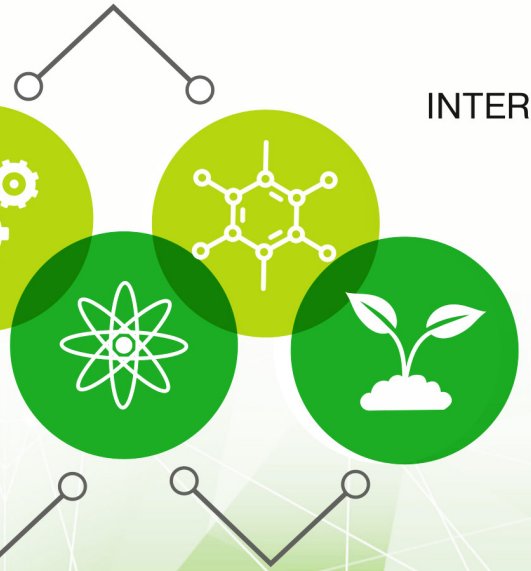
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TEACHING CHEMISTRY DISCIPLINES IN THE CONDITIONS OF DISTANCE LEARNING

Resume. *The article reveals the peculiarities of teaching chemistry disciplines, in particular "Organic Chemistry" and "Biochemistry", from the practical point of view in the conditions of distance learning in higher education institutions. It was determined that teaching chemistry disciplines requires the use of such learning tools as computers with special software, communication and remote sources of information. The authors have considered the forms of teaching chemistry disciplines in conditions of distance learning in higher education institutions. The advantages and disadvantages of distance learning while studying chemistry disciplines in higher education institutions are highlighted. The peculiarities of using virtual laboratories in the conditions of distance learning in higher education institutions are outlined. The authors have identified the programs which help to organize the process of distance learning. Special attention is paid to Moodle platform, which is used by most higher education institutions for teaching chemistry disciplines in the conditions of distance learning.*

Keywords: *distance learning, chemistry disciplines, virtual chemistry laboratory, institutions of higher education.*

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ВИКЛАДАННЯ ДИСЦИПЛІН ХІМІЧНОГО СПРЯМУВАННЯ В УМОВАХ ДИСТАНЦІЙНОГО НАВЧАННЯ

Анотація. *У статті розкрито особливості викладання дисциплін хімічного спрямування, зокрема «Органічної хімії» та «Біохімії», в умовах дистанційного навчання у ЗВО з точки зору практики. Визначено, що при дистанційному навчанні хімічних дисциплін основними засобами навчання є комп'ютери зі спеціальним програмним забезпеченням, зв'язок і віддалені джерела інформації. Розглянуто форми викладання дисциплін хімічного спрямування в умовах дистанційного навчання у ЗВО. Виділено переваги та недоліки дистанційного навчання у ході вивчення хімічних освітніх компонентів у ЗВО. Розглянуто особливості використання віртуальних лабораторій в умовах дистанційного навчання у ЗВО. Визначено програми, за допомогою яких проходить процес дистанційного навчання, зокрема особливу увагу наголошено на програмі Moodle, яку застосовують більшість ЗВО для викладання дисциплін хімічного спрямування в умовах дистанційного навчання.*

Ключові слова: *дистанційне навчання, дисципліни хімічного спрямування, віртуальна хімічна лабораторія, заклад вищої освіти.*

Formulation of the problem. The use of innovative technologies has become an integral part of the modern educational process. The introduction of a convenient and effective distance learning mechanism is necessary to perform the current educational task in accordance with the needs and problems of society. The main mission of higher education institutions is to train positively motivated and professionally competent specialists so that they could independently acquire and update knowledge, as well as respond quickly to constant changes in the educational space.

One of the most difficult tasks in the study of natural sciences, in particular chemistry disciplines, is to acquaint students with the current achievements of chemical science and its practical application both in industry and everyday life. The complexity of the work is mainly due to the limited capabilities of the chemistry laboratory equipment, the use of individual chemical elements and compounds, as well as the fact that today the educational process is mainly carried out remotely. Therefore, one of the ways to solve this problem is the use of so-called virtual chemistry laboratories.

In view of this, the introduction of distance learning in the study of chemistry educational components is quiet relevant today.

Analysis of recent research and publications. The problematic aspects which arise in distance learning of chemistry disciplines in higher education institutions (HEIs) are the basis of research done by many scientists. In particular, thorough research in this direction is carried out by O. Antypenko, I. Voitovych, O. Voskoboinik, N. Dushechkina, J. Georgiou, O. Holovchenko, K. Dimitropoulos, L. Yehorova, A. Manitsaris, I. Nazarko, H. Okrepka, L. Fillipova, N. Chernikova, etc.

