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THE CURRENT STATE OF DEVELOPING CRITICAL THINKING THROUGH STEAM IN PRIMARY SCHOOL LESSONS

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Abstract
This article analyzes the current state of developing critical thinking skills in primary school lessons based on the STEAM (Science, Technology, Engineering, Art, and Mathematics) approach. It examines the implementation of innovative methods in the education system, the significance of an integrative approach, teachers’ methodological preparedness, and existing challenges from a scientific and theoretical perspective. Furthermore, the study highlights the opportunities provided by the application of STEAM technologies in primary education for fostering independent thinking, problem-solving abilities, creative approaches, and logical reasoning among students.

Keywords: STEAM, critical thinking, primary education, integration, innovative technology, methodology, creativity.

Introduction

The modern education system is increasingly being shaped by a competency-based approach. Today, the primary objective of education is not merely to provide students with ready-made knowledge, but to develop their ability to think independently, analyze problems, and make informed decisions. Critical thinking lies at the core of this process.

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Critical thinking ensures that students are able to comprehend a topic, analyze it, provide arguments, and draw well-founded conclusions. However, in traditional education systems, a reproductive approach often prevails, where students tend to act as passive recipients of knowledge.

Therefore, the integration of active methodologies—such as project-based learning and STEAM integration—into the educational process has become increasingly relevant. Since gaining independence, Uzbekistan has experienced rapid and comprehensive development, accompanied by significant political, economic, and spiritual transformations that have led to profound changes in the social life of the country. In light of the limited effectiveness of traditional methods in fostering critical thinking skills, the application of innovative pedagogical technologies—particularly the STEAM (Science, Technology, Engineering, Art, and Mathematics) approach—has gained particular importance. Education based on STEAM enables students to develop problem-solving skills, creative thinking, and a scientific mindset.

Today's learners represent a well-rounded, intellectually capable, inquisitive, and research-oriented generation with broad worldviews. Creating favorable conditions in the educational process to properly guide them and fully reveal their abilities and talents is of paramount importance. Effective utilization of these opportunities, combined with a clear understanding of the demands of the modern era, is essential for preparing competitive specialists for the country's future. The foundation of this process is laid in primary education, where the role of early developmental stages is invaluable in shaping a child's intellectual and personal growth.

In the context of rapid global changes, contemporary education must adapt to evolving conditions and ensure not only the moral and ethical development of the younger generation, but also their intellectual advancement. From this perspective, fostering students' critical and creative thinking, developing scientific and technological competencies, and preparing them to solve real-life problems constitute urgent educational priorities.

In accordance with the Presidential Decree No. PF-5538 and Resolution No. PP-3931 of the President of the Republic of Uzbekistan dated September 5, 2018, the implementation of STEAM methodologies in the public education system has been officially mandated. The STEAM approach integrates science, technology,

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engineering, art, and mathematics, enabling students not only to acquire knowledge but also to develop as inventors, engineers, artists, and mathematicians.

Moreover, through various STEAM-oriented activities—such as experiments and hands-on investigations, design and construction projects, art and design tasks, mathematical and logical challenges, and technology and programming exercises—both in classroom and extracurricular settings, students are encouraged to become active, inquisitive, and creative participants in the learning process.

At the same time, the Presidential Decree No. PF-73 of April 28, 2025, "On Measures for the Development of Pedagogical Education," and the Resolution No. 87 of the Cabinet of Ministers dated March 15, 2023, "On Measures to Improve the Quality of Primary Education," define state-level support for the implementation of the STEAM approach and the development of students' critical thinking skills.

STEAM education is a modern pedagogical approach based on the integrated teaching of science, technology, engineering, art, and mathematics. The central idea of this approach is to direct students' theoretical knowledge toward solving real-life problems in practical contexts.

In scientific literature, the following fundamental principles of STEAM education are identified:

interdisciplinary integration;

orientation toward practical activity;

problem-based and project-based learning;

support for creativity and innovative thinking.

In primary education, the STEAM approach is implemented in accordance with students' age and psychological characteristics, in a simplified, visual, and experience-based format.

