

Development of Online-Course “Physical and Chemical Bases of Nanotechnology”

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Abstract. Tendencies of development and introduction of distance education in Russia and the world are considered. The features of online education, including in the direction of training "Nanoengineering" are given. The article shows the necessity of formation of the basic course "Physical and chemical bases of nanotechnology" on the online-platform in the direction of training "Nanoengineering". The structure of the course is given, the purpose, modules and control measures for checking the residual knowledge of the listener are specified. Presentation of the course "Physical and chemical foundations of nanotechnology" in MS PowerPoint and the availability of video materials makes it easy to integrate the course materials into the distance learning system. The development of the online-course "Physical and chemical foundations of nanotechnology" in the form of a modular structure in the distance education system allows you to embed modules, sections of the course in other disciplines of the specialty. It is proposed to develop a simulation program for practicing practical skills on the topics of the developed online-course.

1 Introduction

In the modern educational environment, distance learning, online learning using the Internet through access to a computer, tablet and even a smartphone, is becoming very popular. Around the world, educational institutions and companies are choosing to implement e-education to educate students and employees. Teachers and Tutors create their own courses and conduct webinars.

The history of distance education begins in the 1700s. In 1728, Caleb Phillips advertised in a Boston newspaper for students to study shorthand anywhere in the country by exchanging letters [1, 2]. This was the beginning of distance education—distance education. In Russia, the beginning of the emergence of distance education should be considered in may 30, 1997, when the order No. 1050 of the Ministry of education of Russia "on conducting an experiment in the field of distance education."

Currently, the line between traditional and distance education is narrowing, as most people are increasingly resorting to the Internet. Due to the rapid development of technologies, the pace of development of information technologies and distance education is also accelerating [3, 4].

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The great advantage of online training is that the student will not be able to spend time on the road, accommodation, etc. It is enough to register on the site and get access to the disciplines of interest. The user will be able to choose the time of training and the speed of mastering knowledge independently.

An obvious feature of online education is the restriction of student contact with the pre-applicant. Many sources attribute this feature to the shortcomings of online courses. However, all the advantages and disadvantages of online education should not be considered in terms of separation from people, their needs and opportunities. Each person chooses according to his capabilities what is closer, more convenient, more accessible in all respects. The opportunity to gain knowledge and skills with the least time and material costs, flexibly adjusting their education to the lifestyle and needs - has the right to exist.

2 Online course «Physical and chemical bases of nanotechnology» for the direction «Nanoengineering»

In 2015, a project to create a "National platform for open education" was initiated in Russia. Currently, the open education platform offers courses in basic disciplines from the leading universities of the country [3]. The project is focused on broad cooperation between universities.

The basic discipline for the direction "Nanoengineering" is the course "Physical and chemical bases of nanotechnology". Users will be able to master the main sections of the course: fundamental aspects of nanomaterials, nanosystems and nanostructures; methods of research of nanomaterials and nanosystems; methods of obtaining nanomaterials and nanosystems; fundamentals of the theory of growth of thin films; mechanisms of growth of nanostructures and thin films [5-7]. In addition to the theoretical knowledge acquired by the student, the possibility of working with a simulator of laboratory equipment is provided for obtaining skills of working with technological equipment.

The aim of the course – ensuring the competence of students in the field of nanomaterials and nanosystems and processes for nanomaterials and nanosystems in a wide range of technical areas, familiarization with the main methods and technologies for the generation and analysis of nanomaterials and nanosystems, acquiring skills of analysis of occupational information.

3 Modeling of the online course «Physical and chemical foundations of nanotechnology»

The course "Physical and chemical foundations of nanotechnology" takes into account all the basics of specialty areas, as well as parts of the course are available for use in a number of subsequent disciplines in the more senior courses of the specialty.

The course is structured according to modules, which corresponds to the modular rating system currently introduced in the higher education system [7]. It is convenient that any module of the developed course can be used for training in different specialty courses.

3.1 Structure and features of the online course

Before transferring the course to the distance learning system, the course structure was worked out. There are four modules in the discipline, the information in which is collected and structured in accordance with the theme of the module (figure 1).

