

Information and Communication Technologies in the Professional Training of Engineers

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Abstract. The article considers the peculiarities of introducing innovative educational technologies into the professional training of future engineers. It highlights the problem of educational innovation, which will be solved both through the support of the university administration, and the teacher's desires and opportunities to involve the student in this process; The teacher plays an important role of the tutor in the process of innovation, since he considers the individual-psychological characteristics of each student and adjusts the educational process. It is noted that the formation of practical skills of applying innovative technologies in the future professional activity is an important component of students' educational activity. The problems of formation of engineering students' information competence are revealed. It is proved that ICT in the educational process contributes to: manifestation, preservation and development of individual students' skills, the unique combination of personal qualities; the formation of cognitive abilities for students, the desire for self-improvement; providing the comprehensive study of the phenomena of reality, the continuity of the interconnection between the humanities, technical sciences and the arts; constant dynamic updating of the content, forms and methods of educational processes. It is proved that the use of innovative technologies in the training of future engineers facilitates: simulation of both remote virtual lab search on the web, providing relatively inexpensive flexible access to the learning experience; international cooperation, overcoming geographical barriers. They give students insights into other cultures and experiences; formative real-time and skill-based assessment. Thus, it can encourage student participation in discussions. Technology support allows you to control skills development; e-learning, open educational resources and massive open online courses.

Keywords: Innovative Educational Technologies; Information and Communication Technologies Training; Future Engineers; Educational Environment; Professional Training.

1 Introduction

The Ukrainian higher vocational education is undergoing significant transformations. The rapid development of information and telecommunications technologies, whose impact is increasingly spreading across all spheres of social life, offers the prospect of improving higher vocational education, exchange of scientific and educational information. On the other hand, there is a shortage of highly skilled engineering staff in the fields related to modern information technologies and the functioning of the market system [7, 9].

The transition of modern society to global informatization requires the widespread use of information technologies in modern educational institutions, because it is information and communication technologies (ICT) that allow educational institutions to apply for innovation status in education [2, 8].

The integration of ICT in educational sector is considered as a tool to innovate teaching practices, provide the introducing of new didactic strategies that increase the students' interest and motivation, improve the quality of teaching-learning processes inside and outside the classroom [4].

Therefore, the integration of ICT in educational context motivates a curricular change; requires the acquisition of technological equipment; the connection to high-speed networks; developed teacher training programs; adequate mechanisms and methodologies that guarantee the use of ICT. Thus, providing society with access to these technological resources and tools increases the quality of education [5].

The continued and increased use of ICTs as learning technologies influences significantly on: what is learned; how it is learned; when and where learning takes place; who is learning and who is teaching. ICT enhances both teaching and learning methodologies through its dynamic interactive and engaging content [1, 10-12].



Fig. 1. Innovative educational space

Analysis of psychological, pedagogical, methodical, technical literature and dissertation researches allowed us to distinguish the following directions of innovative development of pedagogical education in the conditions of ICT implementation in higher educational institutions of Ukraine:

- scientific and pedagogical approaches to the implementation of the requirements of modernization of teaching and educational process;
- development and application of means of informatization of the educational process;
- innovative educational technologies: creation of educational environment of the educational institution, e-teaching and methodical complexes, application of interactive teaching methods, innovations in the system of assessment and evaluation of learning outcomes, modeling, multimedia trainings, distance education, virtual laboratories;
- personal-oriented approach to the organization of vocational education;
- methodical support and provision of vocational training;
- competences in vocational education;
- organization of students' research work;
- library automation;
- innovations in training and advanced training for teaching staff;
- relationships between educational institutions [13-15].

2 Research Justification of Problem of Engineering Training in Higher Educational Institutions of Ukraine

The problem of formation the personality of a competitive engineer is an important pedagogical issue that requires serious study and solution. The urgency of the problem is due to the need of society in the creative personality of the specialist; fundamental literacy of the specialist as well as a continuously developing personal worldview quality; insufficient theoretical and practical development of the system of formation of future engineers' competitiveness in the process of vocational training in the higher educational institution.

The student of a higher technical educational institution should realize from the first days of the study that insufficient level of graphic knowledge, skills and abilities will not allow him in his future professional activity to be engaged in rationalization and invention-related creativity. While writing a course project paper or a diploma project report, the student is aware of the need to complete the lack of knowledge through self-education, the use of computer-aided learning tools. The learning process is self-implemented through a chain of specific problems that need to be solved independently

The use of innovative educational technologies aimed at training a competitive specialist with the required level of personal and professionally relevant qualities that optimally satisfy the production demands opens new horizons for educational activity [6]. Therefore, the purpose of the article is to investigate the effectiveness of the implementation of information and communication technologies in training of future engineers. In times of economic or demographic decline, special attention is paid to

the process of engineering education development, as one of the possible ways out of the crisis is to introduce new engineering solutions based on the high-tech sector of the economy with a high-level knowledge, developed fundamental and powerful applied science.

