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FORMATION OF INNOVATIVE COMPETENCE OF FUTURE MASTERS IN SOFTWARE ENGINEERING IN THE CONDITIONS OF DIGITAL TRANSFORMATION OF EDUCATION

Abstract. The article provides a thorough analysis of the problem of forming innovative competence of future masters in software engineering in the conditions of digital transformation of education. The essence of the concept of "innovative competence" is revealed. It is found that the development of information technologies, the spread of artificial intelligence, cloud services, mobile platforms and cyber security tools determine the need for training highly qualified specialists who are able not only to perform professional tasks, but also to initiate changes in various spheres of society.

It is substantiated that the formation of innovative competence of future masters in software engineering involves the presence of knowledge, abilities, skills and value orientations that ensure the development of critical thinking, research activity, entrepreneurial and communicative abilities, as well as readiness to work in the conditions of digital transformation of education.

The pedagogical conditions for the formation of innovative competence are determined: integration of innovative educational technologies into the educational process of higher education institutions, project-oriented and problem-oriented learning, activation of research and experimental activities, participation in academic mobility programs, organization of an innovative educational space, development of communicative, entrepreneurial, and managerial skills. The experience of the Vasyl Stefanyk Carpathian National University in implementing digital platforms, startup projects and international partnerships is presented, which contributes to the development of innovative thinking and the ability to create high-quality software products among master's students.

It is concluded that the innovative competence of future masters in software engineering is formed through the combination of theoretical training, practical activities and participation in research and startup projects.

Prospects for further research are seen in the development of methodological materials for teachers of higher education institutions aimed at the effective use of digital resources in the process of training future specialists.

Keywords: competence, innovative competence, digital transformation of education, digital technologies, digital environment, future masters in software engineering.

ФОРМУВАННЯ ІННОВАЦІЙНОЇ КОМПЕТЕНТНОСТІ МАЙБУТНІХ МАГІСТРІВ З ІНЖЕНЕРІЇ ПРОГРАМНОГО ЗАБЕЗПЕЧЕННЯ ЗА УМОВ ЦИФРОВОЇ ТРАНСФОРМАЦІЇ ОСВІТИ

Анотація. У статті здійснено ґрунтовний аналіз проблеми формування інноваційної компетентності майбутніх магістрів з інженерії програмного забезпечення за умов цифрової трансформації освіти. Розкрито сутність понять «інноваційна компетентність». З'ясовано, що розвиток інформаційних технологій, поширення штучного інтелекту, хмарних сервісів, мобільних платформ і засобів кіберзахисту зумовлюють потребу в підготовці висококваліфікованих фахівців, здатних не лише виконувати професійні завдання, а й ініціювати зміни в різних сферах суспільства.

Обґрунтовано, що формування інноваційної компетентності майбутніх магістрів з інженерії програмного забезпечення передбачає наявність знань, умінь, навичок і ціннісних орієнтацій, які забезпечують розвиток критичного

мислення, дослідницької активності, підприємницьких і комунікативних здібностей, а також готовності працювати за умов цифрової трансформації освіти.

Визначено педагогічні умови формування інноваційної компетентності: інтеграція інноваційних цифрових технологій у освітній процес закладів вищої освіти, проєктно-орієнтоване та проблемно-орієнтоване навчання, активізація науково-дослідної та експериментальної діяльності, участь у програмах академічної мобільності, організація інноваційного освітнього простору, розвиток комунікативних, підприємницьких, управлінських навичок. Представлено досвід Карпатського національного університету імені Василя Стефаника щодо впровадження цифрових платформ, стартап-проєктів та міжнародного партнерства, що сприяє розвитку в магістрантів інноваційного мислення та здатності до створення якісних програмних продуктів.

Зроблено висновок, що інноваційна компетентність майбутніх магістрів з інженерії програмного забезпечення формується в процесі поєднання теоретичної підготовки, практичної діяльності та участі в науково-дослідних і стартап-проєктах.

Перспективи подальших досліджень вбачаємо в розробленні методичних матеріалів для викладачів закладів вищої освіти, спрямованих на ефективне використання цифрових ресурсів у процесі підготовки майбутніх фахівців.

