

VI International Forum on Teacher Education

Use of Information and Communication Technologies in Engineering Training in Additional Vocational Education in the University's E-Learning Environment

Natalia S. Bodrug* (a), Andrei V. Leyfa (b)

(a), (b) Amur State University, 375027, Blagoveshchensk (Russia), 21 Ignatyevskoye highway,
bodrug82@rambler.ru

Abstract

Implementation of the innovative socially oriented model of development of Russia is impossible without the construction of a system of continuous professional education of engineering personnel. To date, however, there are no modern concepts of continuous engineering education aimed at organizing and training engineering personnel for high-tech enterprises at the post-university stage of continuous education in the system of additional vocational education. The purpose of this study was to develop and justify information and communication technologies in the professional training of engineering personnel in the system of additional vocational education, in the electronic educational environment of the university. Today, professional training of engineering personnel in regional universities should be focused, first of all, on the social economic development of the subject and on high-tech enterprises of the region. The main pedagogical means of education in the electronic educational environment of the university is the application of modern information and communication technologies allowing to implement electronic, remote education. In this regard, the use of information and communication technologies in educational programs of additional vocational education in the electronic educational environment of the university is a pressing scientific task. The study of this issue revealed that to date there is no general approach to the use of information and communication technologies in the electronic educational environment of the university in the system of additional vocational education. It is proposed that certain information and communication technologies are needed to implement professional training of engineering personnel in the system of additional vocational education in the electronic educational environment of the university. A classification is given by the types of educational means and educational means used in the electronic educational environment of the university. A teaching experiment was conducted to diagnose the effectiveness of the use of information and communication technologies in the electronic educational environment in the system of additional vocational education at the University, which showed the positive effect of the use of innovative information and communication technologies in the implementation of programs in the electronic educational environment.

Keywords: information and communication technologies, electronic education environment, additional education, e-learning, remote education technologies.

© 2020 Natalia S. Bodrug, Andrei V. Leyfa

This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and

* Corresponding author. E-mail: bodrug82@rambler.ru

reproduction in any medium, provided the original author and source are credited.

Published by Kazan federal university and peer-reviewed under responsibility of IFTE-2020 (VI International Forum on Teacher Education)

Introduction

The implementation of an innovative socially oriented model of development of Russia is impossible without the construction of a system of continuous professional education of engineering personnel. The system of continuous vocational education should be aimed at creating the necessary conditions for the comprehensive harmonious development of the individual, regardless of age, initially acquired profession, specialty, place of residence, but with mandatory consideration of his abilities, motives, interests, value settings (Tolochek, 2005; Study memorandum through life, 2019). At the same time, it is important that the system of continuous education of engineering personnel should be built on the basis of Federal state educational standards and requirements of employers presented in the professional standard. As a matter of fact, the professional standard sets the employer's requirements for a future specialist and ensures a proper level of professional training of engineering personnel (professional competencies).

The modern market economy of the Russian Federation is aimed at the development of high-tech industries, which contain innovative developments, automation of all production processes, intellectual production, modern active-adaptive equipment, robotics. Therefore, one of the important tasks facing the modern university is the training of engineering personnel of the new formation. In our opinion, this task should be solved by the system of continuous vocational education at the university, aimed at advance and optimal adaptation of future engineers working at high-tech enterprises. One of the important stages of continuous vocational education of engineering personnel is the post-university stage, which is carried out in the system of additional vocational education.

The Far East, is one of the actively developing regions. Large Russian industrial enterprises of mining, shipbuilding, space and energy industries are concentrated in the Amur region, and today the gas and oil industries are gaining momentum. «West Siberian Petrochemical Plant», «RusHydro», «Gidroelektromontazh», «System Operator of the Unified Energy System» «Regional dispatching office of the Energy System of the Amur region», «Far Eastern Generating Company», «Sibur Tobolsk», «Gazprom Pererabotka Blagoveshchensk», «Roskosmos» state corporation, «Far East Distribution Grid Company», «Power Pool System Federal Grid Company treat them» (Bodrug et al., 2019; Plutenko et al., 2017 a).