Comprehensive complicated technological process of human activity requires a community of top-notch engineers.

Consequently, there is an urgency to reform the engineering training system. It must go to a whole new level [3]. The personal development of students is accomplished through the formation of competencies, both general and professional. Deep mental cognitive processes occur and personal qualities are formed: will, self-organization, responsibility, etc.

3 Research on the Implementation of ICT in the Vocational Training of Engineering Students

At the beginning of introducing the specialty course “Engineering information competence” for the-second year students of specialties 121 “Software Engineering”, 122 “Computer Science”, 124 “System Analysis”, 125 “Cybersecurity”, 126 “Information Systems and Technologies” we questioned 193 students of these specialties to identify engineering students’ information competence.

We identified the following indicators of the formation of engineering students’ information competence.

Diagram 1. The level of formation of engineering students’ information competence

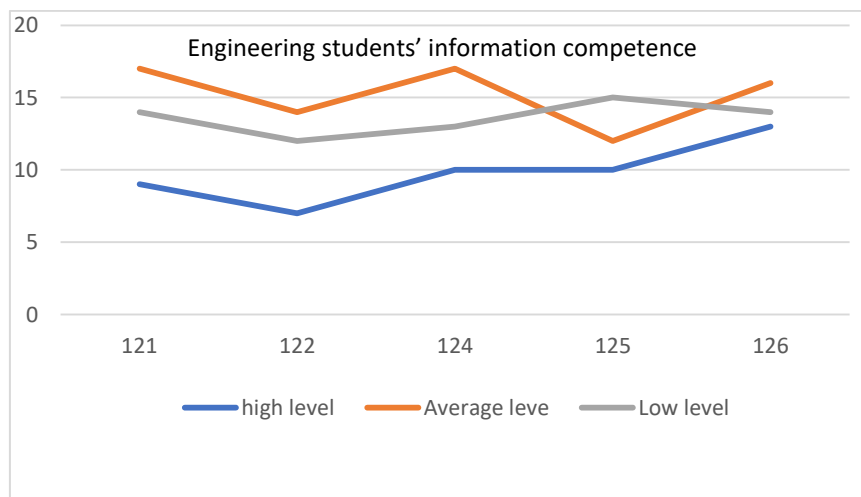


Fig.2. Research of indicators of engineering students’ information competence

The research results are caused by many factors. Despite the accelerated informatization process and the use of computer technologies, there is a serious problem in the system of higher education. Using the actual potential of these resources in the daily educational process is still insufficient.



Fig. 3. Model of formation of the engineering students' information competence

Potential opportunities of information and communication technologies are not fully revealed and demanded by the education system. The following objective and subjective reasons should be taken into consideration when considering the issues raised:

- insufficient elaboration of methodology for introduction of new information technologies into the educational process;
- low level of adaptation of available electronic educational resources to the course of special disciplines, based on educational-methodical complexes (NMC);
- low level of adaptation of available electronic educational resources to the course of special disciplines, based on educational-methodical complexes (EMC);
- lack of specialized system of educational training for teachers: transition from basic ICT competence to professional level of pedagogical ICT competence;
- low level of basic computer training of teaching staff;
- insufficient study of the psychological and pedagogical aspects of computer training;

- insufficient level of elaboration of the following areas: enhancing motivation by creating an incentive system for teachers to innovate using ICT (there is no possibility of implementation due to the lack of objective criteria for assessing the effectiveness of their application), systematic use of ICT in the educational process;

- difficulties in formation the evaluation criteria for assessing the educational informatization and individual educational institutions. This is due, first of all, to the lack of measuring instruments and clear criteria for the effectiveness of ICT use.

To increase the level of information competence, we have developed a model of formation of the engineering students' information competence, which is shown in the figure 3.

Thus, by creating the ICT environment, we get a competitive specialist in today's job market, capable of self-management, who is able to produce new ideas and has practical professional skills.

We consider information and communication technologies (ICT) as a complex of various means, methods and technologies for the collection, storage, processing, submission and transmission of information.

We define the means of information and communication technologies as software, software hardware and hardware devices, a set of technological processes, human resources information system integrated for the search, collection, production, accumulation, storage, processing, information dissemination which provide access to global and local information resources.