Ключові слова: компетентність, інноваційна компетентність, цифрова трансформація освіти, цифрові технології, цифрове середовище, майбутні магістри з інженерії програмного забезпечення.

INTRODUCTION

The problem formulation. The current stage of development of Ukrainian society is characterized by the rapid introduction of digital technologies into all spheres of life, which necessitates the high-quality training of highly qualified specialists in the field of information technologies. The growth of data volumes, the emergence of new digital platforms, the development of artificial intelligence, cloud and mobile technologies, and cybersecurity cause a constant update of the requirements for the training of higher education graduates in the specialty "Software Engineering", which is recognized as one of the most promising and sought-after in the world, as it ensures the formation of human resources for the digital transformation of various industries - from industry and finance to medicine and education.

Currently, it is important to prepare future masters in software engineering, which involves the formation of innovative competence, research skills, critical thinking, interdisciplinary integration, innovation management, and also contributes to the development of mobility, communication and entrepreneurial skills, and lifelong learning.

In this context, the main tasks of higher education institutions are to update the content of educational programs with an emphasis on innovative and interdisciplinary components; actively use digital platforms, cloud services and artificial intelligence technologies in education; develop and implement educational and research projects focused on practical results; develop a culture of teamwork and leadership qualities; and increase the level of mentoring support for applicants for the second (master's) level of higher education.

Analysis of recent research. The issue of formation of innovative competence in Ukraine was studied by scientists I. Kovalchuk, L. Petrichenko, S. Zagorodniy, N. Kalyuzhka, O. Protsenko, S. Yurochko and others. The problem of formation of innovative competence of higher education students in the conditions of digitalization is gaining more and more attention in modern pedagogical science. Scientific research of domestic researchers is focused on studying the content, structure and conditions for the effective development of this competence. Thus, O. Shkurenko, O. Sakalyuk, S. Stetsyk concluded that a high level of innovative and digital competencies of future primary school teachers implies the manifestation of creativity, the presence of creative potential of the individual, professional and motivational readiness for innovative activities in education and science, as well as the ability to implement innovations in practice (Shkurenko, O., Sakalyuk, O., Stetsyk, S., 2021, 201–214).

A similar opinion is held by O. Tsiuniak, who studies the problem of professional training of future masters of primary education, emphasizing the social significance of innovative activity as a factor in professional formation, development of creative potential, and increasing the competitiveness of specialists in the modern educational space (Tsiuniak, O. 2019, 145–148).

Aspects of the formation of innovative competence of higher education students in the context of digital transformation of education were studied by L. Grynevych, N. Morze and M. Boyko, focusing on the components of innovative and STEAM competence (Grynevych, L., Morze, N., Boyko, M., 2020, 1–26).

The structural components of the innovative competence of a mathematics teacher are revealed in the works of V. Achkan (Achkan, V., 2014, 199–207), while the innovative competence of future mathematics teachers at the master's level was the subject of research by Yu. Galayko and V. Motorina (Galayko, Yu., Motorina, V., 2020, 32–36). At the same time, the mentioned scientific works are mostly focused on the training of future teachers. Therefore, the problem of forming the innovative competence of future masters in software engineering in the conditions of digital transformation of education is relevant and little studied.

AIM AND TASKS RESEARCH – is to substantiate the theoretical and methodological principles and determine the pedagogical conditions for the formation of innovative competence of future masters in software engineering in the context of digital transformation of education.

RESEARCH METHODS – theoretical (analysis, synthesis, generalization, classification and systematization of scientific sources on the problem of formation of innovative competence); modeling of pedagogical conditions for the formation of innovative competence; empirical (pedagogical observation, analysis of educational and professional programs and teaching and methodological materials).

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RESULTS OF THE RESEARCH

Digitalization of education is one of the key trends of the 21st century, which fundamentally changes approaches to the organization of the educational process in higher education institutions, and the formed digital competencies become a prerequisite for successful social and professional activity. According to the Law of Ukraine «On Education», among the key competencies are defined:

- competences in the field of natural sciences, engineering and technology, which involve the development of curiosity, the desire to search for and propose new ideas, the ability to observe and research independently or in a group, formulate assumptions, draw conclusions based on experiments, and learn about oneself and the world around us through systematic observation and scientific research;
- innovativeness, which implies openness to new ideas, the ability to initiate changes in the immediate environment (class, school, community), the formation of knowledge, skills that form the basis of the competency approach. This competency ensures the further ability to successfully study, implement professional activities, feel part of the community and actively participate in community life (Law of Ukraine «On Education»).