In the region, one of the classical universities is the Amur State University, capable of improving the quality of training engineers to work in the market economy, with a focus on specific production. The University cooperates with all major industrial enterprises of the Far East within the framework of long-term agreements (Plutenko et al., 2018; Plutenko et al., 2017 b).

At present, digitalization in educational institutions has led to the emergence of an electronic educational environment (EEE), the requirements for which are reflected in article 16 of Federal Law № 273-FL «On Education in the Russian Federation» (About education in the Russian Federation, 2012). In the implementation of educational programs of additional vocational education (AVE) within the framework of the EEE of the university, the key is the use of e-learning and remote educational technologies. It is this format of training that is as comfortable as possible for representatives of workers in the industrial sphere. Professional retraining of engineering personnel takes place on-the-job, which allows to preserve the production process.

However, to date there are no modern approaches to the organization of professional training of engineering personnel in the system of additional education of the university using information and communication technologies (ICT) in the electronic educational environment.

Purpose and objectives of the study

The purpose of this study was to develop and justify information and communication technologies used in vocational training of engineering personnel in the system of additional vocational education, in the electronic educational environment of the university.

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).

Experiment description and procedure

Due to the high rate of economic growth and the development of industrial production in the region, there is an urgent need for professional retraining of engineering personnel. On the basis of the university there is a center of advanced professional training, faculty of additional education, responsible for training and retraining of highly qualified personnel for different spheres of economy of the region

With active interaction with enterprises and large corporations, based on market requests, the University has developed educational programs of professional training «Automation and management systems in the oil and gas industry», «Automation and management systems in energy»), for gas-chemical and energy industries of the region. Based on long-term forecasts of development of industrial enterprises of energy, gas processing, oil industries in the region, emphasis is placed on professional retraining of engineering personnel. The programs are implemented in the AVE system in the EEE of the university and are in demand in the conditions of the real economy.

The use of modern ICT tools is an important factor, for use in educational programs of professional training in the EOS of the university. When implementing programs in AVE in EEE university is not enough, and sometimes even impossible to use traditional means of education. Therefore, the use of special ICT is the main pedagogical means of education in the electronic educational environment of the university.

The training tools used in the professional training of engineering personnel in the system of additional vocational education in the EEE should have peculiarities compared to traditional training tools. To justify the choice of modern ICT, we will define them. (Shestak et al., 2008) describes ICT as a set of methods, technical means, networks and software that meet information needs (collection, processing, storage and display of information) in order to improve the efficiency of other technologies (production, organizational, pedagogical).

Therefore, when choosing modern information and communication technologies used in professional retraining programs «Automation and management systems in the oil and gas industry», «Automation and management systems in energy», implemented in the EEE of the university in the AVE system, we focused on the following criteria:

- 1) the content of the professional retraining program;
- 2) the potential of the university 's electronic educational environment (server capacity);
- 3) capabilities of software products - training environment (convenient content, extended functionality, accessibility, informativity);
- 4) hardware (computers, cameras, recording studio);
- 5) software;

6) network (Internet);

7) the level of personnel capacity of the university.

Educational programs of professional retraining «Automation and management systems in the oil and gas industry», «Automation and management systems in energy» are implemented on social and educational platform with web-interface «Moodle». Moodle is a web application located on a university server and is accessed through a browser. This learning environment is aimed at organizing educational content.

In modern pedagogical society, the most common typology divides ICT training tools into verbal, visual, technical (Hozyainov, 1998; Kudryavtseva, 2008; Noskova et al., 2018).

In determining the use of modern ICT training tools, it is necessary to focus on methods of training organization (lectures, seminars, laboratory exercises, practical exercises, independent work, video lectures, remote practical works, interactive laboratory workshops, online or offline test tasks, remote course works, projects, abstract tasks, essays, web quests), which are reflected in the curriculum of professional retraining programs.

