Distinctiveness of Modes of Study at Professional Training of Engineering Personnel in the System of Supplementary Vocational Education in the Electronic Education Environment of the University

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Keywords: Mode of Study, Type of Learning, Distance Learning, Distance Technologies, Supplementary Education.

Abstract: In modern Russia radical changes are taking place in the economy, science, and technology. All these affect the system of professional education. Economic improvement, the emergence of high-tech production and the latest equipment, the development of automation leads to a shortage of highly qualified engineering personnel capable to respond to the challenges of today. The article shows the regional features of the development of large production companies that need professional retraining of engineering personnel. Implementation of professional training of engineering personnel is carried out through the electronic education environment of the university in the system of supplementary vocational education. When considering this issue, it is revealed that there is no general approach to the use of modes of study in the electronic education environment of the university in the system of supplementary vocational education. It is suggested that certain modes of study are necessary for the implementation of professional training of engineering personnel in the supplementary vocational education in the electronic education environment of the university. The classification of the types of learning and modes of study used in the electronic education environment of the university is given. The ascertaining pedagogical experiment on the diagnosis of the efficiency of studying in electronic education environment in the system of supplementary vocational education at the university showed a positive effect of e-learning programs.

1 INTRODUCTION

1.1 Relevance of the Study

In today's rapidly developing modern world education plays an important role. Social, economic, innovative and technical transformations of recent times have made serious adjustments to the system of professional education that has been developing over the decades. The concept of professional education has changed: «from education for life to education through life» (Tolochek, 2013), the main idea is continuous education, which contributes to the development of a person as a personality throughout life, increasing their labor potential, improving, developing and adapting them to a rapidly changing world (Parakhina, 2017; Andryukhina, 2020; Zhurakovsky, 2017).

Today, in the actively unfolding market economy of the country, there can be observed the development of high-tech production, the introduction of modern equipment, robotics and automation of production. Such changes require a certain quality of labor and productivity of the formation of personnel infrastructure in high-tech industries. In this regard, there are strict requirements for the training of engineering personnel, aimed at improving the quality of the complex of design and productive engineering activities. Supplementary vocational education (SVE) can become a tool for implementing professional training of engineering personnel.

Thus, supplementary vocational education is an important element of the entire system of continuing education. SVE becomes a formed system that is leveled by the market of educational services. The economy of the Russian Federation is undergoing constant changes, which leads to a shortage of

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personnel and the need for mass professional retraining.

Currently the Far East is one of the dynamically developing regions of the country. The Amur region is a center where large industrial enterprises of the power, mining, and space industries are concentrated. Today they are actively developing; at the same time there appear new industries like oil and gas ones. In these sectors of the region's economy, there is a need to train highly qualified personnel. The SVE system becomes a powerful tool for restructuring production needs through professional retraining of engineering personnel.

The Amur State University is one of the universities in the region that is capable of increasing the intellectual and knowledge component of engineering personnel in production. The mobility of the developed SVE system at the Amur State University and the ability to respond to market demand with a focus on a specific customer are quite developed. Today, the university has long-term contracts with such large companies as PAO «Gazprom», OOO «SIBUR Tobolsk», OOO «Gazprom Processing Blagoveshchensk», OOO «West-Siberian Petrochemical Plant», AO «Far-Eastern Power Distribution Company», AO «Hydro-Electro Assembling», AO «System Operator of the Unified Power System», «Regional Operator Management of the Power System of the Amur region», AO «Far-Eastern Generating Company», holding companies of PAO «RusHydro», PAO «Federal Grid Company Unified Energy system», state corporation «Roscosmos» (Plutenko, Leifa, Maslovskaya, 2017; Plutenko, Leifa, Ostapenko, 2017; Plutenko, Leifa, Kozyr, Khaletskaya, 2018; Bodrug, Skripko, Protsenko, 2019; Plutenko, Leifa, Eremina, Khaletskaya, 2019).

1.2 Aim of the Research

When considering the implementation of professional training of engineering personnel in the system of supplementary vocational education, it was revealed that there is no general approach to the use of modes of study in the electronic education environment (EEE) of the university. Therefore, it is necessary to study theoretically and empirically the features of the use of modes of study and to offer options for their implementation in the professional training of engineering personnel in the EEE.

2 RESEARCH METHODOLOGY

The following research methods were used to achieve the objective:

- theoretical (analysis of scientific problem, study of pedagogical experience of engineering personnel training in foreign and Russian universities);
- empirical (systematically included observation, interviews, testing of respondents, stating experiment).

