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ADVANTAGES OF TEACHING NATURAL SCIENCES BASED ON THE STEAM APPROACH

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Abstract: This article analyzes the importance of the STEAM approach in the modern education system, exploring its essence, content, and integration into the pedagogical process. It highlights the different types of STEM and the mechanisms for developing critical and creative thinking, interdisciplinary connections, technical creativity and life skills in students through the STEAM approach terdisciplinary competencies in students and their application to real-life situations using methods and techniques such as Project-Based Learning and Problem-Based Learning.

Keywords: STEM, STEAM, creative thinking, critical thinking, integrated learning, Project-Based Learning, Problem-Based Learning. traditional education, engineering, arts, life skills.

Аннотация: В статье анализируется значение STEAM-подхода в современной системе образования, его содержание и интеграция в педагогический процесс. Рассматриваются виды STEM-образования и механизмы развития критического и творческого мышления, межпредметных связей, технического творчества и жизненных навыков учащихся на основе STEAM-подхода. В статье раскрывается международный опыт STEAM-образования, процессы формирования междисциплинарных компетенций у учащихся и их применение в реальной жизни посредством таких методов, как проектное и проблемное обучение.

Ключевые слова: STEM, STEAM, творческое мышление, критическое мышление, интегрированное обучение, проектное обучение, проблемное обучение. традиционное образование, инженерия, искусство, жизненные навыки.

In today's rapidly developing era, one of the most urgent tasks of every country is to educate a competitive, critical and creative thinker who has the skills of the 21st century, loves his country, takes initiative and is not indifferent to local, national and global problems. Therefore, educational and research institutions in developed countries of the world are introducing advanced technologies aimed at preserving not only the knowledge of students, but also their creative potential, physical health, and mental stability. Through this, young people are prepared for independent life, are directed to consciously choose their profession and actively participate in the development of society. The reforms in the education system being implemented in our country have set a wide range of tasks and tasks to organize the quality and efficiency of education in the continuous education system in our country in accordance with international standards and based on modern requirements, manage them, increase the competence of pedagogical personnel, identify and implement factors ensuring the effectiveness of the main reforms being carried out in the school education system.

According to statistics, since 2011, the demand for STEAM professions has increased by 17%, while the demand for ordinary professions has increased by only 9.8%, which indicates a great demand for this education system around the world.

What is STEAM? STEM is the integration of natural sciences (Science), technology (Technology), engineering (Engineering), mathematics (Mathematics), and these 4 disciplines are the basis of STEM. STEM has been modified by adding disciplines or areas such as Art, Reading + Writing.

The STEM approach was proposed in 1990 by American scientist Rita Colwell. Since the 2000s, due to the problem of a shortage of qualified personnel who can effectively use technology in high-tech companies, it has been introduced into the education system and is currently supported at the government level. The STEM approach was developed in America at the Massachusetts Institute of Technology (MIT). The motto of this famous institute is "Mind and hand". The Massachusetts Institute of Technology has developed STEM courses and even created STEM education centers in some educational institutions. It is widely used in the education systems of Australia, Great Britain, Israel, Canada, China, Singapore, and the USA. The goal of the approach is to develop students' creative thinking and teach them to effectively use natural sciences, technology, engineering, mathematics, and the arts by teaching them through design. STEAM is distinguished by the addition of art to STEM. The STEAM approach is an integrated teaching of natural sciences, technology, engineering, arts and mathematics, which develops students' creativity, critical and analytical thinking, communication and collaboration skills, and guides them to find practical solutions to real-world problems. STREM is an educational approach that is important for understanding the laws of the world through reading and writing. It is aimed at developing scientific and technical thinking in students, as well as strengthening their reading and text comprehension skills. Because not only understanding science and technology, but also reading, analysis and written expression play an important role in the skills of the 21st century. For example, when learning a new law in physics, a student not only does an experiment, but also reads a scientific article and analyzes the idea in it. In mathematics, it is important not only to calculate, but also to understand the text of the problem and write the solution in an understandable way.

Reading, understanding, and proposing solutions to scientific articles on global issues (climate change, energy shortages) is one of the main tasks of STREM. Thus, STREM is an expanded model that adds reading and literacy to education as a central skill.

STEM PhBL – STEM subjects start with the study of a natural or social phenomenon based on a phenomenon (a phenomenon is the study of reality in real life). For example: global warming, water scarcity, solar energy, etc.

STEM PBL – based on the study of problems. The learning process begins with a problem or task. For example: building a robot, creating an ecological garden, etc.

The STEAM approach directly connects the development of young people with the external environment, the world around us, because STEAM (science, technology, engineering, art and mathematics) subjects are closely interconnected and, working together, create new opportunities for solving problems. Through the STEAM approach, young people grow up to be active participants in global problems - climate change, technological changes, environmental problems, health care, etc. Natural Sciences (Science) – Natural sciences help to understand the connection between humans and nature. Biology studies the life of living organisms, the properties of chemicals and their transformations, physics studies the laws of energy and motion, and geography studies the Earth and its resources. Through this, students understand complex processes such as the origin of life, the mechanisms of the human body, the energy cycle in nature, and changes in the atmosphere and climate. For example, scientifically analyzing problems such as the drying up of the Aral Sea or global warming further increases the importance of natural sciences. This

knowledge encourages students to conduct research, conduct experiments, and make new discoveries through scientific observations.

