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Formation of engineering competences of higher education graduate specialists in knowledge field 13 "mechanical engineering"

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Abstract. The relevance of the work is justified by the main task of higher education institutions in providing knowledge and forming skills that will meet the requirements of potential employers in the industry for young specialists.

The best experience of acquiring competences by higher education specialists in the knowledge field 13 "Mechanical Engineering" of the Kyiv National University of Civil Engineering and Architecture was considered. At the same time, it is proposed to gain experience using professionally oriented games intended for engineers.

It is shown how in the conditions of an informational and educational environment, with the help of computerized mannequins, simulators and professionally oriented games, students practice professional tasks and various scenarios of design, manufacturing, technological and organizational-management future activities at enterprises

Keywords: competence, engineering mechanics, industrial mechanical engineering.

INTRODUCTION

In our time, the development of public intelligence is one of the most important factors in the successful and sustainable development of any country. At the same time, education is important for a leading mechanism of reproduction of science, technology and culture in general. Engineering and technical education

is an important element of the innovative potential of society, which takes into account the changing nature of the modern engineer.

Engineers - graduates of institutions of higher technical education should possess both basic and engineering-technical competencies that contribute to the development of modern science-intensive technologies, the implementation of science-based technical projects and the formation of national innovation systems.

Both the current state and the prospect of further development of the state depend on the professional level of graduates, their ability to exert their efforts and work for the development of society. Therefore, solving the problem of the shortage of engineering personnel and attracting talented young people to work at enterprises is relevant for the system of training a modern specialist in branch "Mechanical engineering". At the same time, content saturation of educational training is regulated by educational standards, most of which are currently under development. This is evidenced [1] the presence of approved standards of professional pre-higher education professional degree "specialist junior bachelor", which defines the range of competences that must be mastered by the education seeker (Table 1).

Table 1. Profile of a specialist in the branch of knowledge 13 "Mechanical engineering" [1]

Specialty	The main focus of the specialty is on the development of the ability to:
131 Engineering mechanics	Design, manufacturing, technological, organizational and managerial activities for work at enterprises performing construction, design, manufacture, operation, maintenance and repair of equipment and machines.
133 Industry engineering	Design, manufacturing, technological, organizational and managerial activities for work at enterprises of the construction industry performing construction, design, manufacture, operation, maintenance and repair of equipment and machines working in scientific research, design and technology and educational institutions

At the same time, the profession of a mechanical engineer is unpopular among high school students, as it requires special attention when organizing professional self-determination in senior high school classes. In addition, with high demand on the labor market, training in the specialties 131 Engineering Mechanics and 133 Industrial Mechanical Engineering is characterized by difficulty both in the educational process and in the performance of job duties.

The growth of requirements for the training of mechanical engineers is justified by the constant increase of:

- Complexity, accuracy and productivity of the equipment that is being designed and is in operation;
- Requirements for working conditions of workers and environment protection from pollution;
- The requirement for the ability of specialists to quickly adjust to the release of new products.

Therefore, today, ensuring a high level of training of mechanical engineers is not only important, but also quite a difficult task. Solving this problem, in turn, requires the development of a system for the formation of engineer competencies.

PRESENTING MAIN MATERIAL

The purpose of the article is to investigate the factors that determine the students' education effectiveness of the branch of knowledge 13 "Mechanical engineering" to

take them into account when developing a competence formation system.

The [2] interprets competence as a dynamic combination of knowledge, skills and practical skills, ways of thinking, professional, worldview and civic qualities, moral and ethical values, which determines a person's ability to successfully carry out professional and further educational.

Within the scope of this study, certain professional competencies of a student of higher education specialty 133 "Industrial mechanical engineering" are considered as an integral quality (Table 2), which [3 – 5]:

- Reflects the methodological and technological side of the educational process in the conditions of the informational and educational environment;
- Provides the ability to optimally solve professional tasks.

Specialists of specialty 133 "Industrial mechanical engineering" are knowledgeable in the areas of:

- Development of the basics of optimal technological support of parts' operational properties;
- Development of technological foundations of conversion, reconstruction and technical rearmament of production;
- Increasing the technological efficiency of product production processes;
- Modeling and optimization of technological processes.
- Solving technological problems of production.