Consider several disciplines as an example of the use of modern ICT. For each discipline of the curriculum there is an electronic educational and methodological literature, which can be used by the student, links to electronic library systems (ELS) «IPRbooks», «Jurite», «Book.ru» and others.

In the discipline «Integrated design and management systems» lectures are presented in the format of a video on the topics « Introduction to Automated Management Systems», « Steps for Creating Automated Process Control Systems», « Provision of control design information systems». In addition to the lectures, participants are offered audio and video educational information materials on the topics «Open Systems», «Basic Concepts and Functions of SCADA».

The discipline provides for remote laboratory works, during which the student must learn to create a monitoring system containing automatic power control units, displaying by various means of the operator interface the values of the internal signal generator. All laboratories are performed in the program «Trace Mode 6», which is offered to listeners for download in a hypertext version.

The discipline «Software of control systems» presents hypertext lectures on the topics «Programming software logic controllers. IEC 61131-3 programming languages», «Numerical software management», «Continuous process control systems software». Remote practical tasks involving simulation modeling in the form of development of the visualization screen of the control system and development of the

visualization service program, which are carried out through the software complex CoDeSys presented to the listeners in a hypertext version.

For all disciplines of the course, students and teachers can control "attendance," activity, time of educational work on the network. The assessment of the quality of the disciplines is carried out in the format of current, intermediate, final control and the results are reflected in the evaluation log. For organization of online interaction and communication between participants of educational process in each discipline there is a forum, chat, system of personal messages, e-mail.

In the University, in the course of training engineering personnel in the system of additional vocational education under the programs «Automation and management systems in the oil and gas industry», «Automation and management systems in energy», the EEE uses information and communication technologies specified in Table 1.

Table 1. Means of ICT education in the EEE of the university in the AVE system for the training of engineering personnel in vocational retraining programs implemented by the university

Engineering training programs	Types of tutorials		Tutorials
«Automation and management systems in energy»	<i>Traditional Learning Tools</i>	verbal	oral speech, words
		visual	textbooks and teaching manuals, collections of tasks and exercises, manuals for carrying out independent works, control works, dictionaries, reference books; models, educational laboratory equipment
		technical	projectors, personal computers, multimedia (interactive databases, electronic magazines, computer training programs, electronic textbooks), interactive boards
«Automation and management systems in the oil and gas industry» «Automation and management systems in energy»	<i>Tutorials of ICT</i>	verbal	skype, forum, webinar, system of personal messages in the system of remote education, messenger, voice mail, e-mail
		visual	electronic textbooks, audio-learning-information materials, video-learning-information materials, hypertext

		technical	computer training systems in hypertext and multimedia versions, simulators, electronic libraries, electronic resources, multimedia technologies
--	--	-----------	---

Results and discussion

In order to determine the effectiveness of the use of information and communication technologies in the professional training of engineering personnel in the system of additional vocational education in the electronic educational environment of the university, we conducted a statement pedagogical experiment. Its purpose is to study the opinion of the listeners on the comfort and satisfaction of the used information and communication technologies in the professional training of engineering personnel in the system of additional vocational education in the electronic educational environment of the university.

In order to carry out a statement pedagogical experiment on diagnostics of efficiency of information and communication technologies use in EEE in the AVE system at the university we were:

- tools have been developed to determine the level of comfort of students in the use of modern information and communication technologies;
- diagnostic tools of satisfaction with conditions of information and communication technologies organization in EOS are defined.

Experimental work was carried out with students of courses of students in the period from 2015 to 2020, on programs of professional retraining «Automation and management systems in the oil and gas industry» and «Automation and management systems in energy». The study involved participants in courses with both traditional learning tools and modern ICT learning tools. A total of 95 listeners participated in the experiment.

