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APPLICATION

OF ELECTRONIC EDUCATIONAL AND METHODOLOGICAL COMPLEX IN THE PROCESS OF TEACHING BACHELORS IN ENGINEERING

APLICACIÓN DE UN COMPLEJO ELECTRÓNICO, EDUCATIVO Y METODOLÓGICO EN EL PROCESO DE ENSEÑANZA DE LA CARRERA DE INGENIERÍA

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ABSTRACT

The article discusses the issues of improving the educational process by changing the system of methodological support in technical universities of Russia, individual academic disciplines, taking into account the use of modern technologies that combine the traditional ways of organizing the educational process and techniques and methods, based on new ideological and psychological settings, achievements engineering thought. The article traces the relationship between the content of the subject and the methodology of its teaching through the disclosure of the essence of the electronic educational and methodological complex (hereinafter-EUMC), as well as the integration of the theoretical and methodological components of the subject. Applying the technology of modular-rating training, in the research process an improved EUMC was created using the example of the discipline “Mathematics”.

Keywords: Electronic educational-methodological complex, technology of module-rating education, automated system Educon, students of engineering specialties.

RESUMEN

El artículo discute los problemas de mejorar el proceso educativo al cambiar el sistema de apoyo metodológico en las universidades técnicas de Rusia, disciplinas académicas individuales, teniendo en cuenta el uso de tecnologías modernas que combinan las formas tradicionales de organizar el proceso educativo y técnicas y métodos, basado en nuevos escenarios ideológicos y psicológicos, logros de ingeniería de pensamiento. El artículo traza la relación entre el contenido de la asignatura y la metodología de su enseñanza a través de la divulgación de la esencia del complejo educativo y metódico electrónico (en adelante, EUMC), así como la integración de los componentes teóricos y metodológicos de la asignatura. Aplicando la tecnología de capacitación de calificación modular, en el proceso de investigación se creó un EUMC mejorado utilizando el ejemplo de la disciplina “Matemáticas”.

Palabras clave: Complejo educativo-metodológico electrónico, tecnología de educación de calificación de módulos, sistema automatizado Educon, estudiantes de especialidades de ingeniería.

INTRODUCTION

After the signing of the Bologna Declaration, Russia entered into a single European educational space and significant changes began to occur in the system of Russian higher education. The reform also affected engineering education, began to introduce federal state educational standards of higher education - standards of the "third generation" based on a competency-based approach, which entailed the introduction of new technologies, techniques, teaching methods into the educational process. This is due to the fact that the modern economy is focused on specialists in engineering and technical specialties who do not possess scattered knowledge, but generalized skills, manifested in solving life and professional problems, and the ability to communicate. In addition, in many small and medium-sized cities of Russia unique industries are concentrated, oil and gas processing enterprises, research institutes and institutions that are in dire need of modern qualified engineers. A continuous increase in their level of knowledge, skills and abilities is necessary in connection with greater openness, the engineering sector entering the international level of cooperation and the improvement of new technologies, the transition to conversion technologies, and the exchange of experience between different countries.

In accordance with the standards of the "third generation" there was a redistribution of the academic load: a decrease in the hours of classroom instruction and an increase in the share of students' independent work. In this regard, in order to ensure and improve the quality of the educational process in a technical university, along with traditional teaching aids, it is necessary to develop and implement modern information technologies that will provide comprehensive training for specialists in the field of engineering and technology for innovative engineering activities. A possible solution to this issue could be the introduction of electronic educational and methodological complexes (hereinafter - EUMC) into the educational process, which will allow a fundamentally new way to organize independent work of students of engineering and technical specialties, increase the level of success of students mastering educational programs by almost 1.5 times, to strengthen interdisciplinary ties and strengthen the practical orientation of many taught courses, successfully and quickly adapt students and teachers to the specifics of academic subject, to increase the professional level of teachers in connection with the dynamic changes in EUMC.

By EUMC, we mean a combination of structured teaching materials combined through a computer-based learning environment, providing a complete didactic training cycle and designed to optimize the student's mastery of professional competencies within the framework of the academic discipline.

