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**Improving the Quality of Engineering Education
through Modern Educational Technologies**

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Abstract: *The purpose of this paper is to identify the features of Higher Education Institutions in the transition to the digital economy and the active introduction on this basis IT in the educational process. The changes that are now being implemented in leading universities have been identified. The core concepts of digital economy, information and communication technologies and the result of their pedagogical implementation are considered. It is defined that the active use of information and communication technologies within pedagogical process is one of the conditions for the formation of a harmoniously developed person. The paper contains the results of the research conducted by the authors in the framework of the international project “Excellence in Engineering Education Russia and Tadjikistan / EXTEND” of the Erasmus+ Capacity Building Program in Higher Education. The aim of the study was to estimate the National Research Mordovia State University maturity level in the field of introduction and use of educational and ICT technologies and to identify opportunities for improvement. The methodology of self-assessment of teaching approaches in engineering training programs at the University is proposed. For the self-assessment 3 levels were distinguished: the Institutional level of self-assessment, the level of the educational program, the level of stakeholders. The survey was conducted by the case of more than 300 respondents from different levels of the University. The results of the self-assessment allowed to identify strengths and areas for improvement related to the use of modern educational and ICT technologies and to develop recommendations for solving the problems.*

Keywords: *digital economy; higher education institution; quality of engineering education; information and communications technology (ICT).*

INTRODUCTION

At the current stage of the development of the society and social relations the humanity has moved into a new phase which is commonly referred to as the era of digitization. It supposes that human activity is connected with the creation, revision and use of information and some kind of knowledge in digital form. Digital economy takes the main place in all the spheres of social life and has a significant impact on it. The digitization of the economic system is the main direction of the state, economy and social relations' development, and digital economy is a breakthrough technology in the system of constant social development [8]. The current industrial revolution supposes the formation of a new type of industry, implying a fundamental change of vocational and, first of all, higher education [7].

Nowadays, the world educational system is prone to structural changes that lay in the active introduction of electronic facilities and forms of e-learning. The distributed knowledge is becoming more accessible almost in all parts of the world with the help of actively developing educational platforms. Such changes are currently realizing in the leading universities and they can be classified in the following way:

– *the digitization of education.* In fact it means the expansion of students' access to the educational resources of the world best universities, to the distant data of the results of scientific experiments and researches, to the library of engineering tasks and problems and to the formation of

distributed labour, research and educational commands with the help of digital solutions and informational systems;

- *the personalization of education*, that means intensification and development of the existing practice of the individual educational trajectory formation with a possibility to return to the points of branching and acquisition of additional skills during the whole life. Another aspect of personalization is the registration of claims and requests not only from the students, but also from the direct employers;

- *the project approach* is an essential component of profound education that allows to increase the effectiveness of the educational process from the first stage of understanding to the final stage of practical labour activity. The project approach is intrinsically linked to adaptive education, the main component of which is learning through the practical activities on the market, in industry and science;

- *the integration of formal and informal education*, that actually means the erosion of physical university barriers, where the emphasis is shifting from the process of knowledge acquisition to its acceptance and evaluation regardless of the actual place where the knowledge and skills are being gotten;

- *the formation of creative space*, that actually plays a role of integrative sites for the students of different specialties, for the real business-sector and industry, academic and professional education. There is an indispensable condition of functioning for such sites – it is a common work on the projects which are initiated by a real sector of the economy;

- *the formation of university hubs* – unlike usual universities' networking this means the formation of real sites in the form of research centers with the participation and under the aegis of various universities [1, 4, 5].

Russian educational institutions have both significant experience and potential, but because of the retard in the aspect of modern technologies there is the need in change of educational paradigm. The traditional understanding of technical specialties and human sciences changes under the influence of environmental transformation and the transformation of professional activity structure. In a post-industrial transition there is a shift of engineering activity and thinking (with their basic elements – inventing, constructing and projecting) from the field of technical engineering (machinery, mechanisms, buildings and structures making and operation, etc.) to the field of economic, financial, social, cultural and anthropological constructing, work with information and knowledge. The work of those who are involved in human sciences is also becoming complicated in its structure, the traditional kinds and methods of activities are combining with new ones – projective, constructive and system-modifying, etc [7].