Due to the development of the region's industry, there is a need for professional retraining of engineering and technical personnel. The university structure has the faculty of supplementary vocational education and the center for advanced professional training, and on their basis SVE systems are implemented. The university together with representatives of the production enterprises has developed professional retraining programs (PRP) «Automation and control systems in oil and gas industry» (ACSOGI), «Automation and control systems in power industry» (ACSPI). Each program was approved by expert-employers.

The programs «Automation and control systems in oil and gas industry» and «Automation and control systems in power industry» are implemented in the electronic education environment of the university. The emergence of modern trends, information technologies, distance learning innovations, online learning, etc. in the educational environment has led to the emergence of EEE, including those in the system of supplementary vocational education. The creation of EEE was a response to the requirements of article 16 of Federal Law No. 273-FL «On education in the Russian Federation» (Federal law of the Russian Federation, 2012).

The use of EEE in higher education is an important factor in the implementation of PRP. This provides students with a number of new opportunities. One of them, which is sometimes very crucial, is getting an education on the job.

As a result, supplementary education, implemented in the university's EEE, acts as a catalyst and initiator of new pedagogical processes. Thus, modes of study are an important element. While implementing programs in the system of PRP in the EEE of the university, there has been revealed specific features of the modes of study.

3 RESEARCH RESULTS

Modes of study in the EEE of engineering personnel in the PRP system are different from those in traditional education. Therefore, when choosing modes and types of the study for the formation of professional training of engineering personnel for professional retraining programs «Automation and control systems in oil and gas industry», «Automation and control systems in power industry» based on the university's EEE in the PRP system, the following criteria were taken into account:

1) the place of the study (far from the educational institution or within the university);

2) the number of students; using the potential of EEE in the learning process;

3) the content of the supplementary retraining program;

4) the regulatory and methodological framework of the university that controls the learning process in the EEE system;

5) the level of the personnel education at the organization.

At the university when implementing professional training of engineering personnel, extramural form of study is used.

To substantiate the use of this mode of study in the university's EEE, there is presented a definition of electronic education (EE) and distance learning technologies (DLT). In (Federal law of the Russian Federation, 2012) the concept of EE is given: this is the organization of educational activities with the use of information contained in databases; the information is processed with the help of information technologies and technical means, as well as with information and telecommunication networks providing transmission of this information over communication lines and ensuring interaction of students and teachers. DLT refers to educational technologies implemented mainly with the use of information and telecommunication networks, with indirect (at a distance) interaction between students and teachers.

In today's pedagogical society, the most common typology divides electronic education models into three types: web-based learning, blended learning, and online learning (e-learning). The main differences between the models are in the teaching strategy and the amount of time that is distributed between the classroom and electronic load (Veledinskaya, 2014; Ruliene, 2010; Bates, 2013; Carey and Obama, 2013).

By the format of blended learning there has been developed and implemented a program of professional retraining ACSPI. This model focuses on the symbiosis of traditional and electronic modes of study. The model is based on the reduction of the educational classroom load; about 80% of each discipline is assigned to work in the EEE. The work is aimed at effective interaction of the student with the educational material, teachers and other students. All types of distance learning (practical classes, lectures, independent work, current control, intermediate control, final certification) of the student are conducted using the distance learning system (LMS Moodle), and classroom classes (laboratory work) are carried out in the laboratories of the department of «Automation of production processes and electrical engineering» (APPEE). Two weeks are allocated for each discipline. The program is implemented for five months, during the ninth and tenth weeks of training. Students come to do the laboratory work, process the results of the measurement and defend the results of laboratory works. For example: the discipline «Integrated design and management systems» has a total labor intensity of 36 hours, of which 8 hours are allocated for classroom classes (conducting, performing, and defending laboratory work), and 28 hours for distance learning classes (including independent work).

By the mode of e-(online) learning, the program of professional retraining ACSOGI was developed. In this model, about 90-100% of the educational process is carried out in the EEE of the university. It includes making the entire learning process completely in the electronic educational environment of the university (Veledinskaya, 2014; Ruliene, 2010; Bates, 2013; Carey and Obama, 2013). The program is implemented within 4 months and involves distance learning using e-learning and distance education technologies (LMS Moodle). All types of distance learning activities (practical classes, laboratory classes, lectures, independent learning, current control, intermediate control, final certification) are conducted using the LMS Moodle. One week is allocated for each discipline. For example: the discipline «Automation of technological processes and production in oil and gas industry» has a total labor intensity of 36 hours, of which distance learning classes are 36 hours, including independent work of students.