Taking into account the research of the named authors, we note that the issue of distance learning of chemistry disciplines with the use of practical approach in higher education institutions is not fully considered.

The purpose of the research is to reveal the advantages and disadvantages of teaching chemistry disciplines, in particular “Organic Chemistry” and “Biochemistry”, from the practical point of view in the conditions of distance learning in higher education institutions.

Presentation of the main material. Distance learning technologies offer a wide range of opportunities to provide educational content, to check the quality of knowledge and students’ progress. The main task is to develop an entire course of study by specialty, integrating all the possibilities of modern information and educational technologies.

The implementation of distance learning is based on the application of the most modern electronic media technologies, as well as on the use of traditional teaching aids and paper materials: training manuals, teaching recommendations and other available software and methodological support [1, p. 10].

The use of information technologies in the study of chemistry disciplines can radically change the way teachers work and therefore lead to changes in students’ understanding of the nature of educational materials.

It is necessary to single out the advantages of distance learning in the study of chemistry disciplines in higher education institutions [2]: 1) accessibility and quick search of the necessary information; 2) performance of work and recommendations for studying at a time convenient for students; 3) a continuous communication process with teachers; 4) individualization of active cognitive processes and learning; 5) the opportunity to provide students with modern and up-to-date knowledge; 6) communication which takes place through e-mail, forums, private chat and organization of video conferences. At the same time, the disadvantages of such training are: 1) difficulties in choosing the necessary material from the available amount of information; 2) absence of mobile connection and the Internet in most rural settlements; 3) inability to acquire practical skills by conducting chemistry experiments; 4) overloaded educational systems; 5) aggravation of the problem of students' identification, self-confidence and formulation of beliefs.

In order to teach chemistry disciplines, we implement online learning quite actively and search for alternatives to provide practical laboratory and project components of distance learning.

Due to recent events in the country, it is impossible to conduct real experiments and chemistry experiments with reagents. Hence, students cannot effectively study chemistry disciplines and perform all the experiments and research provided by the curriculum of the educational program. Therefore, special virtual laboratories have been created to conduct such experiments and research in distance learning mode. The use of virtual laboratories in the conditions of distance learning has a number of advantages, including the possibility of modeling and visual demonstration of certain chemistry experiments or research.

In addition, the advantage of using virtual laboratories in the conditions of distance learning in higher education institutions is the development of students' training, since compared to real laboratory works, it allows the following: to simulate the processes that cannot be implemented in laboratory conditions; to work safely with hazardous materials or equipment; to save money on expensive reagents and equipment; to ensure independent organization and conduct of virtual experiments by students. When studying certain topics on such disciplines as "Organic Chemistry" or "Biochemistry", the use of virtual laboratories significantly expands the list of visualization tools and allows you to illustrate theoretical problems with chemistry experiments and research.

The organization of students' independent work by means of distance learning has many advantages. In particular, it is the individualization of the process of acquiring knowledge, skills, and competencies. At the same time, distance learning can be based on the use of computer training manuals, electronic textbooks, etc., which are currently available to students through the Internet and local (internal) computer networks [3].

Since the effectiveness of learning during laboratory works on such educational components as "Organic Chemistry" and "Biochemistry" largely depends on the quality of the educational material visualization, it is recommended to use auxiliary software such as editors of chemical formulas and application programs to create three-dimensional models of molecules, etc. For this, it is worth using the chemical editors BKChem (Beda Kosata, open source software) and ChemSketch (Advanced Chemistry Development Inc., free for academic use), KingDraw (a free chemical structure editor available on Android, iOS 69 and Windows PC)

and Avogadro molecular modeling software. The specified software can be integrated with MS Teams through the "share content" function to show the working window of the specified application to the participants of the video conference. The use of Avogadro molecular modeling software proved to be most useful, as the demonstration of models made it much easier for students to explain such phenomena as stereoisomerism, the effect of the spatial structure of organic compounds on their reactivity and mechanisms of chemical transformations, the structure of proteins, etc.

It is worth noting that the use of MS Whiteboard software in combination with such devices as a graphics tablet has proven to be effective in teaching the subject of "Organic Chemistry". A graphics tablet has a stylus and a touchpad, and it is a relatively inexpensive device. Using a graphics tablet makes particular sense if handwritten information needs to be entered, since here the input of information is much more accurate and faster than with the help of classic mouse-type manipulators. The experience of using graphics tablets led to the creation of structures, reaction schemes that describe the mechanisms of chemical transformations [4].

The process of developing the content of chemistry materials for distance learning is based on the following methodological approaches [5]:

1) system approach (configuration of the content of the communication course in accordance with the work schedule);

2) complex approach (complex implementation of educational tasks, various methods and means of learning, application of modern information technologies, assessment and taking learning outcomes into account);

3) active approach (different levels of students' activity, with their individual capabilities being taken into account);

4) personally-oriented approach (disclosure and use of students' individual skills, cognitive abilities).