The importance of the specialists' information and communication competence under the conditions of educational informatization increases. The international practice confirms the possibility for improving the quality of education based on a wide introduction of methods and tools of ICT. These tasks become particularly important in training future teachers and tutors. The IT in the educational process have an increasing impact on building the contemporary information worldview. Advanced general educational, cultural and professional skills of information processing, the ability to do networking, to design objects and processes, responsibly implement the plans is the basis of the teaching staff information and communication competence. The relevance of IT use in the university educational process is due to the social needs in the improvement of the quality of education and the practical needs in the use of advanced software in higher educational institutions. Upgrading of the educational process requires a transition from the passive strategies of learning (mostly lectures), to the active group and individual forms of work, the organization of independent research activity of the students, what will make it possible to train professionals with an outspoken individuality and carry out activities in different environment. In our opinion, this can be facilitated by the introduction of ICT and digital educational resources into the educational process. The competent use of ICT increases the pedagogical impact on the development of students' creative potential.

The teaching staff must know how to choose and apply ICT that fully correspond to the content and the purposes of the certain disciplines and learning processes, contribute to the achievement of those goals that will help to develop students harmoniously, taking into account their individuality [3].

I. METHODS

But it should be noted that the system that will train the teaching staff to work within modern digital educational environment is only being formed now. In this regard, in January-March 2018 within the framework of the international project “Excellence in Engineering Education Russia and Tadjikistan / EXTEND” of the Erasmus+ Capacity Building Program in Higher Education at National Research Ogarev Mordovia State University there was conducted a self-assessment with regard to the introduction and use of modern educational technologies in the University. The purpose of the study is to estimate the University maturity level in the field of introduction and use of educational technologies.

1.1 General information about higher educational institution

National Research Ogarev Mordovia State University is a federal state budgetary educational institution of higher education. The University carries out fundamental and applied researches in a wide range of sciences. The scientific and pedagogical potential of the University is about two thousand people. There are over 17000 students of all cycles of education who are currently studying at the University. There are 2000 international students among them. The University provides all the levels of higher education and a number of specialties of secondary vocational education, the programs of refresher courses and further training. There are full-time and part-time forms of study at the University.

1.2 Methodology of Self-assessment of Teaching and Learning Approaches in Engineering Training Programs at the University

For the self-assessment 3 levels were distinguished (figure no.1):