Analyzing traditional forms of education and electronic ones, we conclude that:

To implement the training of engineering personnel based on EEE, the following modes of study should be used in the PRP system: extramural (blended learning), extramural (e-learning).

Forms of organization of academic studies are divided into traditional types: classroom and out of classroom.

At e-learning and distance learning technologies used in the EEE system of the university, distance learning classes are usually used as a form of organization of class activities.

Distance learning classes are classes in which teachers interact with students in order to transfer knowledge, control the level of their assimilation and the formation of appropriate skills and abilities, using information and communication technologies, technical means, information and telecommunication networks, web technologies, special information and technical means [Ruliene, 2010; Kaverzneva, 2020].

To implement training of engineering personnel on the basis of EEE in the system of PRP the following types of classes are applied: «extramural – blended learning» – «classroom, out of classroom, distance learning classes» (for PRP ACSPI) and «extramural – e-learning» – «distance learning classes» (for PRP ACSOGI).

The following methods of organizing studies are used in the PRP «Automation and control systems in oil and gas industry» and «Automation and control systems in power industry»: lectures, seminars, laboratory classes, practical classes, all types of independent work, video lectures, remote practical work, interactive laboratory workshops, online or offline test tasks, remote term papers, projects, abstract tasks, essays, web-quests, etc. For example, in the PRP ACSPI the discipline «Automation of technological processes and production» is implemented through classroom, out of classroom, and distance forms of organization of academic studies. Classroom classes are held in the laboratory of the APPEE Department «Technical means of automation» equipped with sets of educational equipment, complexes «Siemens S7-200 Controller», «Aries PLC 154 Controller and Aries MWA8 and MVU8 i /o modules», «Remikont P-130 Controller», «Electric actuators», interactive whiteboard, etc. Video lectures, lectures-presentations and a remote course project on the topics «Automatic and automated production systems», «Means of technological equipment, automation, control, and diagnostics of the main and auxiliary production facilities» are organized distantly. In the professional retraining program ACSPI, the discipline «Microprocessor control systems» is implemented through distance forms of organizing academic studies through LMS Moodle. Video lectures, remote laboratory work (learn how to write programs in Debugger, CoDeSys), offline test tasks are presented for students. Communication between students and teachers is carried out through forums, chats, e-mail and video communication.

Forms of organization of class activities (individual, group, frontal) are used for PRP ACSPI and ACSOGI in accordance with the modes of study and forms of organization of academic studies implemented on the basis of EEE. For ACSPI individual, group and frontal forms of organization of class activities are used. In PRP ACSOGI which is implemented only in e-learning, the frontal and individual forms are used. The frontal form is used in the format of a video conference between the teacher and all students when discussing the subject of course papers. Distance practical training (individual form) is aimed at solving a specific task for each student – for example «to determine the relative stability of closed control systems». An interactive Scriptorium complex is used to defend laboratory work (group form).

The university uses the modes of study specified in table 1 for the implementation of professional training of engineering personnel in the programs «Automation and control systems in power industry», «Automation and control systems in oil and gas industry» in the EEE in the SVE system.

Table 1: Modes of study in the university's EEE in the SVE system for the formation of professional training of engineering personnel for PRP implemented by the university.

Modes of study	Type of learning			Professional retraining program for professional training of engineering personnel
	Forms of education	Forms of organization of academic studies	Forms of organization of class activities	
	Modes of study specified			
	Distance e-learning	Distance learning	Frontal Individual	Automation and control systems in oil and gas industry
	Extramural-blended studies	Classroom Out of classroom Distance	Individual Team Frontal	Automation and control systems in power industry

4 THE DISCUSSION OF THE RESULTS

When determining the effectiveness of the use of study modes for professional training of engineering personnel in the system of SVE in the EEE of the

university, there was conducted an ascertaining pedagogical experiment. Its purpose is to study the audience's opinion about the comfort and satisfaction with the distinctive modes of study in the professional training of engineering personnel in the system of supplementary vocational education in the electronic educational environment of the university.

To conduct an ascertaining pedagogical experiment on the diagnosis of the effectiveness of the use of modes of study in EEE in the SVE system at the university, there were:

- developed tools to determine the level of comfort for participants in using the electronic educational environment;
- found diagnostic tools of satisfaction with the conditions of organization of modes of study in the EEE.

Experimental work was carried out with students of the courses on professional retraining programs ACSPI and ACSOGI of different modes of study. The research included 82 students enrolled in «extramural-blended studies» and «extramural e-learning».