Determination of the level of comfort in the use of information and communication technologies in the EOS of the university. An important factor in the effectiveness of the use of information and communication technologies in the training of engineers in the system of additional vocational education in the electronic educational environment of the university is the level of comfort of students in the use of ICT. Today, the issue of environment comfort is considered by many scientists. Thus, authors Ananiev (1979), Slobodchikov & Isayev (1995) highlight the main collecting components of environment comfort - it is psychological, physical and intellectual.

Based on the specifics of implementation of professional retraining programs «Automation and management systems in the oil and gas industry» and «Automation and management systems in energy» in EEE in the system of AVE of the university, we will determine the main components of comfort of use of information and communication technologies. Physical comfort is manifested by the degree of satisfaction created by the object-spatial conditions of ICT learning tools. Intellectual comfort is expressed by the results of the use of ICTs, their ability to use them, to carry out thought activities. Psychological comfort is determined by the state of the listener throughout the training period and is characterized by signs: excitement, misunderstanding, disappointment, excitement, joy, delight, surprise, comfort and so on.

The high level of comfort of ICT use is characterized by signs: absolute satisfaction with the object-spatial conditions of ICT learning tools (full information on the ways of ICT application, use of electronic library, software products for download is presented, the rating log is displayed conveniently, a forum, chat, personal message system is provided); presence of cognitive interest; High quality of use of ICT learning tools; Absence of excitement about inconvenience of presented educational material; Full satisfaction with online and offline communication with teachers in forums and chat rooms, Skype; Delight in the ways and means of presented lecture, practical, laboratory materials (video-educational and information materials of high quality, hypertext links always work).

The average level of comfort is characterized by signs: sufficient satisfaction with the object-spatial conditions of the EEE (information on how to use ICT and ELS is provided, but not in full, software products for download are not fully presented, the rating log is displayed conveniently, forum and chat, Skype is not used in all disciplines of the course, the system of personal messages is used); presence of cognitive interest; Partial use of ICT learning tools; Excitement about inconvenience of the presented educational material; There is sufficient online and offline communication with teachers in forums and chat rooms; Slight disappointment with the ways and means of presenting lecture, practical, laboratory materials (video-educational and information materials are well voiced, image of good quality, hypertext links do not always work).

The low level of comfort in the use of ICT is expressed by such factors: dissatisfaction with the object-spatial conditions of the EEE (incomplete information on how to use ICT and ELS, software products are not presented or downloaded correctly, forum and chat, Skype is rarely used, the system of personal messages is not used, the results of evaluations are not displayed in the rating log); lack of cognitive interest; Indifference to how educational material is presented; Insufficient online and offline communication with teachers in forums and chat rooms; Dissatisfaction with the quality of lecture, practical, laboratory materials (video-educational and information materials of low quality, hypertext links do not always work).

Determination of the level of satisfaction with the conditions of ICT organization in EEE. Satisfaction with the ICT organization environment is a determining factor in the effectiveness of modern information and communication technologies in the training of engineers in the AVE system. It was said above that the programs of professional retraining programs «Automation and management systems in the oil and gas industry» and «Automation and management systems in energy» are oriented to regional peculiarities, the social order of the economy of the region is taken into account. Therefore, the use of modern ICT is important for the representatives of production. Since the application of innovative information and communication technologies will allow to implement professional retraining programs in the forms of training, which provide for remote and electronic education («correspondence - mixed training», «correspondence - electronic training»). Thus, when using ICT in the EEE of the university, the training takes place in-service, as the training takes place in free time.

A diagnostic tool (low, medium, high level of satisfaction) has been developed in EEE to determine the level of satisfaction with the ICT organization.

The low level of satisfaction with the conditions of ICT organization in EEE corresponds to the fact that students are practically unable to own information and communication technologies, technical means, Internet, browsers, software products, chat, forum.

The middle level is achieved by those students who can use a certain type of information resources and technologies, work on the Internet, use browsers, ELS. The use of special information, technical tools and software products for students is partial.