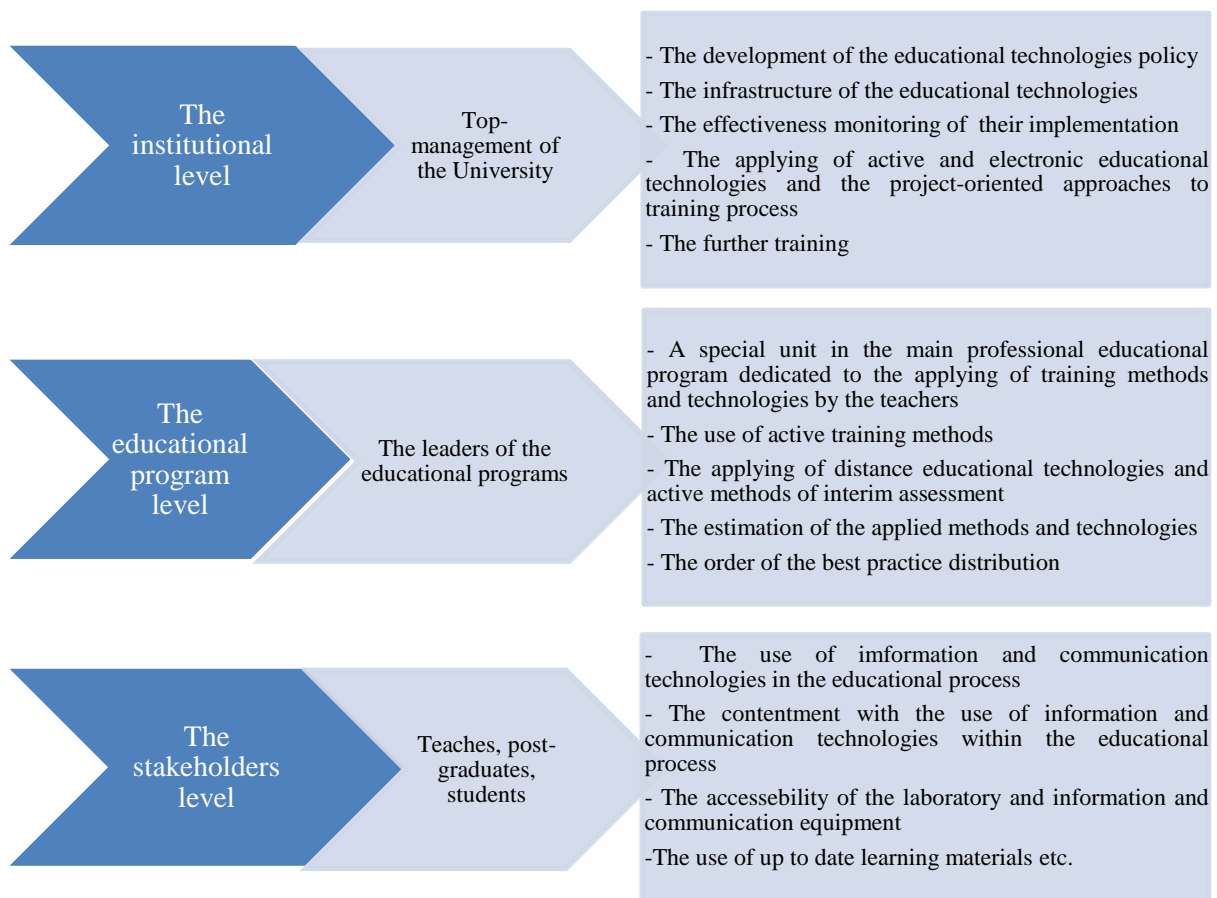


Figure no.1 – The levels of self-assessment with regard to the introduction and use of modern educational technologies at the National Research Ogarev Mordovia State University

II. RESEARCH MATERIALS

2.1 The Institutional level of self-assessment

Figure no.2 presents the results of self-assessment at the institutional level. The top-management of the University (vice-rectors, the heads of the departments) took part in the questionnaire. According to the results of self-assessment the University takes the highest level on such key elements as the infrastructure of educational technologies, the effectiveness monitoring of the use of educational technologies, the use of electronic educational technologies, further training in the field of educational technologies applying, the training of post-graduates. The lowest level was shown on such a key element as “the use of active educational technologies” (2) and “the development of the policy for the improvement of educational technologies” (3):