Various aspects of improving the methodological support of the educational process represented the sphere of scientific interests of many researchers. The importance of applying innovative teaching methods in the classroom is reflected in many studies published in our country and abroad. Recently, a large number of studies have appeared that consider the content of electronic courses in various disciplines using virtual teaching aids (Brinson, 2015; Broadbent & Poon, 2015). Of particular interest to us are works that address the use of electronic resources and modular training programs; monitoring the activities of a large number of students through the use of EUMC, provided that the number of class hours is reduced; individual communication between teacher and student through the use of information and communication technologies to optimize academic performance. Many scholars have noted that the use of EUMC as part of the study of disciplines stimulates the development of various mental abilities in students. The works of foreign authors emphasize the importance of personality-oriented planning of the content of EUMC in the disciplines, taking into account the development of professional competencies among students (Caputi & Garrido, 2015). We were also interested in the experience of using EUMC at the Department of Electric Networks and Electrical Engineering of Tomsk Polytechnic University, in the development of which it is necessary to take into account the didactic, psychological, methodological and ergonomic requirements for e-learning resources (Fix & Troshchinskiy, 2015).

So, despite the ever-increasing level of computerization of the education sector, it should be noted the low efficiency of the use of computer technology in the teaching process and the lack of high-quality modern electronic tools in specialized engineering disciplines. In this regard, the urgent problem of providing the educational process with innovative developments, namely the possibility of applying EUMC in the process of teaching a particular discipline, taking into account the capabilities of the system of higher engineering education.

METHODOLOGY

Pilot work was carried out on the basis of the Tyumen Industrial University, during which the EUMC was developed and implemented in the discipline "Mathematics". The importance of this discipline for our research was determined by the fact that as a result of training, qualities such as the ability to abstract, generalize, analyze, and critical thinking are formed; it requires constant tension

of attention, perseverance, the ability to focus; reinforces good work skills among students of engineering specialties. EUMC is built on the technology of web pages and is, in fact, a site. This made it possible to structure the material, equip it with graphic objects, make it visual and streamline the student's direct work with him.

The created EUMC in mathematics has significant advantages over other complexes and they are as follows: all teaching materials meet the requirements of the federal state educational standard of higher education; contains copyrighted teaching materials created by highly qualified teachers; clear structuring of educational material; the inclusion of a variety of supporting materials in the structure of the EUMC (glossary, guides, interactive crosswords, tasks, etc.); allows you to directly connect to thematic Internet resources in the process of work; creates an opportunity for creative initiative of teachers; work with professionally oriented tasks in mathematics; the possibility of self-monitoring and monitoring of knowledge among students; regular direct communication between the teacher and students through the use of chats; the presence of inter subject links.

In this work, the basic principle of creating a EUMC for preparing students is an understanding of the integrity of the learning process, which is ensured by the unity of the teaching, developing and controlling influences on the educational and cognitive activity of students.

In accordance with the didactic, methodological and psychological-pedagogical requirements for computer-based training systems, the structure of the EUMC in the discipline "Mathematics" is defined, which can serve as a model in the development and implementation of the EUMC in any other discipline (Table 1).

Table 1. The structure of the EUMM in mathematics.

GEF HE	Professional standard	Working programm	
Input block	Questions, tasks, tests for incoming control	Survey to determine the motivation for studying the discipline	
	Recommendations for updating knowledge and studying the discipline	Discipline study schedule	
Training unit	Lecture course summary		Information interaction with the teacher (personal communication, chat, forum, email, etc.)
	Professionally-oriented tasks		
	Tests for self-control, remote communication with the teacher		
	Basic and additional literature, online sources, individual creative assignments		
	Guidelines for the study of discipline, for practical exercises, for preparing for independent work, for performing test work, virtual laboratory complexes		
	Glossary		
Self control unit	Questions, tests for self-control	Interactive, professionally oriented tasks	Results of Interim Control and Research
Research unit	Internet conferences, sites, forums	Research topics	
Final block	Final work on discipline	Tasks for the final control, survey	Technological map of the study of discipline

This structure is due to the principle of comprehensive support of the educational process and the use of the training system in all types of classes.

Below is a version of the EUMM in mathematics in the EDUCON support system at Tyumen Industrial University.

The basis of the design of the EUMC for the vocational training of students of engineering and technical specialties was laid on the requirements: as a didactic tool (the requirements of science, accessibility, problematic, visual, systematic and consistent learning, activity and consciousness of students in the learning process, the strength of mastering knowledge, the unity of educational, developing and educational functions of learning); as a means of new information technologies (individuality, interactivity, adaptability of learning, systematic and structurally-functional connectedness of the presentation of educational material).

The use of electronic EUMC has led to a change in the ratio between classes conducted under the guidance of a teacher and independent work of students. At the same time, the role of the teacher did not decrease, since in these conditions the learning process becomes manageable, its forms and methods are being improved.

In the course of the pedagogical experiment, students were questioned in order to identify their opinions on the appropriateness of using EUMC in the studied discipline.