Table 2. Fragment from the list of specialty competencies 133 "Industrial engineering"

Competences	The list of graduate's acquired competences
General (GC)	<p>GC1. The ability to think abstractly.</p> <p>GC2. Ability to apply knowledge in practical situations.</p> <p>GC3. Ability to plan and manage time.</p> <p>GC4. Ability to search, process and analyze information from various sources.</p> <p>GC5. Ability to generate new ideas (creativity).</p> <p>GC6. The ability to conduct research at a certain level.</p> <p>GC7. Ability to communicate in a foreign language.</p> <p>GC8. The ability to act socially responsibly and consciously.</p> <p>GC9. Ability to motivate people and move towards a common goal.</p> <p>GC10. Skills in using information and communication technologies.</p> <p>GC11. Ability to work in a team.</p> <p>GC12. The ability to realize one's rights and responsibilities as a member of society, to realize the values of a civil society and the need for its sustainable development, the rule of law, the rights and freedoms of a person.</p> <p>GC13. The ability to preserve and multiply moral, cultural, scientific values and achievements of society based on understanding the history and patterns of development of the subject area, its place in the general system of knowledge about nature and society and in the development of society and technology.</p>
Special (SK)	<p>SC1. Ability to apply typical analytical methods, effective quantitative methods of mathematics, physics, engineering sciences, as well as appropriate computer software for solving engineering problems of industrial mechanical engineering.</p> <p>SC2. Ability to apply fundamental scientific facts, concepts, theories, principles to solve professional problems and practical problems of industrial mechanical engineering.</p> <p>SC3. Ability to evaluate and ensure the quality of the work performed.</p> <p>SC4. Ability to implement engineering developments in industrial mechanical engineering, considering technical, organizational, legal, economic and environmental aspects throughout the life cycle of the machine.</p> <p>SC5. Ability to use computerized design systems and specialized application software to solve engineering tasks in the field of mechanical engineering.</p> <p>SC6. Ability to evaluate the technical and economic efficiency of typical systems and their components based on the application of analytical methods, analysis of analogues and the use of available data.</p> <p>SC7. Ability to make effective decisions regarding the choice of construction materials, equipment, processes and combine theory and practice to solve an engineering task.</p> <p>SC8. Ability to realize creative and innovative potential in project development in the field of mechanical engineering.</p> <p>SC9. Ability to carry out commercial and economic activities in the field of mechanical engineering.</p> <p>SC10. Ability to develop plans and projects in the field of mechanical engineering under uncertain conditions, aimed at achieving the goal, considering existing limitations, to solve complex problems and practical problems of improving product quality and its control.</p>

In table 2 the analysis of tasks, responsibilities, knowledge, and qualification requirements are reflected, which makes it possible to distinguish the special competencies of bachelors of specialty 133 "Industrial mechanical engineering".

At the same time, professional development is a multi-level process consisting of the following stages [3, 6]:

I. Emergence of professional intentions and admission to a professional educational institution.

II. Reproductive assimilation of professional knowledge, abilities and skills.

III. Professional adaptation.

IV. Realization of personality in professional activity.

Interest in the profession arises in different ways. Sometimes it manifests even before the beginning of education, but more often it appears already during studies in institutions of higher education or in the process of practical activities. But a student studies more successfully if the interest in a certain activity is clearly expressed.

A significant share of success belongs to such components of education as [3 – 6]:

- A cognitive component characterized by an individual's desire to gain a deeper understanding of a professional activity content that he/she likes:

- An emotional component that manifests itself in the individual's attitude to this activity as a positive stable long-term state;

- Willed component, which illustrates the individual's confidence in overcoming difficulties while mastering the profession and does not bear the imprint of "violence" in the case of a sufficient level of interest in the activity;

- An activity element that reflects the individual's need for a specific activity and its real activity in the in-depth development of the profession.

In the process of training at the preparatory department, gradual integration into the space of the future profession is of great importance for the formation of the professional interest of the student. At the same time, to assess the ability to acquire professional knowledge and

skills, it is relevant and appropriate to use computer game tasks of a professional orientation that reflect these abilities [6 – 8].

Examples of computer game tasks that reflect learning abilities in specialty 133 "Industrial Mechanical Engineering" of the Faculty of Automation and Information Systems of the Kyiv National University of Civil Engineering and Architecture are shown in fig. 1.



a



b

Fig. 1. Examples of professional computer game tasks for majors 133 "Industrial engineering":

a – SimCity;

b – Kerbal Space Program

SimCity (Fig. 1a) is one of the iconic computer games of all time, in which players can create cities with centers, residential areas, shopping centers and complex transport systems to meet the needs of the city's growing and developing population [7].

Kerbal Space Program (Fig. 1b) is a unique aerospace computer game in which the Player builds an aircraft using various parts of planes and rockets. Engines are required to be able to overcome the force of the planet's gravity and

launch the device into space. The game involves a rocket simulator [8].

Throughout the Kerbal Space Program game, Player must consider factors such as:

- Settings for different flight stages;
- Amount of fuel to be loaded for missions;
- Calculating the trajectory of the spacecraft to ensure that it can enter and maintain its orbits around various space objects.

These games in the list vary from games for construction to games for collaborative work and management, so they can be used not only to identify professional intentions when entering a professional educational institution, but also for the reproductive assimilation of professional knowledge, competences and skills and professional adaptation (productive implementation stage of professional development).