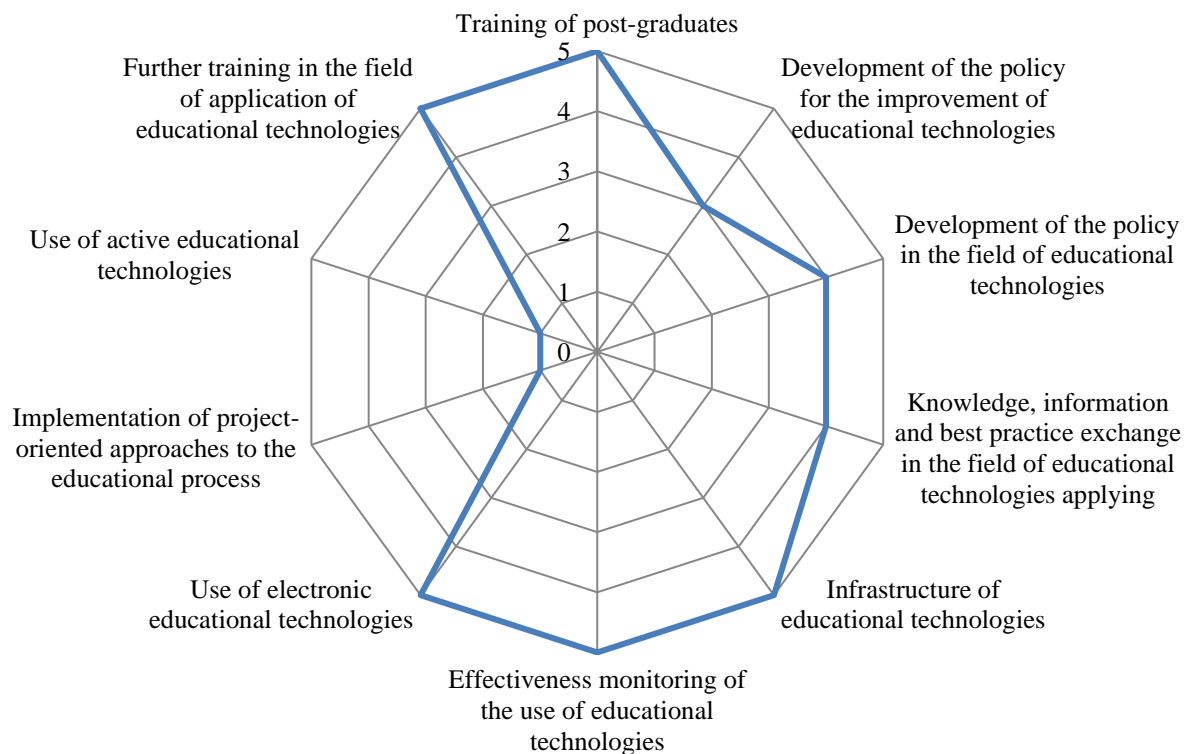


Figure no.2 – The results of Ogarev Mordovia State University self-assessment at the institutional level

2.2 The level of the educational program

At the second stage of self-assessment the educational programs in engineering were analyzed. The supervisors of educational programs took part in the survey. On the basis of the results it was determined that the teaching methods and technologies used by the teaching staff in the educational process are presented in the syllabuses implemented in the University’s main professional education programs. However, according to the respondents, the completeness of this section is estimated at 2 points (on a 5-point scale). The methods generally correspond to the goals of the educational program (according to the respondents it is estimated at 4 points out of 5). The teaching staff of the University are applying various training technologies, but their list is not wide enough (3 points out of 5). The teaching staff use active methods of interim assessment within the implementation of the educational program, among which there is the case-method, group discussion, work in small groups, brainstorm, project method, moderation, field classes, etc. The frequency of their use is indicated as rather high (80% out of the total).

E-learning technologies are also used in the educational process as a part of the educational programs, but their application has not been noted in the engineering training programs. The active methods of interim assessment are used during the implementation of the educational programs, but their application is not of a mass scale (principally, there is the students' testing).

Among the methods of the best practice distribution in the field of educational technologies application the following ones are used: participation in conferences, seminars and contests, annual pedagogical readings, further training programs. Within the realization of the educational programs each tutor has an access to the laboratory, information and communication and other kinds of the equipment and facilities that they need for the application of the educational technologies.

2.3 The level of stakeholders

At stakeholders level the heads of the institutions and chairs, faculty members, post-graduates and students of the University took part in the survey about the use of information and communication technologies in the educational process. At the level of the heads of the departments 12 people took part in the survey. The results of the survey are presented in Figure no.3.

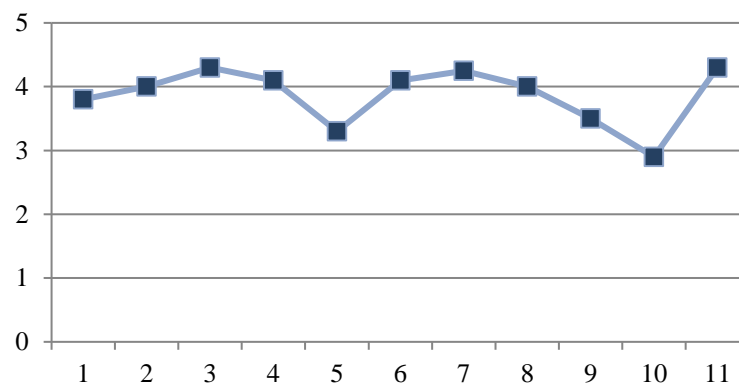


Figure no.3 – The results of the survey among the heads of the institutions and chairs of Ogarev Mordovia State University.

