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ЭФФЕКТИВНЫЕ МЕТОДЫ РАЗВИТИЯ ИННОВАЦИОННОГО МЫШЛЕНИЯ И ИЗОБРАЗИТЕЛЬНОЙ ДЕЯТЕЛЬНОСТИ

EFFECTIVE METHODS OF DEVELOPING INNOVATIVE THINKING AND INVENTIVE ACTIVITY

Аннотация. В статье рассматриваются вопросы развития инновационного мышления и формирования изобретательской деятельности у студентов и молодых исследователей. Анализируются эффективные подходы с использованием проблемно-ориентированного и проектно-ориентированного обучения, интерактивных методов, цифровых образовательных сред, STEM/STEAM, моделирования и прототипирования. Предложенные методы служат для дальнейшего повышения креативности в образовательном процессе и достижения практических результатов.

Ключевые слова: изобретательская деятельность, творческое мышление, методология исследований, проектное обучение, подходы STEM и STEAM, компьютерное моделирование, технология прототипирования, инновационная учебная среда, критическое мышление.

Abstract. The article discusses the issues of developing innovative thinking and forming inventive activity in students and young researchers. Effective approaches are analyzed through problem-based and project-based learning, interactive methods, digital learning environments, STEM/STEAM, modeling and prototyping. The proposed methods serve to further enhance creativity in the educational process and achieve practical results.

Keywords: Inventive activity, creative thinking, research methodology, project-based learning, STEM and STEAM approach, computer modeling, prototyping technology, innovative learning environment, critical thinking.

1. INTRODUCTION

Nowadays, science and technology are developing at an unprecedented pace, requiring new approaches and creative thinking in every field. Innovative thinking is a thinking process aimed at new ideas and solutions, which plays a key role in the modernization and development of society. This type of thinking includes new thinking, creativity, the development of new ideas and

technologies, and through them the improvement of existing systems [1]. Innovative thinking is thinking outside the box, breaking away from standard thinking patterns, connecting facts in a contradictory way, creating flexible ideas outside fixed mental patterns, and developing original ideas that have practical significance [2]. This process constitutes a higher stage of human thinking and is the basis of inventive activity.

The essence of innovative thinking is to critically analyze existing experience, create new ideas from it, test them in practice, and transform the results into social and economic benefits. Inventive activity is a practical expression of this thinking process, aimed at creating new technologies, products or methods.

To develop innovative thinking in the higher education system, methods such as problem-based learning [3], project method [4], interactive technologies [5], modeling of digital learning environments [6] can be used. These approaches form independent decision-making, innovation and unconventional thinking skills in students.

New requirements for the content, organization and entire educational environment of the educational process shape modernity, change the essence of education and its results [7].

In this regard, the development of innovative thinking in students and the formation of an educational environment focused on inventive activity are one of the most urgent tasks of our time.

2. MATERIALS AND METHODS

Historically, countless innovative technological inventions that have transformed the economy and culture have come into being not because of the market, but because of the knowledge and creativity of scientists and engineers [8].

Innovative thinking is the process of analyzing existing experience, creating new ideas from it, and effectively applying them in practice. Inventive activity is a practical manifestation of this thinking, aimed at creating new technologies and products. That is, invention means the creation of new devices, processes and combinations, and a new understanding of existing devices [9].

This type of thinking requires a person to take an unusual, creative look at existing problems, taking them out of the usual approach. At the heart of innovative thinking are factors such as creativity, critical analysis, a systematic approach, and experimental thinking.

Innovative thinking transforms a person from a mere possessor of knowledge into an enterprising creator. Because it combines theoretical knowledge with practice, paving the way for the creation of new inventions, technologies, or useful models. Also, innovative thinking teaches a person to make independent decisions, approach problems systematically, and make decisions in conditions of uncertainty.

Today, the changes taking place in the technical, economic, ecological, and social spheres have raised innovative thinking to the level of necessity. Each achievement of scientific and technological progress is, first of all, the result of a new vision in human thinking. Therefore, the development of innovative thinking not only increases personal creative potential, but also strengthens the intellectual and economic potential of society.

Scientific research, experimentation, and modeling serve as the main tools in the formation of innovative thinking. Especially in the modern education system, the development of independent analysis, ideation, and inventive skills in students creates the foundation for innovative thinking. Thus, innovative thinking is a form of strategic thinking of a modern person, which is one of the most important factors in future technological progress.

Stages of inventive activity:

Inventive activity is one of the highest manifestations of human thinking, which is the process of analyzing an existing problem in a new way, finding a solution on a scientific basis, and achieving a practical result. This activity is carried out in stages, and each stage requires its own scientific and methodological approach.

1. *Problem identification.* The inventive process begins, first of all, with the correct identification of the problem. The researcher analyzes the shortcomings, needs, or opportunities for improvement in the existing system, device, or technology. At this stage, the problem is identified based on the results of scientific observation, experimentation, statistical analysis, or modeling. The right problem is the most important factor determining the success of the next steps.