Mathematics is the basic discipline for students of engineering and technical specialties 1-2 courses of the Tyumen Industrial University of the direction "Oil and Gas Business". In total, 102 (4 groups of students) people took part in the experimental work. Classes in one group were conducted according to traditional technology (control group), other groups were experimental, and they used didactic support developed by the author. Students of the control group studied according to traditional technology (attendance at lectures, practical classes). For the training of experimental groups, EUMC was additionally introduced into the educational process in mathematics, taking into account the technology of modular-rating teaching, which allowed working in a computer class to independently study theoretical material. The technology of modular-rating training is actively involved in creating EUMC through the organization of the educational process, through a modular version of a workbook or study guide, of which tests are a part. This technology allows you to combine classroom work with independent, which significantly activates the mental activity in the course of training. For a long time, students performed various mathematical tasks, and of varying difficulty, passed colloquiums, worked on creative tasks. Each student formed his own rating in the discipline

At the beginning of the experimental work, we checked the initial level of basic training of first-year students. The basic training of first-year students was approximately the same and the average score was 3.2 points. This gave us the opportunity to identify weaknesses in the preparation of students and adjust the learning modules.

The study of theoretical material for the control and experimental groups was accompanied by periodic current monitoring organized by the teacher in various ways: a written survey, testing using the Conversation program included in the EUMC, final lessons using active teaching methods, and consultations on the analysis of unclear questions that students had in the process of learning the course.

Upon completion of training, questionnaires were conducted in the experimental groups in order to find out the students' opinions on issues reflecting the most important features of the teaching technology using EUMC and the perception of material by including EUMC in the educational process, its impact on obtaining quality knowledge.

RESULTS

Upon completion of training, questionnaires were conducted in the experimental groups in order to find out the students' opinions on issues reflecting the most important features of the teaching technology using EUMC and the perception of material by including EUMC in the educational process, its impact on obtaining quality knowledge. At the same time, almost 100% of students consider the use of computers and computer training programs reasonable in the study of theoretical, especially technical, disciplines. Students also note that they have the opportunity of a new, open and full access to educational materials in accordance with the specialization of training. The following data testify in favor of using EUMC in the educational process: 100% of students believe that computer-based training programs, in particular EUMC, have great demonstration capabilities; 60% note the intensification of independent work, 54% say that EUMC significantly facilitates the understanding and study of the material. Among the mentioned answer options, only 4% of students believe that computer-based training programs tire and reduce their working capacity; 80% of students prefer to study independently on the electronic educational-methodical manual with the simultaneous consultation of a teacher; 89% of students note the ease in mastering new computer programs and, as confirmation, speak of improving perception and facilitating the process of studying educational material, enhancing cognitive activity, and changing the usual ways of working. However, 5% say that they partially do not perceive information. Among the features of the EUMC that contribute to the assimilation of educational information and the acquisition of quality knowledge, students distinguish the following: a large number of illustrative material (drawings, diagrams, charts, tables, etc.) was noted by 90% of respondents, structured material - 82%, the possibility of immediate self-examination of knowledge with the help of a training manual and a testing program, the logical sequence of presenting information is 54%, the possibility of obtaining new knowledge and skills of professional activity is 74%, 74% of students liked the developed EUMC in the discipline, 21% of respondents chose the answer "rather liked it", 4% did not like the complex.

At the end of the second year, we conducted a final test module "Basic concepts of probability theory" of students in the control and experimental groups (Table 2).

Table 2. Students knowledge level experimental and control groups.

Knowledge level in points	Experimental groups		Control group	
	Input testing	Final testing	Input testing	Final testing
92 – 100 (fine)	14%	52%	15%	18%
76 – 91 (good)	72%	36%	69%	24%
61 – 75 (satisfactorily)	14%	12%	16%	58%
Less than 61 points	0	0	0	0

The level of assimilation of knowledge was determined according to the method proposed by Bespalko (2017), according to which the control test consists of tasks and a standard, a sample of their complete and correct implementation, and the amount of acquired knowledge is characterized by the number of knowledge elements reproduced by students. The coefficient of this indicator was the ratio of the number of acquired knowledge elements to the number of knowledge elements available in the content of educational material.

To (volume) = the number of all learned elements of knowledge / number of knowledge elements in the standard.

From the above data it follows that the results of qualitative performance in students of the experimental group where EUMC was used are significantly higher than the control.

At the controlling stage of the experiment, we rechecked the effectiveness of EUMC through a comprehensive test in mathematics, which includes 10 tasks and the solution of one professionally oriented problem (using the example of one of the complex topics of the course - "Solving Differential Equations").