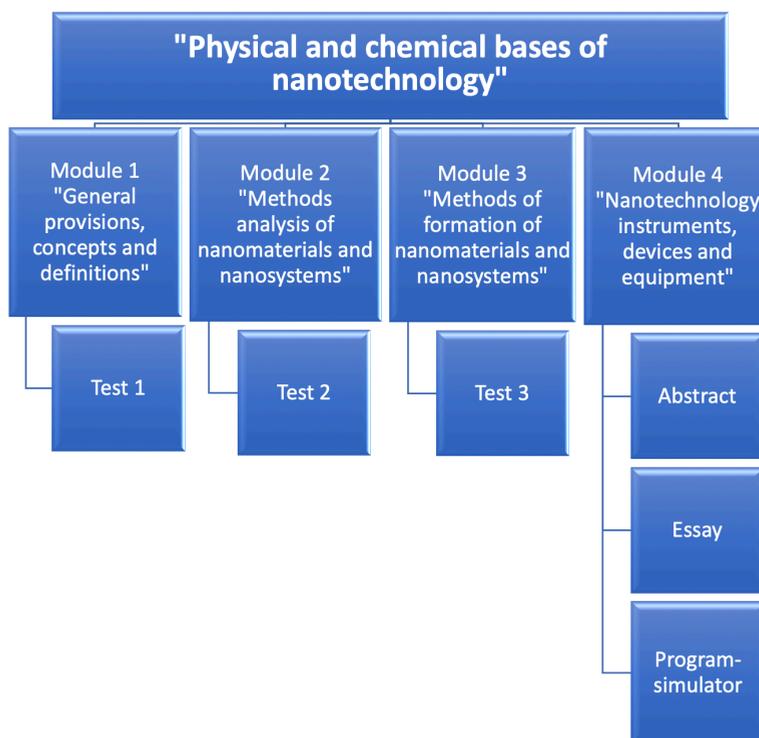


Fig. 1. The structure of the course «Physical and chemical bases of nanotechnology» with the use of control measures.

At the end of each module, control activities are expected to be carried out. So, for modules 1-3, test tasks are provided, having answered correctly 60% of these questions, the listener is credited with completing the module. If the student scored less than 60% of the declared maximum points, he is invited to re-pass the module and again pass the test tasks.

The completion of module 4 is characterized by the fact that the student prepares an abstract on the proposed topic and sends it through a special feedback form on the website of the distance learning system to the teacher for verification. In order to ensure that the work done does not end only with an assessment of a certain number of points, conferences are provided at which students present their abstracts, their work done.

Such online conferences are planned to be held in the "live" mode. Of course, it is difficult for all students to become participants of such a conference at the same time. Therefore, it is envisaged to save the presentations of participants for further viewing of the information provided by other users of the course. This approach allows to develop in the listener the competence of communication skills and the ability to present and defend their point of view. And for all students, such video presentations will become additional material on the topics of the course.

For a deeper immersion in the subject of the specialty, students are invited to visit a thematic professional exhibition and write an essay about the visit.

The developed structure of the course for each module provides structural (training) elements (lectures). In each lecture (figure 2.) there are three parts: orientation, information and diagnostic.

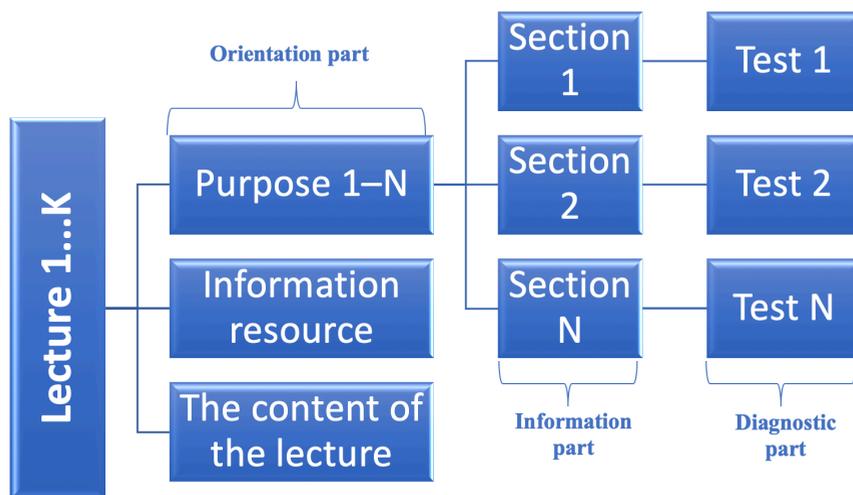


Fig. 2. Generalized structure of lectures of the course «Physical and chemical bases of nanotechnologies».

In the orientation part, the objectives of the lecture are formulated, information resources are given and the structure (content, content) of the lecture is presented. The information section highlights the thematic sections of the lecture. And the diagnostic part involves the formulation of test tasks with performance criteria and the given reference answers (for the possibility of further automated testing of the listener's knowledge).

When creating materials for an online course, the way information is presented is very important. It is obvious that the information presented in the form of text is not rational for use in online training, since there is not much clarity and structuring. For this reason, when modeling the course "Physical and chemical foundations of nanotechnology" used diagrams, tables, graphs and animated fragments. The content of the course is prepared in the form of presentations in MS PowerPoint and videos explaining the most important sections of the discipline. To consolidate the acquired skills, it is provided to perform the tasks of the course with the help of simulation programs.

As a result of mastering the online course "Physico-chemical foundations of nanotechnology" the student will not only form knowledge in the subject area, but also gain the skills of necessary calculations, analysis and structuring of information, as well as its presentation.

