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Teaching Physical Chemistry: Developing and Using an Electronic Course in the Discipline

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Abstract. An electronic course (EC) "Physical Chemistry" was created on the basis of the Hypermethod platform for full-time bachelors of the Chemical and Technological Institute of the Ural Federal University (180 people in 2019). The developed EC refers to mixed (hybrid) courses. It combines the classroom work of students in lectures and laboratory work and work on the Hypermode platform to fulfill educational tasks. The choice of the course model is due to both the specifics of the training discipline and the peculiarities of the content of the curriculum of the discipline. Most of the course is e-Learning. It includes the performance of 4 calculation works in physical chemistry. Each design work contains 2 to 4 tasks. Each task provides for arbitrary variation of the option number for each student, and the total number of options for one task is 20-22 options.

INTRODUCTION

Recently, information technologies have been intensively developing. They are gradually being introduced into the educational process. Different authors, considering this issue, note the peculiarities of the use of electronic educational resources and their impact on the quality of the educational process [1-4].

L.V. Dobrova considers the problems of using modern information technologies in the independent work of students of engineering specialties in a technical university [1]. She emphasizes that «the goal of higher education is not so much to fill students with a certain amount of information, but to form them cognitive strategies for self-study and self-education as the basis and integral part of future engineering activities» [2].

I.K. Voytovich reviews the published literature on the role of the electronic information and educational environment of educational institutions in the conditions of informatization of society and education, assessing its quality and results and influencing the achievements of students [2,3]. Great attention is paid to the situation of teachers in e-learning. Particularly important in the opinion of the author of the article are: issues of information literacy and information and communication competencies, which should be owned by a modern teacher; development and design of electronic educational resources; teaching in a different educational environment from the traditional one, which involves ways and styles of interaction that are uncharacteristic for the traditional student group; evaluation of student knowledge and e-learning quality in general.

Great attention is paid to creation of electronic course or network educational and methodical complex [3,4].

In work of reference [3] the algorithm of electronic course creation is given:

- Selecting or creating course content for electronic presentation;
- Definition of the model of the electronic training course taking into account the didactic and methodological principles of its construction;
- Selecting the toolkit that will be used to create digital content;
- Selecting a platform for remote content hosting;
- mastering a new type of interaction.

The difference between the online electronic educational and methodological complex and the usual textbook, according to E.Ya. Sokolova [4] is that the teacher has the opportunity to update constantly the material and make adjustments. Various electronic resources are located on the educational platform that allow organizing educational interaction. The student not only studies the material on his own but has the opportunity to interact with the teacher and other students in the group. The electronic complex provides interactive operation with ease

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and ease of navigation, as it quickly moves from one topic to another in the structure of the electronic educational publication.

L.M. Teslyuk and coworkers reported [5] on the basis of the analysis of the use of the electronic course in the economic discipline using the e-learning system on the Hypermethod platform considers the peculiarity of the use of electronic courses and assesses their impact on the quality of the educational process. Data were systematized, analyzed and interpreted on the components of the educational process that determine its quality. Data sources were information provided by the Hypermode system (number of students entering individual classes, dates and time of passing tests, etc.), data from the ballroom rating system, student feedback.

EXPERIMENTAL PART

Consider the development of electronic courses in physical chemistry in network electronic education on the Hypermethod platform. Department of Physical and Colloidal Chemistry of Ural Federal University, where the authors of this work have been working, has long been successfully introducing information technologies into the educational process [6,7]. Before the creation of electronic courses, the main attention was paid to the development of electronic educational complexes, electronic laboratory work, and electronic educational resources. So over the past 10 years, 16 electronic educational resources have been posted on the portal of information and educational resources of the Ural Federal University, which have been developed on the topic of the course "Physical Chemistry" according to the documented procedure. These resources were examined by specialists and approved by the methodological commission of the university.

The authors developed the educational content of future electronic courses themselves, and not searched the Internet. The authors tried to cover the material of the entire work program.

The creation of an electronic course in physical chemistry is ripe simultaneously with the work on the creation of methodological support for the independent work of students in the study of physical chemistry. The methodological support is that the authors have prepared textbooks. These manuals have recently been published to explain the solution of problems in physical chemistry [8-11]. The need for publishing these manuals was due to the exclusion of practical training from the work plans. It is known that it is impossible to study such science as physical chemistry without applying theoretical provisions to solve practical problems. Solving problems in physical chemistry without methodological advice from a teacher is almost unrealistic.