2. *Ideation.* Once the problem is identified, a new idea is developed to solve it. This process uses creative thinking [10], analogical reasoning [11], brainstorming [12], and morphoanalytic methods. The idea is the heart of inventive activity, it must have an element of novelty, be practically useful, and scientifically substantiated. At this stage, the technical, economic, and environmental effectiveness of the idea is assessed.

3. *Research and analysis.* At this stage, the proposed idea is subjected to in-depth scientific analysis. The researcher studies existing scientific sources, patents, and previous developments, and assesses the degree of novelty of his idea. The scientific validity of the idea is also checked through mathematical modeling, experimental measurements, or computer simulation. At this stage, the main parameters and characteristics of the invention are determined based on the results of scientific experiments.

4. *Model or prototype creation.* Based on the results of the research, an initial model (prototype) of the device or technology is developed. This process is carried out through laboratory tests, computer modeling or the creation of a prototype. Using the model, the operation, stability, efficiency and safety of the invention in real conditions are assessed. At this stage, the technical

specifications are clearly defined and the invention is brought into a form ready for practice.

5. *Patenting and popularization*. The final stage of inventive activity is the legal protection of the invented invention or utility model. For this, it is necessary to obtain a patent, formalize copyright, and enter it into the state register of intellectual property. The patented invention is then applied in production, education or scientific practice. Thus, inventive activity forms a complete innovation cycle from a scientific idea to a real product.

Effective methods for developing innovative thinking:

Developing innovative thinking is of great importance for organizational growth and success [13]. To effectively develop such skills, a number of methods and approaches should be used in educational and research practice. The most effective types of them are discussed below.

1. *Project-Based Learning* [14]. In this approach, a student or researcher works independently on a project aimed at solving a specific real-world problem. As a result, the student combines theoretical knowledge with practical activities, acquires the skills of logical thinking and a systematic approach to the problem. In the process of project-based learning, innovative thinking develops naturally, because the student feels the need to make creative decisions at each stage.

2. *STEM and STEAM approaches* [15] are based on the integration of science, technology, engineering, art, and mathematics. These approaches teach how to solve complex problems from an interdisciplinary perspective. In particular, the combination of engineering and art elements encourages students to find aesthetic and functional solutions. This method simultaneously develops students' systematic, critical, and creative thinking.

3. *Hackathons and innovation competitions* [16]. Hackathons are team competitions aimed at developing new technical or software solutions in a short period of time. They teach students to think quickly, work in a team, manage time, and make creative decisions. Through innovation competitions, young inventors have the opportunity to test their ideas in practice, receive expert evaluation, and prepare them for the real market. This process is also of great importance as a motivational factor in increasing inventive potential.

4. *Computer modeling and prototyping*. Using modern technologies, testing an idea in a virtual environment is one of the most effective tools for developing innovative thinking. For example, programs such as COMSOL Multiphysics, Proteus, Tinkercad, MATLAB allow modeling the physical, electrical or mechanical processes of an invention or utility model. This approach not only reduces the cost of conducting experiments, but also develops students' analytical thinking and scientific reasoning skills.

5. *Invention laboratories (Makerspace)*. Invention laboratories are technical spaces that serve to create a free creative environment for young people and researchers. In such laboratories, new prototypes are created using 3D printers, Arduino platforms, sensors and other equipment. This allows applying

theoretical knowledge to practice and bringing creative ideas to reality. The “Makerspace” environment also develops a culture of collective thinking and experience sharing.

6. *Mentoring system* [17]. The role of experienced teachers - mentors in the formation of innovative thinking is invaluable. The mentoring system provides guidance to young inventors, helps them analyze their mistakes, evaluate their results, and develop new ideas. In the process of working with a mentor, students gain a deeper understanding of the logical structure of scientific thinking, the culture of experimentation, and the social significance of innovative processes.

3. RESULTS AND DISCUSSION

The conducted analysis shows that innovative thinking and inventive activity are closely interconnected, creating the necessary conditions for the development of each other. Innovative thinking activates the creative, analytical and strategic aspects of human thinking, which directly affects the emergence of new ideas and technical solutions. The success of inventive activity, in turn, depends on the degree of formation of this culture of innovative thinking.

Research confirms that the most effective results are achieved when project-based learning, computer modeling, innovative competitions and mentoring systems are used together to form a creative approach in students and young scientists. These approaches not only strengthen theoretical knowledge, but also develop independent thinking, analysis and innovation skills in solving practical problems.

4. CONCLUSIONS

The development of innovative thinking is one of the priority tasks of the national science and education system today, and is an important factor in creating technological innovations, increasing economic efficiency and ensuring sustainable development. The results of the study show that approaches such as problem-based and project-based learning, interactive methods, digital learning environments, STEM/STEAM, modeling and prototyping are highly effective in forming innovative and inventive competencies in students and young researchers.

Creating an environment that encourages inventive activity in the education system, supporting startups and scientific and practical projects, and strengthening university-enterprise cooperation serve to align the creative potential of young people with the needs of the real economy. Also, the formation of an innovative culture, teaching the basics of intellectual property and patenting create the basis for further strengthening the intellectual and technological potential of our country.

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