3.2 Development of a simulator program for an online course

To practice the skills developed a simulator program that allows each student to try himself as a designer of nanotechnology equipment. The listener is invited to remotely design and test a vacuum process plant by drawing up its scheme of standard elements. The result of such boundary control is confirmed its efficiency vacuum circuit installation, graphics of physical processes and conclusions of the listener about the work done.

The Windows Presentation Foundation (WPF) platform was chosen for the development of the user interface, which allows flexible configuration of the interface, as well as supports dynamic management of window elements, which is key for writing programs that include a component of building unique schemes. WPF is based on a vector visualization system, so that the content of the interface will not depend on the resolution of the application window. At the heart of WPF graphics technology is Di-rectX, which significantly increases the performance of the program by using hardware acceleration graphics.

As the language responsible for the dynamic component of the program, the object-oriented language C# was chosen, which stands out for its high reliability and stability of applications. The language has adopted much from its predecessors, eliminating many problematic and unreliable models, thus establishing itself as a convenient and flexible programming language.

Since it is necessary to build the vacuum system under study to calculate the pumping of the vacuum chamber, the first step in creating a program that simulates the pumping process of the vacuum system is a designer that allows schematically placing the elements that make up the pumping system and setting their real parameters. Classes were formed on the basis of the selected groups of elements (figure 3).



Fig. 3. An example of selected classes of program-simulator.

Figure 3 shows that all elements of the vacuum circuit have common fields and methods in connection with which it is necessary to introduce a parent class "element", which will contain all the software components of each element of the vacuum circuit. The physical parameters of the elements will remain in the classes of these elements. We will also add a class, "pump", which will contain General information for all pumps. The decision-based class diagram is shown in Figure 4.

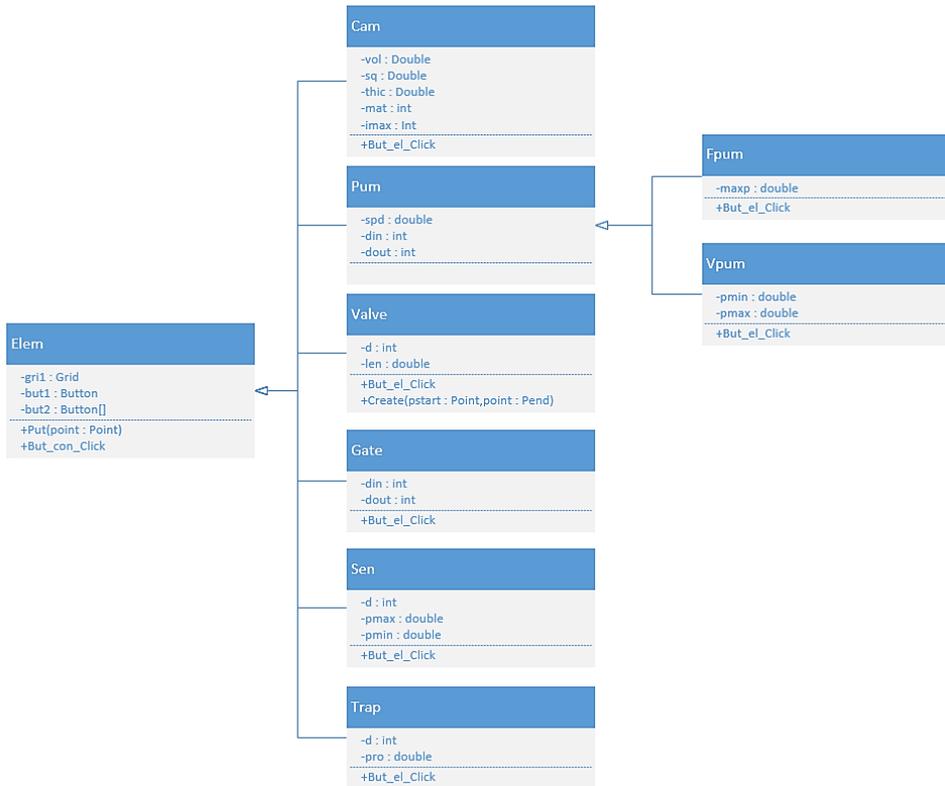


Fig. 4. Class diagram.

Based on the compiled class diagram, the development of the program responsible for the Assembly of the vacuum circuit has begun.

4 Conclusion

As a result of the implementation of remote online education, there is more time for the development of the material, and in a user-friendly form and at a convenient time. Presentation of the course "Physical and chemical foundations of nanotechnology" in MS PowerPoint and the availability of video materials makes it easy to integrate the course materials into the distance learning system. The development of the online course "Physical and chemical foundations of nanotechnology" in the form of a modular structure in the distance education system allows you to embed modules, sections of the course in other disciplines of the specialty "Nanoengineering". The features of the developed online course is its modularity and flexibility in the study, the possibility of practicing practical skills with the help of a simulator program.

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