Having completed these textbooks, the course authors have thus established an extensive framework for the development of e-courses in physical chemistry.

RESULTS AND DISCUSSION

The electronic course «Physical Chemistry» developed by us refers to mixed (hybrid) courses, which combines the classroom work of students in lectures and laboratory work and work in a networked environment on the Hypermode platform to fulfill educational tasks. The choice of the model is due to the course both the specifics of the training discipline and the peculiarities of the content of the training curriculum of the discipline. Physical chemistry refers to the fundamental chemical sciences. When presenting the material, great attention is paid to the theoretical conclusions of various equations obtained experimentally. This cannot be transferred only to the independent work of students. For a better understanding of the material, it will be better if the teacher considers these questions, showing the features of the conclusion, assumptions, and methods of conducting the analysis of the resulting equations. The role of classroom work in the form of lectures in the case of physical chemistry is very large and its replacement with independent study will reduce the quality of student education.

The second type of classroom work in the electronic course under consideration is a laboratory workshop. Laboratory work in chemistry is the acquaintance of students with the method of conducting experiments and obtaining skills in conducting an experiment, analyzing results, these are student achievements and errors, etc. It is believed that the laboratory workshop on chemistry should be only real. But laboratory work on physical chemistry in a general number of laboratory work on chemistry has features. The student not only looks qualitatively at what happened in laboratory work, or quantifies, for example, concentration, or some other parameters. The main difference between laboratory work on physical chemistry and laboratory work on other chemical disciplines is that dependencies are obtained here, often described by some equations, and the student then works with these dependencies. This factor allows you to translate real experimental laboratory work into the format of electronic laboratory work, without compromising the goals of laboratory work. Which, for example, was done in the spring of 2020 during the period of distance learning in the disciplines «Non-equilibrium phenomena in complex chemical processes» and «Experimental studies of physicochemical laws». These disciplines are the second part of physical chemistry.

Most of the course is taken for electronic training. It includes 4 calculation works in physical chemistry. Each design work contains 2 to 4 tasks. Each task provides for arbitrary variation of the option number for each student, and the total number of options for one task is 20-22 options.

The components of the educational process of the electronic course, implemented on the basis of the Hypermethod platform for full-time bachelors of the Chemical and Technological Institute of Ural Federal University (180 people in 2019).

1. It is worthy to note the openness and availability of information about the course. Before the e-course student there is always a schedule for learning the discipline, methodological recommendations for studying the course.
2. Another important component of the educational process is the openness and accessibility of educational materials. Despite the fact that lectures in this electronic course are held as an audience, the course materials include notes of all lectures. This is convenient for students. The availability of notes allows you to supplement those fragments that did not have time to write to lectures, to clarify some points. Course lecturers in the electronic course have developed examples of problem solving and task options for self-study. For self-control and preparation for intermediate control in discipline included control questions and tests in physical chemistry.
3. Let's take a look at the interaction between the teacher and the students when performing training tasks. Structured by section of the work program, the training tasks have evaluation criteria, a list of literature. Links to reference materials and solution examples can be attached to the training if necessary. Training assignments change by about 25% each.
4. The work of students (and this can be a photo of a decision recorded on paper; files typed in Word, etc.) as well as reviews of the solutions given by the teacher are saved in the system with the date and time. This is another component. It gives students the opportunity to present their works in a convenient form and get acquainted with the results of the audit.
5. In Hypermode, learning achievements are conveniently monitored and monitored using the menu function Material Study Statistics and Scorecard. The solution of an individual student is always available to the teacher.
6. The degree of satisfaction of trainees in studying the discipline is quite high. Students like the freedom to choose the time to study the discipline and complete the educational task. They are not shy about communicating with the teacher. You can still add the degree of satisfaction of teachers because the activity of students in passing the tasks of calculation work has significantly increased.

CONCLUSIONS

The use of information technologies in the educational process increases the capabilities of the teacher, allowing the use of new methods and techniques of training.

Students' motivation to study discipline is increasing.

The student has the opportunity for self-education, self-realization and self-development.

The combination of classroom and out-of-audience work improves the quality of training.

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