1. The ICTs used correspond to the purposes and content of the training materials.
2. The choice of teaching methods is justified taking into account the age and individual characteristics of the students, the level of their theoretical and practical training and also their own capabilities.
3. A variety of the implemented teaching methods is used in the University.
4. Teaching methods correspond to the real material and technical base of the University.
5. The University professors are rewarded for using innovative ICTs.
6. A reward is valuable for the teaching staff.
7. The teaching staff have an access to the laboratory, information and communication and other kinds of the equipment and facilities that are necessary for the ICT applying.
8. The positive results of the teaching staff work aiming at the implementation of innovative ICTs are distributed within the professional community of the University.
9. The teaching staff have no doubt that the expected results correspond to their capabilities.
10. The achievement of the expected results doesn't require constant excessive tension.
11. You consider it necessary to introduce innovative ICTs in your activities.

According to the survey results presented in Figure no.3 a variety of the implemented teaching methods is used in the University, the teaching staff have an access to the laboratory, information and communication and other kinds of the equipment and facilities that are necessary for the ICT applying, and also the heads of structural departments of the University consider it necessary to introduce innovative ICTs in their activities. But they mention that the level of the reward for the use of innovative ICTs is not so high, in spite of the fact that their introduction requires constant excessive tension.

33 respondents from the faculty members took part in the survey. 30% of them are men and 70% are women. The average age is 39 years. The teaching experience is 18 years. The structure of

respondents in the context of their positions: 30% are tutors, 70% are associate professors. The results of the survey are presented in Figure no.4.

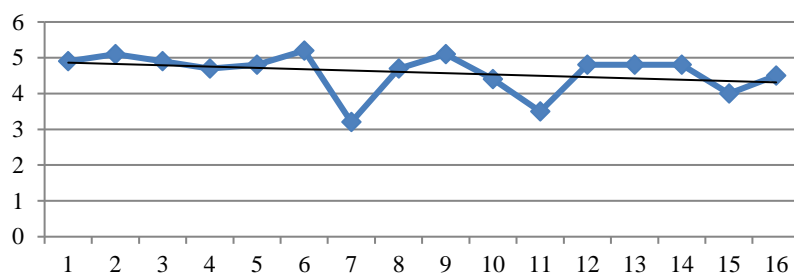


Figure no.4 – The results of the survey among the faculty members

1. The ICTs used correspond to the purposes of the educational program.
2. The work program of my discipline involves the use of ICTs.
3. The choice of teaching methods depends upon the audience (the target group of my lectures, practical and laboratory classes).
4. I use different ICTs.
5. The University equipment and infrastructure correspond to my teaching methods.
6. I consider it necessary to use new ICTs in my teaching practice.
7. I have enough time to develop a new work program with the introduction of ICTs.
8. I have an access to the laboratory, information and communication equipment and facilities necessary for the ICT applying.
9. I consider it necessary to know psychology and pedagogy for the process of teaching.
10. The positive results of the teaching staff work in the field of ICT introduction are distributed within the professional community of the university.
11. I consider it necessary to introduce electronic courses in a number of disciplines in order to replace the classroom studies.
12. I use a practice-oriented kind of training.
13. I use an interdisciplinary approach to develop educational programs and courses.
14. I use an individual approach to the process of education and also to the research and study work with students.
15. It is easy for me to develop ICT educational resources.
16. My study materials are available to the students in the e-learning/online system.

According to the survey results the teaching staff consider it necessary to use new ICTs in their pedagogical practice and to know psychology and pedagogy for the process of teaching. The work programs of the disciplines imply the use of ICTs, all the applied ICTs correspond to the purposes of the educational program. The choice of teaching methods depends upon the audience (the target group of lectures, practical and laboratory classes). When introducing new educational methods or tools into the learning environment, the teaching staff mention the following barriers: lack of time; workload; work experience; overload with paper work; lack of technical equipment in the classrooms of some faculties; low level of students' susceptibility to the new methods and tools.

Among the forms of the University support to the teaching staff in order to improve the effectiveness of the courses respondents note the following: the possibility to upgrade your education on the courses of the further training department; the information infrastructure and resources (an access to the programs, databases, and library); the methodical and consulting support, etc.