The topical issues facing higher engineering education are: an increasing amount of educational information, the need to revise and adjust the content of the existing methodological and didactic base, as well as the study of academic disciplines.

The picture shows the effectiveness of ICT use in the professional training of future engineers.

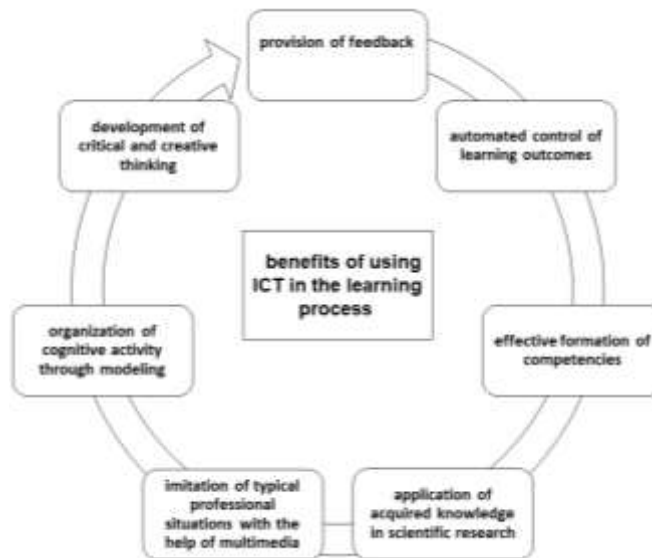


Fig. 4. Benefits of ICT use in the educational process

During the specialty course “Engineering information competence” students created projects. The main requirements for using technology project were: a significant research problem or creative task, creative plan or task, a research method for solving it; practical, theoretical, cognitive significance of predicted results; independent (individual, paired, group) student activities; structuring the content of the project (with staged results); use of research methods (formulating a research problem, research objectives and hypothesis for solving them, discussion of research methods; registration of final results; analysis of received data; summarizing, adjusting, conclusions).

The criteria for evaluating project development were identified. They are: the importance and urgency of the research problem; thorough study of the problem using knowledge from different fields of pedagogy; completeness, content of the project; urgency and prospects of the project. The learning process was based on the student's active purposeful activity during which they realized the importance of the acquired knowledge and the need to gain new knowledge related to engineering. The task of the teacher was to help students find new sources of information and direct their independent activity. The choice of project topics was determined by the teacher, according to the content of the academic discipline, or by the students themselves, if the project was intended for extracurricular work.

The work on the project involved the following stages:

- 1) search stage (set project goals; organizational work; formulation of research problem; to determine object and subject of research; hypothesis);

- 2) design stage (to determine directions of activity, tasks; ways of finding information resources; research methods; organization of groups, tasks allocation);

- 3) technological stage (independent work in groups, exchange of information; execution of planned technological operations; ongoing quality control; analysis of information collected by groups, drafting the project protection scenario: the purpose of the project; defense hypothesis; conclusions, tables, diagrams, figures, etc.; answers the questions);

- 4) the final stage (collective discussion, project examination, analysis of project implementation results, conclusions).

As a result, students independently solved the problem by applying the necessary knowledge. The results of the projects were presented in the form of research papers, abstracts, scientific articles, videos, models, albums, scripts, performances, programs, presentations, etc.).

Thus, the technology of projects was based on the development of students' cognitive skills, the ability to independently design their knowledge and orient themselves in the information space, the development of critical thinking, which is an integral part of the engineering information competence.

We used the ICTs shown in the figure 5. when teaching the specialty course “Engineering information competence”.

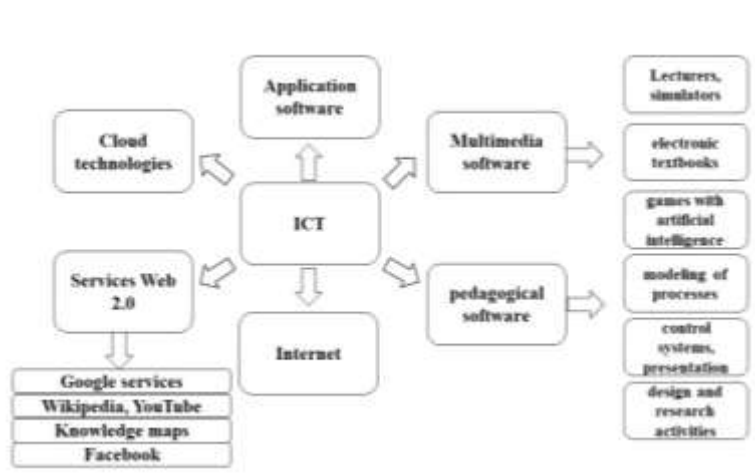


Fig. 5. Information and communication technologies of the specialty course “Engineering information competence”

Let's briefly run over the effectiveness of Web 2.0. Web 2.0. - these are social networks (Social Networking), Wik, social bookmarks (Social Bookmarks), the most developed forums.