In the context of our research, we will analyze the essence of the concept of «innovative competence».

The first systematic study of innovative competence was carried out by the Ministry of Education of Denmark, which was based on the experience and achievements of the Organization for Economic Cooperation and Development (OECD). Within the framework of this study, a key category was added to the general list of competencies: creative and innovative competence. It is noted that creativity is considered as an individual characteristic of a person, manifested in the ability to generate new ideas, propose non-standard solutions and implement them in practical activities. This approach focuses on the importance of integrating creative thinking and innovative skills into the system of training specialists, which is especially relevant in the context of rapid changes in the modern educational and professional environment (Grynevych, L., Morse, N., Boyko, M., 2020, 1–26).

The team of authors (A. Kharkivska, A. Prokopenko, T. Otroshko, T. Bhan) notes that innovative competence in mathematics education encompasses several key aspects. Firstly, it is creative thinking, the ability to find non-standard approaches to solving mathematical problems. Secondly, digital literacy, which involves the ability to effectively use mathematical software, online platforms and visualization tools. Thirdly, communication skills necessary for presenting mathematical ideas using modern digital tools (Kharkivska A., Prokopenko A., Otroshko T., Bhan T., 2024, 87–91).

It should be noted that researchers identify 12 components of innovative competence (Fig. 1), including: risk tolerance (the ability to act in conditions of uncertainty and make informed decisions); interdependent behavior (readiness for cooperation and collective responsibility for the result); problem solving (the ability to effectively analyze situations and find optimal solutions); integrated thinking (the ability to combine knowledge from different fields to comprehensively solve problems); communication skills (the ability to listen, ask questions and clearly express thoughts); observation skills (careful perception of information and its analysis); experimentation (the willingness to try new approaches and methods); networking (the ability to establish professional and interpersonal relationships); decision-making (the ability to evaluate options and make choices based on analysis); implementation planning (organization of one's own activities and resources to achieve the goal); enthusiasm (active motivation for activity and involvement in innovation processes); satisfaction (gaining positive experience from implementing innovation activities) (Unlocking Innovation: Training Teams and Individuals to have Every Day Breakthroughs).

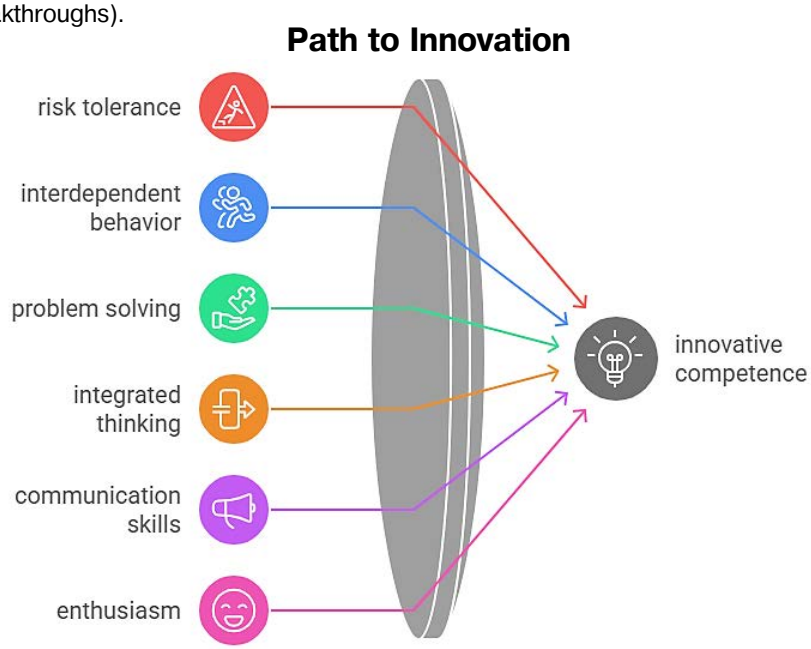

Fig. 1. Components of innovation competence

We believe that the formation of innovative competence of future masters in software engineering is a purposeful process that combines the acquisition of theoretical knowledge, the acquisition of practical experience, the development of critical thinking and research skills aimed at generating new ideas, developing innovative software solutions, applying modern digital technologies and adapting to the rapidly changing conditions of the professional environment. In addition, such a process involves the integration of theoretical training, practical activities, project and research work, and the formation of the ability to work in a team and effectively implement innovative projects in the field of software.