One of the disadvantages of distance learning, especially in the course of teaching chemistry disciplines, is the lack of laboratory (experimental) classes. In this regard, the use of virtual laboratories and computer simulations is promising. Although they cannot completely replace real chemistry experiments, they allow us to model and to some extent manipulate the objects that prevent their implementation [6].

The main problem in distance learning of chemistry disciplines is the performance of practical tasks. In most universities the main requirements for studying chemistry disciplines include laboratory work and internships, and the corresponding courses require at least one month of laboratory work per semester. In distance learning, laboratory classes can be conducted with the help of virtual chemistry experiments. Unfortunately, it is impractical and does not allow students to feel and see the types and conditions that make chemistry an experimental science.

We would like to note that information technologies have a number of specific opportunities. Their use is important and can be effective if it is provided with a well-balanced and didactic use of research in the field of chemistry, in particular [7]:

1) the virtual world allows you to conduct chemistry experiments without any harm to students' health;

2) you can demonstrate complicated chemistry experiments while reading lectures or use videos of experiments which show harmful and explosive chemical reactions;

3) you can demonstrate complex models of various projections;

4) transformative activity according to the subject of study;

5) bringing the educational process closer to the real sphere of activity.

A virtual learning environment, in particular a virtual laboratory, can be used as programs that perform integrated educational functions, providing students (users) with theoretical background information and helping them interpret experimental results. Also, the use of the virtual laboratory gives an opportunity to get acquainted with the equipment of the chemistry laboratory and conduct virtual experiments.

The virtual chemistry laboratory contains a separate module of laboratory work on the construction of mechanisms of chemical reactions, which are intended for the creation of educational presentations for such disciplines as "Organic Chemistry" or "Biochemistry". When we construct the mechanisms of chemical reactions, atoms, substances, chemical bonds are assembled, and operations are performed with the elements of a chemical reaction (allocation, displacement, addition, subtraction, etc.). The high degree of animation interaction and the variety of design options have a positive effect on training students' sustained attention, as well as greatly facilitate the study of chemistry disciplines, in particular the specified educational components.

The use of chemistry virtual laboratories in higher education institutions is an integral part of the educational process organization, especially in the conditions of distance learning, which: contributes to the formation of practical skills during interactive laboratory courses which are provided with real conditions; provides an individual pace for mastering the skills of a chemistry experiment; allows you to study processes that require special conditions; helps increase motivation to learn new material by working in a virtual environment that resembles a modern student environment; provides independent preparation for conducting experiments in real laboratory conditions [8]. However, the use of virtual laboratories for chemistry disciplines cannot completely replace traditional laboratory work. Using virtual laboratories, the student acquires the skills of conducting chemistry experiments, expands the limits of performing laboratory experiments.

Among many other virtual laboratories, the ChemCollective virtual laboratory is widely distributed and used. It includes a set of virtual laboratories, learning scenarios, manuals and tests [9].

In the distance learning of chemistry disciplines, various ICT tools are also used, such as e-books, computer networks and educational portals. It should be noted that the use of ICT depends on a set of didactic goals. Practice shows that today in the conditions of distance education: it is possible to demonstrate the conditions and solve chemistry problems with the help of such programs as Skype, Viber, WhatsApp, Telegram, etc.; to conduct chemistry experiments using a virtual chemistry laboratory or video conferences; to assess knowledge using tests in Classroom or Moodle programs, etc.

Many HEIs have a learning management system Moodle (Modular Object-Oriented Dynamic Learning Environment). When organizing remote work for teaching students the basics of organic chemistry and biochemistry, the flexibility of Moodle platform allows teachers

to create and manage distance courses using time limits, create their own system for evaluating students' educational achievements, control the process of submitting completed tests, assignments, web cases etc; to track the timeliness or delay in assignments submitted by students.

In the conditions of distance learning, Moodle platform for teaching chemistry disciplines in the information and educational environment of higher education institutions should contain the course structure, work program, curriculum, glossary, rating scale, distribution of points, recommended literature, feedback on the distance course; meaningful modules; topics and questions for independent work; a list of individual educational and research tasks, projects; modules and final assessment, etc.

Research conclusions and prospects for further work in this direction. According to the results of the research conducted during distance work with full-time students, it was determined that the formation of high-quality chemical knowledge, abilities and skills that will become the basis of students' future professional competence is possible in the conditions of distance learning, where students can study the theory with the help of modern ICT, and laboratory work can be performed with the help of virtual chemistry laboratories. Distance learning can be considered an alternative to classical education, since students have the opportunity to master the material of the educational components presented in the curriculum of such disciplines as "Organic Chemistry" and "Biochemistry".

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