Since students were able to create social projects, social networks were an effective means of their implementation.

We will consider the “Stop smoking” social project as an example. During the project implementation, anti-smoking social advertising was posted on Instagram and Facebook. It was necessary to collect statistics among those interested in the anti-smoking project. The survey made it possible to reach the target audience, get their opinion, and real-time data that helped to quickly analyze and continue or adjust the information campaign implementation plan. The students also created a “stories” questionnaire that included the question “Do you smoke cigarettes?” and “Yes” or “No” answers.

To implement the project, students developed social advertising using Pinnacle studio tools and spread it on social networks. Some projects included videos and presentations.

At the end of the specialty course “Engineering information competence” we conducted repeated questioning of students. The questionnaire contained more complex questions, for example “How do you use ICT in academic and out-of-class activities?”, “What are the challenges facing implementation of ICT in the educational process?”, “Write your recommendations on the use of information technology tools in the educational process”, etc.

The research results are shown in the diagram.

Diagram 2. The level of formation of engineering students’ information competence

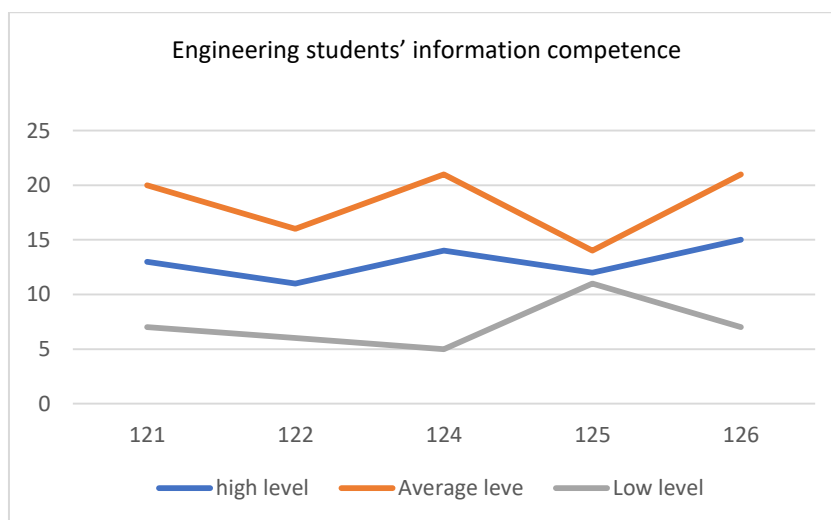


Fig.6. The level of formation of engineering students' information competence

Therefore, having conducted the research, we can observe a positive dynamic of the formation of engineering students' information competence.

4 Conclusions

Innovation of the educational environment of future engineers' training significantly influences the knowledge acquisition process. Innovative learning technologies allow to intensify the educational process, to increase the speed of perception, understanding and depth of mastering a vast array of knowledge.

Application of innovative technologies in education due to the available multiple analytical procedures; an open structure that allows you to quickly change the curriculum content, depending on the results of its testing; the ability to save and process a large amount of heterogeneous information and to compile it in a convenient way facilitates:

- manifestation, preservation and development of the individual students' skills, and unique combination of personal qualities;
- the formation of cognitive skills for students, the desire for self-improvement;
- providing the comprehensive study of the phenomena of reality, the continuity of the interconnection between the humanities, technical sciences and the arts;
- constant dynamic updating of the content, forms and methods of educational processes.

Successful achievement of pedagogical goals, use of innovative technologies is possible in the information-educational environment. We consider the information-educational environment as a set of conditions that contribute to the emergence and development of processes of information-educational interaction between the student, teacher and the means of innovative technologies, as well as the formation of cogni-

tive activity of the student, provided the filling of the environment components with the subject content of a certain training course.

Key recommendations for the use of ICT in higher education:

1. Technology should be considered as an enabler or means of enhancing and promoting the pedagogical experience of students.
2. University departments must actively keep up with students in order to keep abreast of technological trends and act accordingly.
3. The discovery by students of a number of carefully selected digital platforms develops digital confidence, students' practical knowledge and their digital skills.
4. Purchasing ICT tools can be an important issue, especially for higher education institutions trying to partner with smaller start-ups. Scaling up successful pilot studies to an institutional context can be a challenge because of procurement thresholds.

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