A high level is typical for those students who have skills and skills of integrated ownership of information communication technologies, technical means, web-technologies, special information and technical means, Internet network, browsers, software products, chat, forum.

Noting the pedagogical experiment to identify the effectiveness of ICT use in professional training of engineering personnel in the AVE system in the EEE of the university was carried out with students after completion of training. The results of the experiment are shown in Table 2.

Table 2. Effectiveness of ICT in engineering training in the EEE AVE system of the university, %

Indicator	Low comfort level	Average comfort level	High comfort level
Comfort in the use of ICT in the EEE	3	17	75
Satisfaction with the conditions of organization of ICT in the EEE	2	21	72

The results of the experiment showed that the use of information and communication technologies in the training of engineering personnel in the system of additional vocational education in the electronic educational environment of the university is quite effective.

Conclusion

The necessity of applying modern information and communication technologies in the electronic educational environment of the university in the system of additional vocational education is interpreted by time, is relevant and necessary in the educational space. The University effectively uses information telecommunication technologies in the training of engineering personnel in the system of additional vocational education in the electronic educational environment.

Thus, the use of information telecommunication technologies is revealed through innovative approaches and methods used in the electronic educational environment of the university. Information communication technologies provide new means of training in the system of additional vocational education in the electronic educational environment of the university.

References

Ananiev, B. G. (1979). *Man, as a subject of knowledge*. Moscow: Thought - Mysl.

About education in the Russian Federation: Federal law of the Russian Federation of 29.12.2012 No. 273-FL (2012). Reference and legal system «Consultant Plus» - *Spravochno-pravovaya sistema «Konsul'tant Plyus»*. <http://base.consultant.ru/cons/cgi/online.cgi?req=doc; base=LAW; n=158429;dst=0> (accessed 22.04.2020).

- Bodrug, N. S., Skripko, O. V., & Protsenko, P. P. (2019). Prospects for the development of professional retraining of engineers taking into account the needs of the region. *The Emissia. Offline Letters: electronic scientific journal*, 6. <http://emissia.org/offline/2019/2739.htm>
- Hozyainov, G. I. (1998). Learning tools as part of the pedagogical process. *Sbornik trudov*, 5, 130-136.
- Kudryavtseva, T. Yu. (2008). Use of multimedia technologies as a tool for building information competence. *Distance and virtual learning*, 2, 63-67.
- Noskova, T. N., Pavlova, T. B., & Yakovleva, O. V. (2018). ICT-tools of professional activity of the teacher: comparative analysis of Russian and European experience. *Integraciya obrazovaniya*, 1, 25-45.
- Plutenko, A. D., Leifa, A. V., & Maslovskaya, A. G. (2017 a). Modern role of the university in training personnel for the socio-economic development of the Amur region. *The standard of living of the population of Russian regions*, 2(204), 106-112.
- Plutenko, A. D., Leifa, A. V., Kozyr, A. V., & Khaletskaya, T. V. (2018). Specific features of vocational education and training of engineering personnel for high-tech businesses. *European Journal of Contemporary Education*, 2, 360-371.
- Plutenko, A. D., Leifa, A. V., & Ostapenko, A. A. (2017 b). On the issue of training engineering personnel in a classical university. Modern problems of science - *Sovremennye problemy nauki*. Blagoveshchensk: Amurskij gosudarstvennyj universitet, 67-69.
- Study memorandum through life (2019). Commission of the European community. <http://www.info.adygnet.ru/mo17012007/oz3.htm> (accessed 22.04.2020).
- Shestak, N. V., Astanina, S. Yu., & Chmykhova, E. V. (2008). *Andragogica and additional vocational education*. Moscow: SGU.
- Slobodchikov, V. I., & Isayev, E. I. (1995). *Fundamentals of psychological anthropology. Human psychology: Introduction to the psychology of subjectivity: the manual for high schools*. Moscow: Shkola-Press.
- Tolochek, V. A. (2005). *Modern psychology of labor: a textbook*. St.Petersburg: Piter.