The respondents point out the following examples of the ICT applying in the educational process: e-learning, distance learning, the use of e-mail and other ways of communication with students in the Internet, the electronic information-educational environment of the University, providing the ability to lay out training materials and communicate with students, the assessment of learning activities of the students on their personal pages in the aforementioned environment, the use of video, interactive

boards, specialized software (online trainers, etc.), etc. In the process of the disciplines' implementation the following kinds of materials are used: textbooks, monographs, articles, videos, photos, databases, websites, Russian and international standards, etc.

23 respondents from the post-graduates took part in the survey. 96 % of them are men, 4 % are women. The average age is 25 years. The results of the survey are presented in Figure no.5.

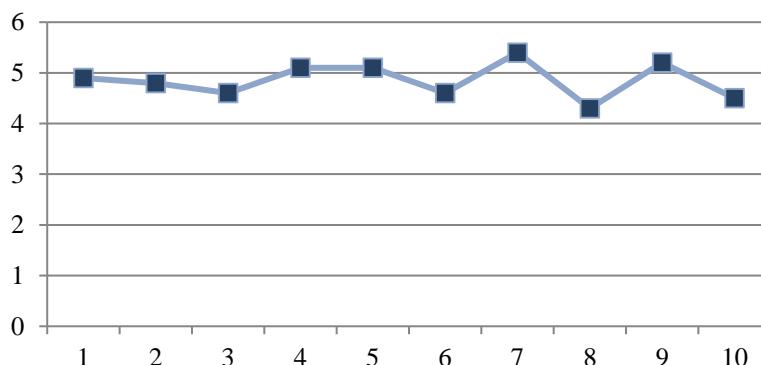


Figure no.5 – The results of the survey among the post-graduates

1. I am satisfied with the quality of learning with the use of ICTs.
2. The balance between the theoretical and practical parts of the course is adequate.
3. I am satisfied with the quality of the organization of the training workshop for the post-graduates.
4. The training materials used within pedagogical courses are relevant.
5. I know what competencies I must acquire at the end of my educational program.
6. I'd like to become a tutor at the University after finishing my studies.
7. I consider it necessary to introduce ICT into the educational process at the University.
8. Distance learning is a part of my educational process.
9. I want to increase the role of international experience in my education.
10. During my studies I become acquainted with the real branch of my future profession.

The respondents gave the following examples of the ICT use in the educational process: e-mail; electronic textbooks, handbooks, presentations; video conferences; electronic libraries; personal page in the electronic information- educational environment of the University; specialized software, equipment; skype sessions. Among the most effective tools for the study of engineering disciplines the respondents point out: alternation in the ways of presenting information; practical studies, professional consultations, internships, group work, interactive materials. Considering the methods of knowledge assessment used by the teaching staff in the educational process, they are testing, rating-point system, oral questioning, essays, test papers.

The most important competencies for the teaching staff, according to the post-graduates, are: the ability to present the material in a clear and accessible way, communication skills, practical experience, the relevance of the material, the ability to develop students' skills in the field of study, etc. Among the competencies that the post-graduates expect to acquire after their studies there are: the project management based on the experience got from writing a thesis, the leadership qualities and organizing skills, system and critical analysis skills, the ability to evaluate and analyze the information; the ability to conduct a research by yourself.

The average number of scientists/professors with whom the post-graduates consult during their studies in order to obtain a wider range of knowledge, opinions and recommendations is 3.5 people. The majority of the respondents have no experience of foreign education.

154 respondents from the students took part in the survey. 74 % of them are men, 26 % are women. The average age is 22 years. 70 % of the respondents are the 4th year students. The results of the survey are presented in Figure no.6.

