the general-didactic component of teacher preparation, a system of ICT-related knowledge, skills, and competencies is developed, while in the specialized component, these are consolidated and specified according to particular subject needs.

The final stage in assessing teachers' readiness and ICT competence is the practical application of acquired knowledge, skills, and competencies in actual teaching activities. At this stage, the teacher's preparedness reaches its logical conclusion.

The readiness of young teachers who are newly entering the profession is particularly important. For them, acquiring knowledge about ICT in the initial stages of their professional activity is essential. To achieve this, it is advisable to include a specialized section in skill development centers, such as "Information Technologies in the Educational Process.".

Conclusion and Recommendations. Based on the general-didactic principles outlined in numerous studies, we aim to highlight the core principles of ICT application in higher education. The principle of compliance with the laws of teaching within a didactic system is considered fundamental, as it ensures that students' learning activities are organized according to objective educational laws. The essential nature of these laws lies in the gradual assimilation of scientific content by the learner. Consequently, when applying ICT, teaching goals should be achieved step by step, through the resolution of a series of specific didactic tasks.

The principle of relevance of theoretical knowledge emphasizes the appropriateness of organizing the didactic process with ICT involvement. At the initial stage, students acquire information about the theoretical content of the topic; in the intermediate stages, they assimilate specific aspects of each task; and by the final stage, they achieve comprehensive understanding and mastery of the subject.

The principle of unity of scientific, educational, and assimilative functions of teaching must also be observed. Its implementation begins at the stage of designing electronic educational resources. Such resources, which store learning materials, not only support the learning process but also facilitate the scientific, developmental, and educational functions of teaching. From a methodological perspective, well-designed computer programs are closely linked to the teacher's personal expertise and, importantly, influence students' emotional and cognitive engagement. For example, working with computer-based laboratory practicums enhances students' analytical thinking, develops their ability to justify decisions, and fosters essential qualities such as responsibility, conscientiousness, and moral integrity.

The Principle of Problem-Based Learning reflects the laws governing the creative assimilation of knowledge and activity methods, as well as the acquisition of creative skills. This principle encourages teachers to create problem situations when applying ICT, thereby activating and intensifying the learning process. It promotes the development of creative and research-oriented traits in students.

The Multimedia Principle can be considered an advanced form of the traditional principle of visual demonstration. Its essence is that teaching should be multimedia-based. In accordance with this principle, ICT-supported learning must be organized to ensure interconnections across disciplines, creating a coherent and integrated learning environment.

The Principle of Activating Independent Learning emphasizes that ICT use should support personal development, enable the learner to identify and develop their capabilities, recognize their subjective experience, and establish pedagogical interactions based on that experience. The ICT-based educational environment should not restrict student activity; rather, it should

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provide conditions for learners to independently choose their paths of development and engage in self-directed learning.

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