As practice shows, the formation of innovative competence requires effective pedagogical conditions. It is worth noting that at the Vasyl Stefanyk Carpathian National University, these conditions are implemented through the integration of modern educational technologies, the organization of research and project activities, as well as the expansion of international cooperation.

Teaching educational components («Fundamentals of Programming», «Organization of Computer Networks», «Web Design», «Fundamentals of Artificial Intelligence», etc.) involves the use of digital platforms, modeling systems, virtual laboratories. Such an environment promotes the development of creativity, critical thinking, and the ability to work with big data. For example, when studying the educational component "Fundamentals of Artificial Intelligence", students work on the tasks of building neural networks for analyzing texts and images, which combines fundamental knowledge with practical skills in working with modern Python libraries (TensorFlow, Keras).

Special attention is paid to involving master's students in working on real cases and startups in cooperation with IT companies in the region, which in turn ensures the formation of practical skills of innovative activity: the ability to work in a team, make non-standard decisions, create socially significant products. Higher education students participate in the development of mobile applications for educational needs and cyber defense systems that have practical significance in modern wartime conditions.

An important factor in the formation of innovative competence is participation in international educational programs Erasmus+, internships and joint research with foreign universities. It is undeniable that the combination of educational, scientific and practical activities at the KNUVS contributes to the creation of an open educational environment, where master's students learn not only to generate ideas, but also to implement them into specific solutions, think critically, work in conditions of uncertainty, and create innovative technologies to solve socially significant problems.

Taking into account the above, it is advisable to model pedagogical conditions for the formation of innovative competence of future masters in software engineering that meet modern challenges and needs of the labor market in the context of transformations of Ukrainian education. In particular, we define the following:

- integration of innovative digital technologies into the educational process of higher education institutions, the use of adaptive platforms, virtual laboratories, simulation systems and digital tools for studying complex algorithms, which will contribute to the formation of digital and innovative competence of master's students;
- project-oriented and problem-oriented training, which involves creating conditions for the implementation of complex interdisciplinary projects in cooperation with IT companies in the region;
- activation of scientific research and experimental activities, attraction of future masters to scientific laboratories and research centers of the university, which ensures the combination of theoretical knowledge with the practice of innovative activities;
- participation in academic mobility programs, international conferences, hackathons and joint research projects;
- organization of an innovative educational space that combines educational programs, scientific developments, IT hubs that allow second-level (master's) higher education students to implement their own ideas into specific products and technological solutions;
- development of communication, entrepreneurial, and management skills, which is an integral part of innovative competence.

Thus, the formation of innovative competence of future masters in software engineering is possible under the condition of comprehensive implementation of the specified pedagogical conditions, which ensures the training of competitive, mobile and creative specialists capable of operating in the conditions of digital transformation of education.

CONCLUSIONS AND PROSPECTS OF FURTHER RESEARCH

The conducted study showed that the formation of innovative competence of future masters in software engineering is one of the key conditions for improving the quality of their professional training and ensuring competitiveness in the labor market. In the context of digital transformation of education, innovative competence acquires strategic importance, as it involves the ability to integrate theoretical knowledge and practical skills, the effective use of modern digital technologies, the development of new software products and the implementation of innovative solutions in various spheres of social activity. The experience of the Vasyl Stefanyk Carpathian National University confirms that the combination of fundamental theoretical training with practical project activities creates favorable conditions for the development of creative and innovative thinking in higher education students. Undoubtedly, future masters in software engineering should not only be performers of individual technical tasks, but also generators of new ideas, team leaders, and initiators of digital transformation processes in various spheres of society.

We see prospects for further exploration in the creation of instructional and methodological materials for teachers of higher education institutions that contribute to the effective use of digital resources in order to develop innovative thinking, form professional competencies, cooperation skills, teamwork, and improve digital literacy.

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