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THE IMPORTANCE OF INTRODUCING STEAM EDUCATIONAL TECHNOLOGY IN CHEMISTRY TEACHING IN SECONDARY SCHOOLS

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Abstract
The article explains the advantages of using Steam educational technologies for teaching chemistry. At the same time, the importance of integrating disciplines in the organization of lectures, practical and laboratory classes in chemistry, and the formation of students' interest in science based on classes, is expressed.

Keywords: Steam learning technology, Phet Interactive Simulations, chemcollective, PBL problem-based learning.

Introduction

Today, the introduction of modern innovative approaches into the education system is becoming important. STEAM educational technology (Science, Technology, Engineering, Art, Mathematics) is an interdisciplinary approach aimed at strengthening students' scientific knowledge, developing problem-solving skills and forming creative thinking. The use of Steam educational technology in chemistry teaching will help you better master the theoretical and practical knowledge of this subject.

STEAM Education is a methodology that connects traditional subjects with each other and guides students to solve real-world problems [1]. This is an approach:

Science – an in-depth study of natural sciences, including chemistry;

Technological (Technology) – the formation of skills in working with various devices and technologies;

Engineering – design, modeling and creation of innovations;

Art (art) – the development of a creative approach and aesthetic taste;

Mathematics – allows you to accurately calculate and form logical thinking.

STEAM Education is not only a learning method, but also a way of thinking.

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In the STEAM educational environment, children acquire knowledge and immediately learn how to use it. Therefore, when they grow up and face life's challenges, be it environmental pollution or global climate change, they will realize that such complex problems can only be solved by relying on knowledge from different fields and working together. It is not enough to rely only on knowledge of one subject [2].

Steam's approach is changing the way we look at education and learning. By focusing on practical abilities, students develop their willpower, creativity, flexibility, and learn to collaborate with others. If we say that the main purpose of traditional education is to teach knowledge and use this knowledge for thinking and creativity, the Steam approach will teach us how to combine acquired knowledge with real skills. This gives students the opportunity not only to get some ideas, but also to put them into practice and implement them [3].

The introduction of Steam technology in chemical education.

Steam technology (Science, Technology, Engineering, Arts, Mathematics) is one of the innovative and effective methods of teaching chemistry. This approach provides interdisciplinary integration, contributing to the development of students' creative thinking, deeper assimilation of knowledge through practical experience [4].

The role of the steam approach in chemistry education. The use of Steam technology in chemical education creates the following opportunities:

Interdisciplinary correlation - since chemistry is closely related to mathematics, physics and biology, steam technology strengthens these links [5].

Practice and Experimentation – Laboratory experiments, problem solving, and design play an important role in STEAM projects.

Creativity, an element of art, develops visual and creative presentations, increasing interest in chemistry.

The principles of engineering make it possible to conduct research on chemical processes, materials and their properties in practice [6].

Ways to implement STEAM technology.

A) Project-based learning: students develop projects to solve chemical problems. For example, the Creation of Bioplastics project discusses environmental issues and integrates chemical and physical sciences.

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B) Digital technologies and virtual laboratories: performing complex experiments in a secure environment using virtual laboratories such as Phet Interactive Simulations, chemcollective. Visualization of molecules and reactions using 3D modeling software.

C) experiments related to engineering and technology: practical examples of topics such as “fuel and energy”, “nanotechnology”, to improve the integration of chemistry and engineering. Development of chemical monitoring projects related to Arduino or Raspberry Pi.

D) Art and creative approaches: explaining chemical processes through infographics and animations. Conducting creative experiments on the chemistry of color, pigments and dyes.

STEAM technology results: students' interest in chemistry is increasing. Through the understanding of interdisciplinary connections, critical and creative thinking develops. Practical skills are formed, that is, students learn to use a scientific approach to solve real problems [7].

By implementing this methodology in chemistry lessons, students receive an education based on scientific research and have the opportunity to apply theoretical knowledge in practice, as shown below [8].

Increasing Student engagement – Increasing interest through the use of laboratory experiments, projects, and interactive methods instead of traditional teaching methods.

A combination of theoretical and practical knowledge – students will be able to understand the laws of chemistry, linking them with their lives.

To develop creative thinking is to stimulate the development of new solutions through projects and experiments [9].

Building teamwork skills – through group projects, students learn to collaborate with each other.

Improving technological literacy is the preparation for working with modern technologies and equipment [10].

Organization of chemistry lessons using the Steam methodology.