Technology – Technology is one of the most important fields of science today. Fields such as computer technology, the Internet, artificial intelligence, biotechnology and nanotechnology have changed almost all areas of our lives. In the STEAM approach, technology teaches students not only to use ready-made devices, but also to create and improve them. For example, smart sensors that increase productivity in agriculture, medical robots in healthcare, or the development of environmentally friendly vehicles in everyday life are real manifestations of technology. This process serves to shape students as modern innovators and inventors.

Engineering – Engineering is one of the main foundations of human development. From ancient water structures to space stations, all achievements are the result of engineering thinking. By studying engineering, students have the opportunity to solve tasks ranging from simple life problems to global issues. For example, the construction of solar and wind power plants to eliminate energy shortages, waste recycling plants to reduce environmental problems, and the construction of environmentally friendly transport routes in urban planning - all of these are based on engineering solutions. This subject allows students to combine creativity and practical thinking.

Art – Art is a field that enriches human thinking and emotions, forms aesthetic views. In STEAM education, art develops students' imagination, creative approach and design skills. For example, through national patterns, crafts, music and theater, students learn to express themselves. When technology is combined with engineering, art allows for innovation in areas such as product design, architecture, fashion, graphic design or animation. Therefore, art is the spiritual and aesthetic foundation of the STEAM approach, which educates students not only as creators, but also as individuals who express the values of society in their products. Mathematics – Mathematics is the foundation of all sciences. It allows us to explain the laws of nature and solve real-world problems through numbers, formulas, graphs and models. In STEAM education, mathematics develops students' logical thinking, analysis, modeling and accurate calculation skills. For example, calculating a bridge project in engineering, budget planning in economics, measuring energy consumption in natural sciences, or creating an algorithm in technological programming require direct mathematical knowledge. Mathematics also prepares students to approach complex problems in the future on a scientific basis.

Unlike the STEAM approach, traditional education has the following characteristics:

- In traditional education, fixed lesson types are selected for all subjects;
- Knowledge, skills, and competencies are formed and strengthened on the topic of the lesson;
- A new topic is explained, reinforced, checked, and given assignments;
- Students are limited to listening to and learning from the teacher, completing the assigned tasks;
- Each teacher uses the modules and algorithms of the lesson in accordance with the method they use;
- Traditional education covers the general scope of subjects without directly focusing on or delving deeper into some selected parts;
- The teacher is the main character in the traditional curriculum lecture, which involves talking about a topic in class, students taking notes, and then applying the knowledge gained in a test or exam.

In the traditional education system, class structures and lectures can be monotonous, which can be boring for students and cause them to quickly lose focus. STEAM-based lessons, on the other hand, are an approach that aims to develop the student in all aspects by integrating science,

technology, engineering, art, and mathematics as a whole. It allows students to analyze real-life problems, find practical solutions to them, and model these solutions, not just theoretical knowledge. In this approach, the student investigates as a scientist, builds as an engineer, expresses as an artist, analyzes as a mathematician, and learns with interest as a child.

How STEAM education develops problem-solving skills:

Analytical Thinking: STEAM activities often present students with complex problems that require analysis and evaluation. Students learn to think logically to break problems down into smaller parts, identify patterns and relationships, and find solutions.

Creative Thinking: STEAM education encourages students to think creatively and seek innovative solutions. By integrating art and design into the learning process, students are encouraged to think outside the box, develop original ideas, and consider multiple perspectives.

Iterative Problem Solving: STEAM projects often involve an iterative process in which students continually refine their solutions through experimentation and feedback. They learn that failure and mistakes are part of the learning process and that they can iterate and improve their solutions based on feedback and new insights.

Collaboration and Communication: STEAM activities often involve teamwork, where students collaborate with their peers to solve problems. This collaboration enhances their communication and interpersonal skills as they learn to express their ideas, listen to others, and work together to achieve a common goal.

Integration of Multiple Disciplines: STEAM education encourages students to approach problems from an interdisciplinary perspective. By combining knowledge and skills from science, technology, engineering, the arts, and mathematics, students learn to use the strengths of each discipline to solve complex problems.

Real-world application: STEAM education aims to connect classroom learning with real-world contexts. By engaging in practical projects, students are exposed to problems that are relevant and applicable to their lives. Applying this knowledge in practice strengthens their problem-solving skills and helps them understand the value of learning.

The STEAM approach increases motivation, encourages students to be active, and connects knowledge with practice. By participating in project work, students develop their social, communication, and collaboration skills. Through this, students are formed as individuals who are able to create real products based on their ideas. Implementing such an approach in education not only builds students' competencies, but also prepares them for their future professions. For this reason, the STEAM approach is gaining great importance as an important and modern approach to the modernization of education today.