Evaluation of the effectiveness of using EUMC in the educational process was determined using quantitative and qualitative indicators. To quantify the effectiveness of EUMC, we used a "regressive" technique based on comparing the results immediately after studying the topic and after completing the study of the mathematics course (in the control paper No. 2 there were also 10 tasks and one professionally oriented task, similar in content and complexity to control work No. 1). For the experiment, two groups were randomly formed from the experimental and control flows of 15 people each. After the control work No. 1, the following results were obtained (Table 3).

Table 3. Data on the academic performance of students in experimental and control groups according to the results of control work No. 1.

Experimental group				
Points	0-60	61-75	76-91	92-100
Number of works	0	1	4	10
Control group				
Points	0-60	61-75	76-91	92-100
Number of works	3	6	6	0

Then, a random sample of these groups was compiled: they took 6 works from the experimental group and 9 works from the control group (Table 4).

Table 4. Data on the student performance of the experimental and control subgroups according to the results of the control work No. 1.

Experimental group				
Points	0-60	61-75	76-91	92-100
Number of works	0	0	1	5
Control group				
Points	0-60	61-75	76-91	92-100
Number of works	2	6	1	0

The hypothesis H0 was tested - the proposed methodology for conducting classes using EUMC is ineffective. Alternative hypothesis H1 - the proposed methodology for conducting classes using EUMC is effective. We performed a statistical evaluation of the effectiveness of the proposed methodology for conducting classes using EUMC using the two-way McNamara criterion. Since F nab> F crit, the null hypothesis H0 is rejected and the hypothesis H1 is accepted that the methodology for conducting classes using EUMC is effective.

Also, at the end of the fourth semester, students from the control and experimental groups participated in the Internet exam in the field of vocational education (FEPO), which was carried out in the form of computer testing (44 tasks). FEPO, in our opinion, allows you to objectively assess the degree of compliance of the content and level of training of students with the requirements of the Federal State Educational Standard (Table 5).

Table 5. Online Exam Results.

Groups	Number of students (X ≥ 80 %)	Number of students (50%≤ X < 80%)	Number of students (X < 50%)
Control	4 (13%)	12 (40%)	14 (47%)
Experimental	20 (28%)	47 (65%)	5 (7%)

Within the framework of FEPO, a model for assessing learning outcomes is used, which is based on the approach of Bespalko (2017): the student coped with testing and has a high level of development if he correctly completed at least 80% of the tasks (for our case, it is 35-44 tasks), average, if correctly completed at least 50%, but less than 80% (in our case 22-34 jobs) and low if less than 50% (less than 22 jobs). This model, being student-centered, allows you to focus on the results of each individual student. It should be noted that the results in the experimental groups were significantly higher than the results obtained in the control group.

CONCLUSIONS

One of the active ways to improve the quality of training of engineering personnel is to improve the system of methodological support of the educational process of technical universities. As the results of the study show, this can be obtained by improving the EUMC in the disciplines.

Summing up the results of the experimental work, we can conclude on the basis of quantitative assessments of the effectiveness of the training system as a whole, based on the use of EUMC in mathematics, in comparison with the "traditional" training system.

In addition to quantitative changes, the use of EUMC also led to such qualitative changes in the educational and cognitive activities of students, which are a factor in the personal and professional formation of future engineers and their professional mobility. Since the proposed training contributed to the building up of subjective potential, it can be concluded that the intensification of training on the basis of EUMC also serves as a reserve for improving the quality of professional training of specialists at a university.

The results allow us to conclude that the technology used to include in the educational process of EUMM in mathematics for students of engineering and technical specialties in experimental groups was more effective than conventional traditional lectures in classrooms. The study of educational information and the simultaneous consolidation of acquired knowledge through repeated repetition and intensification of students' independent work with the use of EUMC made it possible to obtain more solid knowledge in experimental groups in an equal time period in comparison with the control group.

Working with EUMC, which comprehensively affects students, through various forms of presentation of information contributed to a better understanding, memorization and assimilation of educational material. It should also be noted that the knowledge gained using EUMC turned out to be not only qualitative, but also more extensive, since this made it possible to familiarize oneself with a large volume of material compared to the amount of information that is limited to lecture classes. These possibilities of using EUMC in the educational process, as well as positive feedback from students have proved the feasibility of using electronic teaching materials in the educational process.

The use of EUMC in mathematics allowed to increase interest in the subject itself, in independent work, made it possible to conduct self-assessment and self-examination of mathematical knowledge, skills and practical skills. In addition, the modular-rating technology allows you to most fully take into account all activities for each student and the group as a whole, allows you to rationally organize the educational process and has a great influence on its effectiveness.

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