When applying the STEAM methodology in chemistry lessons, you should pay attention to the following steps:

Problem statement: for example, "why is the amount of CO_2 in the atmosphere increasing?"or " how to recycle plastic waste?"the choice of actual problems, such as [11].

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Research and experimentation: Students strengthen their theoretical knowledge through experimentation. For example, laboratory classes, such as studying the effects of acids and alkalis, and explaining how batteries work.

The use of modeling programs in studying the properties of chemicals. Simulation of laboratory equipment on a 3D printer.

Develop students' design and creative approaches by creating infographics, visually representing chemical processes, and preparing presentations.

In practical exercises, such as drawing up equations of chemical reactions, calculating the percentage of substances and determining concentrations, the technology of using STEAM increases the effectiveness of the lesson [12].

Methods of organizing lectures, practical and laboratory classes based on STEAM technology in chemistry teaching

Organizing the lesson process based on the STEAM approach:

The main goal of organizing chemical education based on STEAM technology is to link theoretical knowledge with practical life, teach students creative and critical thinking, and solve problems based on an engineering approach. To achieve this goal, it is necessary to organize lectures, practical and laboratory classes based on innovative methods.

Organization of lectures.

A) specific aspects of the lecture:

Steam-powered lectures are based on methods that enable interactive and interdisciplinary integration, unlike traditional lessons.

B) Methods of lecture organization:

Interdisciplinary communication-explanation of chemistry topics through their connection with mathematics, physics, biology, engineering and art. For example: when discussing the topic "electrochemistry and energy", the basics of physics and engineering are also added [13].

Problem-Based Learning (PBL-Problem-Based Learning): Example: “How do petroleum products affect the environment?" to ask a problematic question on the topic and engage readers in a discussion.

Digital technologies and visualization: visualization of the structure of molecules and chemical reactions using tools such as PhET Simulations, ChemCollective, 3D Molecule Viewer [14].

Presentations related to Steam projects. Providing students with practical assignments for conducting research on topics such as “production of

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environmentally friendly fuels", "the importance of nanotechnology in pharmaceuticals".

Organization of practical classes

Hands-on classes based on Steam technology help students develop skills in conducting scientific research and solving real-world problems.

A) methods used in practical classes:

Project-based Learning (PBL).

Project example: Students experiment with the production of bioplastics and apply knowledge related to chemistry, engineering and ecology in the process.

Constructive problem solving. Example: "What chemicals can be developed to reduce environmental pollution?"organizing teamwork based on issues such as.

Interactive laboratory practices. Students conduct experiments on topics such as "electrochemical batteries", "polymers and their properties", and "water purification technologies" [14].

Organization of laboratory classes

A) laboratory training methods based on STEAM principles:

Engineering approach: example: battery design development on the topic "electrochemical cells and the principle of their operation".

Digital Laboratories: Safely and accurately perform experiments such as Reaction Kinetics, thermochemistry, and catalyst effects using virtual laboratories.

Adding elements of art and creativity: Students represent chemical reactions using infographics, models, 3D design, or animation. Example: explaining molecular geometry by drawing using an artistic approach [14].

An example of a Steam-based lesson structure

The lesson stage is a	Methodical approach the	STEAM element
Introduction (10 minutes)	Problem statement, visual examination of materials	Science, Art
The main part (30 minutes)	Interactive lecture, experiments, teamwork	Technology, Engineering
Practical part (30 minutes)	Virtual laboratories, project work, solving real problems	Mathematics, Engineering
Discussion of the results (20 minutes)	Presentation, Discussion and conclusion in groups	Science, Art
The final stage (10 minutes)	Reflection questions and answers and evaluation	All STEAM elements

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The use of steam technology in chemistry teaching has forced students to develop scientific and creative thinking, increasing their abilities in chemistry. A guide to this technique: students' games for analyzing and solving problems. As interdisciplinary communication strengthens, the likelihood increases that chemistry will test knowledge in practice. Between the interactive, design, and engineering fields, chemistry becomes red and clear.

Teaching chemistry based on steam educational technology helps consolidate students' knowledge of the subject, their practical application and the development of performance thinking. This method will motivate teachers who have fallen in love with their daughter and contributed to the achievements of science and technology in their future. Therefore, one of the urgent tasks is the large-scale introduction of steam technology in educational institutions. Steam technology support in chemical education makes the process interactive, fun, and effective. This approach gives students the opportunity to apply theoretical knowledge to solving real-world problems in the garden, using technology in the staff, and solving management problems.

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