Advantages of the STEAM approach:

1. Close connection with the real world around us: for example, let's take the topic of water pollution. Through Science, they study water samples and identify pollutants. Through Technology, they collect data and use sensor devices. Through Engineering, they build a small model device for water purification. Through Art, they prepare posters and videos to raise environmental awareness. Through Maths, they measure pollution levels and draw graphs. This process shows students not only how to learn science, but how to use it to solve real-world problems. This is the essence of STEAM.

2. Motivation for students: In the STEAM approach, “motivation for students” refers to the intrinsic interest and active participation of students in learning. In this case, students understand why they are learning and see themselves as important participants in the process. This approach transforms them from passive listeners to active problem solvers. A concrete example: Students are

given the task of building a model of a solar-powered car. To complete this task, they use various disciplines: they study the laws of physics, understand the principle of operation of a solar panel, create drawings and finally build a model. In this process, the student sees the result of their work, and is encouraged to act more effectively.

3. Encouraging student cooperation: The STEAM approach understands the processes of students working together, exchanging ideas, dividing into roles, and working towards a common goal. Through this approach, each student applies their knowledge and skills in accordance with their role in the team. A concrete example: Students work in teams to design an eco-friendly automatic irrigation system for the school garden. Each member of the group plays a different role: one designs the water circulation system, another writes the control program using Arduino, and another draws a model or prepares a presentation. They listen to each other's ideas, work together to find solutions to problems, and share the results. In this way, collaboration is not just about dividing up tasks, but also about building a culture of mutual responsibility and support.

4. Critical thinking in STEAM approach: this is the ability of students not only to receive information, but also to analyze it, ask questions, evaluate and choose the most effective methods by comparing different solutions. In STEAM approach, this process, in addition to acquiring knowledge, serves students to deeply analyze existing problems, propose solutions with an innovative approach and apply them in real life through practical models, create a practical product or innovative idea. This means not only acquiring knowledge, but also turning it into a useful product or idea in real life. A specific example: Students are given the task of developing a project for a “smart home” that saves electricity. They are: Critical thinking - students use critical thinking to deeply analyze the existing problem, substantiate the evidence, compare different solutions with each other and test them using a practical model. This process educates them not only as creative individuals, but also as responsible, scientifically based and innovative decision-makers.

5. In the STEAM approach, “creating a product” means that students create a final result in the form of a practical solution, project or model based on their knowledge, ideas and creative approaches. This process is carried out through the student’s independent work on themselves, identifying the problem, planning it and bringing it to reality. A concrete example: Students are given the task of building a device that automates the switching on of lights at school. They create a working model using sensors, microcontrollers and programming. The device turns on the light when someone enters the room and turns it off when they leave. This project combines their technical knowledge, engineering approach and practical thinking. Through this, the student gets a product that is their own, useful, and visible result. This is one of the main outcomes of STEAM. Through this created product, students strive to solve the problem not only theoretically, but also practically. The finished model is tested, its usefulness is evaluated in a real environment and installed in the kindergarten. In this way, the student has the opportunity to transform knowledge into a useful, socially useful product. Project work and research work based on the STEAM approach are further strengthened through research skills. Research skills are the student's skills and abilities to conduct scientific research, identify a problem, ask questions, collect and analyze information, conduct experiments, draw conclusions, and present results. Research is a process of activity that creates qualitatively new material and spiritual values or is the result of creating subjectively new ones.

The conclusion reveals the results of the research and their significance in the natural sciences and STEAM fields. Scientific innovations, practical applications, engineering solutions and changes in creative processes are highlighted here. In addition, recommendations are given for the development of new research directions and innovative technologies in these fields in the future.

Integrated approaches in the STEAM field - the combination of science, technology, engineering, art and mathematics - create new opportunities. Therefore, researchers need to closely cooperate not only in their own field, but also with other fields.

In general, conducting research in the natural sciences and STEAM serves not only to discover new knowledge, but also to create innovations, solve practical problems and improve the quality of human life. At each stage, the combination of determination, patience, critical thinking and creativity is important. Also, strict adherence to scientific ethics is taken into account as a basic principle in any research.

So, as a result of such lessons, students:

- Apply their knowledge in different situations;
- conduct experiments and research;
- think creatively and be responsible;
- offer different methods of collaborative research;
- study evidence and engage in scientific research;
- help to study science in depth;
- strengthen students' knowledge through problem solving;
- demonstrate students' creative abilities;
- teach them to apply theoretical knowledge in real life.

In conclusion, the STEAM approach is one of the important approaches to modern education, as it transforms the student from a simple learner into an active creative and inquisitive person. In this approach, through interdisciplinary integration, the learning process becomes closer to real life, and knowledge is combined with practical activities, mastering theoretical concepts, but also testing them, creating new ideas, sharing its results with others. As a result, the educational process is not limited to just imparting knowledge, but also developing life skills, laying the foundation for professional training, and forming independent thinking. The greatest advantage of STEAM is that it prepares the student for future professions, forming responsibility, creativity, cooperation, and innovative thinking in them. Therefore, STEAM is considered not only the most relevant approach to today's education, but also an effective and reliable solution for future education.

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