Furthermore, if we compare the views of several philosophers and educators, the following perspectives can be highlighted:

The comparative views of prominent philosophers and educators regarding experiential, developmental, and integrative learning approaches are presented below:

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No.	Scholar	Key Idea
1	American philosopher and educator **John Dewey**	Advocated the principle of "learning by doing," emphasizing that knowledge is acquired through experience, observation, and practical activities.
2	Russian psychologist **Lev S. Vygotsky**	Proposed the concept of the "Zone of Proximal Development," according to which a child develops by performing complex tasks with the guidance of adults or more capable peers.
3	**Jean Piaget**	Argued that children assimilate knowledge more effectively through real objects and concrete experiences rather than abstract concepts.
4	**Howard Gardner**	Emphasized the importance of developing multiple types of intelligence (logical-mathematical, spatial, kinesthetic, visual, and others) within the educational process.
5	**Rodger Bybee, Georgette Yakman, and Linda Sanders**	Highlighted that STEAM education fosters critical thinking, problem-solving skills, and creativity among students.

These theoretical perspectives substantiate the pedagogical and psychological foundations of STEAM education and confirm its effectiveness in fostering critical thinking skills in primary school students.

In primary education, this approach contributes to fostering students' interest in academic subjects from an early age.

In our country, STEAM education has recently begun to be introduced for the first time in general secondary schools, particularly in primary grades through the subject "Natural Sciences." When implementing any new approach in the field of education, several important factors must be taken into consideration. First, in the proposed STEAM module, students' age characteristics and psychological features must be carefully considered. Second, internal continuity and coherence within its structural components should be ensured. Third, it must produce tangible educational outcomes, namely the formation of knowledge, skills, abilities, and competencies in learners.

When introducing STEAM education to young learners, special attention should be paid to psychological and hygienic requirements. The learning process should be organized in connection with adventures, games, and engaging experiments, which is particularly important in primary education. Among the positive aspects of STEAM education are the development of analytical thinking and interest in

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exact sciences, as well as teaching children to work not only individually but also collaboratively in teams.

In practice, during natural science lessons, students are asked questions such as: "Why do trees lose their leaves in winter?" or "Why does water evaporate?" While searching for answers, students compare their existing knowledge, formulate hypotheses, and draw simple conclusions. This process helps to shape the foundational mechanisms of critical thinking.

Regarding the pedagogical effectiveness of STEAM, research findings indicate that STEAM methods can increase children's logical thinking by up to 30% and their creativity by approximately 40%. Thus, STEAM represents not merely an integration of subjects, but the formation of a new worldview for the younger generation.

In primary grades, practical examples of integration and STEAM implementation include the following:

Mathematics + Art: constructing geometric shapes using colored paper; explaining the concept of symmetry through patterns and designs.

Natural Sciences + Engineering: a "Planting a Pepper" project involving plant cultivation and observation journals; constructing simple mechanisms such as levers and ramps.

Programming + Mathematics: creating simple algorithms using the Scratch Jr program.

When studying the current state of developing critical thinking through STEAM in primary school lessons, the practice of general secondary schools plays a crucial role. Today, elements of STEAM are being gradually introduced into primary classrooms across various regions of the republic. In this process, it is important that teachers strive to develop students' critical thinking skills through interdisciplinary, integrative activities.

STEAM lessons organized through the integration of mathematics and natural sciences in primary grades have proven effective in developing students' logical and critical thinking. For example, within the topic "Units of Measurement" in a Grade 3 mathematics lesson, students may be assigned a simple engineering task—constructing a model bridge using paper and cardboard. During this task, students measure distances, compare the strength of materials, and select the most appropriate solution, thereby demonstrating elements of critical thinking.

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Similarly, conducting STEAM-based experiments in natural science lessons contributes to the development of analytical thinking. For instance, in a lesson on "States of Water," students observe the processes of freezing and melting, record their results, and draw conclusions. In doing so, they compare observations, identify cause-and-effect relationships, and attempt to justify their reasoning.

In primary technology classes, organizing project-based activities within the STEAM framework has also yielded positive outcomes. For example, under the topic "Simple Mechanisms," students are divided into small groups to design and construct a hand-operated device model. During this process, they plan tasks, identify problems, propose solutions, and evaluate the final results. This not only enhances critical thinking but also develops collaboration and communication skills.

Integrated STEAM lessons combining visual arts and mathematics have likewise demonstrated effectiveness in practice. For instance, within the topic of geometric shapes, students may be tasked with creating a model or artwork using specific shapes. They analyze the properties of the shapes, compare them, and select the most aesthetically appropriate option. This process promotes the harmonious development of both critical and creative thinking.

In conclusion, the opportunities for developing critical thinking through STEAM in primary school lessons are extensive. Lessons organized on the basis of the STEAM approach increase students' cognitive activity, teach them to approach problem situations consciously, and foster independent reasoning skills.

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