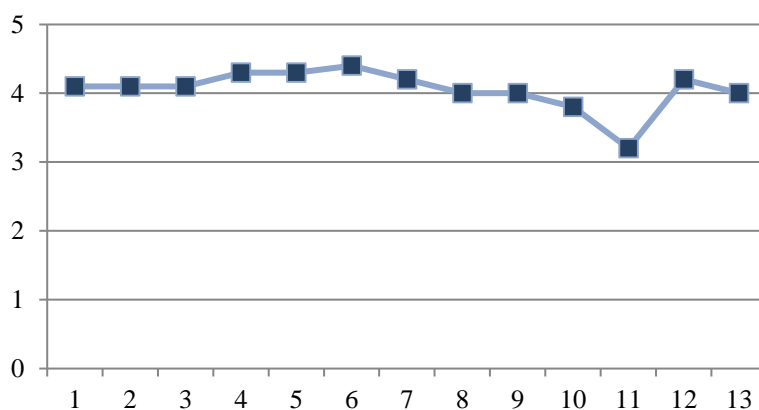


Figure no.6 – The results of the survey among the students

1. I am satisfied with the quality of learning with the ICT use.
2. The teaching staff use the ICT materials of a high-quality.
3. I use ICT to analyze and demonstrate the results of my academic work.
4. It is easier for me to study when a tutor uses ICT.
5. The young teaching staff use ICT more often.
6. The real projects and topical researches help students to be closer to their professional activities.
7. I have an access to the laboratory, information and communication equipment and facilities that I need to complete my learning tasks.
8. The educational materials on engineering disciplines are relevant.
9. The teaching staff of engineering disciplines use ICTs more often than the tutors of human sciences.
10. The balance between the theoretical and practical parts of the courses is adequate.
11. Distance learning is a part of my educational process.
12. I want to increase the role of international experience in my education.
13. During my studies I become acquainted with the real branch of my future profession.

Among the examples of the ICT use in the educational process the students pointed out: presentations, webinars, social media, e-mail, e-library, personal pages in the educational information environment of the University, infrastructure and specialized software. Among the methods of the knowledge assessment used by the teaching staff in the educational process the students pointed out: tests, practical cases, oral questioning, essay, written papers, rating-point system, laboratory work, etc.

From the students' point of view the most important competences for a tutor are: the presentation of training materials, communication skills, practical experience, the ability to maintain the students' interest to the course in question, creativity, etc. The most effective tools/methods to study engineering disciplines, according to the students, are: group work, interactive materials, internships, practical tasks, videos, games, analysis of scientific publications, etc.

III. CONCLUSIONS

The survey results at all levels – institutional, educational programs, stakeholders show that the University has highly developed infrastructure of educational technologies. Meanwhile a wide variety of teaching methods and approaches is used in implementing educational programs of all cycles (Bachelor, Master's, PhD). It is worth to highlight that all stakeholders show a high level of awareness regarding the benefits of introducing new methods and technologies in the educational process. That means that the university has already overcome the crucial stage in introducing new educational

technologies – bridging the key stakeholders’ resistance to change. Nevertheless, they have not massively been expanding owing to the barriers – lack of time; workload; lack of experience; overload with paper work; etc. All of this confirms the fact that solutions of the problems should be translated into concrete actions – training the teaching staff, process re-engineering at the university and academic departments’ levels aimed at removing existing chronophages and improving the quality of

Reference Text and Citations

- [1] Aleksankov A.; Fourth industrial revolution and modernization of education: international experience. *Culture and Security*. 2017. Available at: <http://sec.chgik.ru/chetvertaya-promyishlennaya-revolutsiya-i-modernizatsiya-obrazovaniya-mezhdunarodnyiy-opyit-2/>
- [2] Barber M., Donnelly K., Rizvi S., *An avalanche is coming. Higher education and the revolution ahead*. L.: The Institute for Public Policy Research. March. 2013.
- [3] Mironenko O. V. The use of modern information technologies in the educational process. *Young Scientist*. 2015. 13. p. 664-668. Available at: <https://moluch.ru/archive/93/20666/>
- [4] Salimova T., Vatolkina N., Quality management under the transition to the industry 4.0. *Standards and Quality*, 2018, 6 (972). pp. 58-62.
- [5] Salimova T., Vatolkina N., Makolov V. Vectors of quality management system development in transition to industry 4.0. *Standards and Quality*, 2018, (974), August, pp. 44-48.
- [6] Schwab K. *The Fourth Industrial Revolution* / K. Schwab - Eksmo, 2016. 138 p. (Top Business Awards)
- [7] Yastreb N.A. Factors of development of education in the context of the fourth industrial revolution. *Psychology, sociology and pedagogy*. 2014. 11. Available at: <http://psychology.snauka.ru/2014/11/3911>
- [8] Yusupova S, Pozdeeva S. Education of digital economy. Management of Economic Systems. 2018. Available at: <http://uecs.ru/uecs-108-1082018/item/4786->