Determining the level of satisfaction with the conditions of organization of study modes in EEE. The determining factor of the effectiveness of the use of study modes in the formation of professional training of engineering personnel in the EEE system is satisfaction with the conditions of the organization of study modes. Modern information education is aimed at improving the ability to teach. EEE in SVE is a factor that encourages students to improve their professional development. Orientation of professional retraining programs on regional features and social order makes their implementation in the modes of «extramural-blended studies» and «extramural e-learning» significant. Such modes of study in EEE are of particular importance for production workers, since studying in EEE is carried out on the job; and for students who get higher education or secondary vocational education since studying takes place in their free time.

To determine the level of satisfaction with the conditions of the organization of study modes in the EEE, an appropriate diagnostic tool was developed (low, high, and average level of satisfaction).

The low level of satisfaction with the conditions for organizing study modes in EEE corresponds to the fact that students do not know how to master information and communication technologies (ICT), as well as technical means.

The average level is achieved by those students who can use certain types of information resources and technologies. The use of special information and technical means for students is partial, though.

A high level is typical for those students who have the ability and skills of comprehensive knowledge of information and communication technologies, technical means, web technologies, special information and technical means.

Determining the level of comfort in using EEE. An important factor in the effectiveness of the use of modes of study in the formation of professional training of engineering personnel in the SVE-EEE system is the level of comfort of students in using the electronic educational environment. In the works of scientific researchers V.I. Slobodchikov, E.I. Isaev, and B.G. Ananiev, three main components of the comfort of the environment are identified: psychological, physical, and intellectual.

Focusing on the specifics of the implementation of the formation of professional training of engineering personnel in the EEE in the SVE system at the university, there will be highlighted the main components of the comfort of using the electronic educational environment for studying. Physical comfort is expressed by the level of satisfaction created by the object-spatial conditions. Intellectual comfort is determined by the results of mastering the program, the ability to learn, and to carry out mental activity. Psychological comfort is determined by the condition of the student during the entire study period and can be characterized by indicators: agitation, misunderstanding, disappointment, excitement, joy, delight, surprise, comfort, etc.

The low level of comfort in using EEE is expressed by the following factors: complete dissatisfaction with the object-spatial conditions of EEE (incomplete information about the educational process, the wrong sequence of course subjects, poor placement of educational materials, inaccessible grade record book); lack of cognitive interest; inability to solve tasks; dissatisfaction with the fact that studying is conducted on schedule; insufficient online and offline communication with teachers; dissatisfaction with the quality of lecture, practical, and laboratory materials; concern about current and final learning results.

The average comfort level is characterized by indicators: sufficient satisfaction of object-spatial conditions of EEE (information about the educational process is provided, but not in full, the sequence of disciplines of the course is satisfactory, the placement of teaching materials is quite easy, accessible grade record book); the presence of cognitive interest; the ability of partial tasks; the anxiety of the fact that the training is on schedule; sufficiently carried out online

and offline communication with teachers; slight disappointment with the quality of lecture, practical, and laboratory materials; concern about the current and final learning results.

High comfort level is characterized by indicators: overall satisfaction of object-spatial conditions the EEE (fully presented information about the educational process, logical sequence of disciplines of the course, instructional materials are available for each discipline, the gradebook displays are comfortable); the presence of cognitive interest; a high quality solution of the tasks; the excitement of the fact that training is on schedule; full satisfaction with online and offline communication with teachers; delight in the quality of the presented lecture, practical, laboratory materials; satisfaction with the current and final learning results.

The ascertaining pedagogical experiment to identify the effectiveness of the use of study modes in the professional training of engineering personnel in the SVE-EEE system of the university was conducted with students after completion of studying. The results of the experiment are shown in table 2.

Table 2: Efficiency of using modes of study for professional training of engineering personnel in the system of SVE in the EEE of the university, %.

Indicator	Low comfort level	Average comfort level	High comfort level
Comfort in using EEE	7	14	79
Satisfaction with the conditions for organizing modes of study in EEE	11	15	74

The results of the experiment showed that the use of study modes «extramural-blended studies» and «extramural e-learning» for the formation of professional training of engineering personnel in the system of SVE in the EEE of the university is quite effective.

5 CONCLUSIONS

The formation of professional training of engineering personnel in the EEE system is relevant and necessary in the modern educational world focused on the social order and needs of the region. The specifics of this process are important. One of the issues to study is the use of study modes in EEE. Classification of study modes in the system of supplementary vocational education in the electronic educational environment of the university has a complex structure; it differs from the traditional one and contains features by types (education, organization of academic studies, organization of class activities) and specified modes of study.

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