Namely (Table 2):

- SimCity is suitable both for the formation and development of GC: 2, 3, 5, 8, 9, 10, 11 and 13, and SC: 3, 4, 6, 7, 8 and 10;
- Kerbal Space Program is suitable both for the formation and development of GK: 1, 2, 4, 5, 7, 8 and 10, and SC: 1, 2, 3, 4, 5, 7, 8 and 10

Games that are intended for engineers are most often simulators and are used mainly for training. Such computer games have content and an educational concept.

Beginners with the help of games get the opportunity to practice various scenarios in

industrial mechanical engineering on computerized mannequins and simulators. Another advantage of game-based learning technologies is the possibility to avoid life-threatening mistakes/

The process of learning in the laboratory takes place through the acquisition of experience and the analysis of results. At the same time, the evaluation of learning results can take place both within the game process and outside of it (Fig. 2).

Evaluate of effectiveness of each team player in achieving the set goals and objectives is a very important component of the learning process (GC 8 – 12).

Some of the games have explicit mechanisms for evaluating the results: the time spent on the task, the number of correct answers, etc. However, the introduction of gaming computer technologies into the educational process also requires the formation of a competent approach to the evaluation of the activities of both education seekers and teachers.

The prospects for the development of the information and educational environment should also include the rapid development of computer games that are able to automatically adapt the scenarios of events in virtual reality to the player's abilities. When participating in such a game, information is collected based on which the learning process can be adjusted.

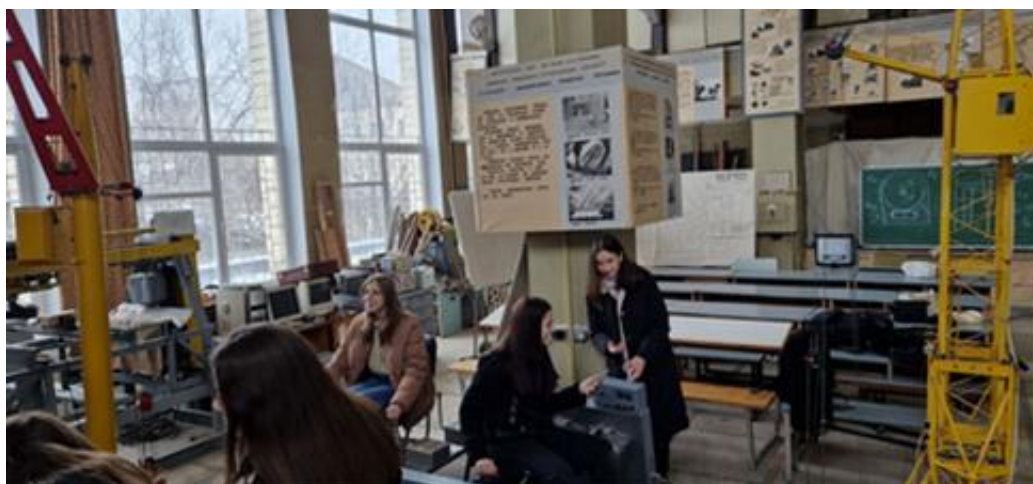


Fig. 2. Work in the laboratory of construction equipment

CONCLUSION

The study of the factors that determine the effectiveness of students' training in the branch of knowledge 13 "Mechanical Engineering" and trends in the development of information and communication systems and technologies in general showed that:

1. Professional computer games have great educational potential and should be used in education in the modern relations information communication system.

2. The effectiveness of computer game technologies directly depends on the compliance of tasks with the requirements for the profile of a specialist and considering the general and professional competencies that are formed in the process of learning in an informational and educational environment.

3. Factors that must be considered in the formation of the engineer's competence are related to the higher education system, the level and quality of pre-university education, the state policy in the field of higher education, the course of changes in science and technology, the participation of employers in the training of engineering personnel.

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Формування інженерних компетентностей випускників вищої освіти галузі знань 13 «Інженерна техніка»

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Анотація. Актуальність роботи обґрунтована основним завданням закладів вищої освіти в наданні знань та формуванні навичок, які будуть відповідати вимогам потенційних роботодавців галузі до молодих спеціалістів.

Розглянуто передовий досвід набуття компетенцій здобувачами вищої освіти фахівця галузі знань 13 «Механічна інженерія» Київського національного університету будівництва і

архітектури. При цьому набуття досвіду запропоновано здійснювати з використанням професійно орієнтованих ігор, які призначені для інженерів.

Показано як за допомогою комп'ютеризованих манекенів, симуляторів і професійно орієнтованих ігор здобувачі освіти в умовах

інформаційно-освітнього середовища відпрацьовують професійні завдання і різні сценарії майбутньої проектно-конструкторської, виробничо-технологічної і організаційно-управлінської діяльності на підприємствах.

Ключові слова: галузеве машинобудування, компетенція, інженерна механіка.