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Didactic Opportunities for the Application of Steam Technologies in Primary Education

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Abstract: This article examines the didactic possibilities of STEAM technologies in primary school classes. It analyzes the works of researchers in the field of STEAM technologies. The role of the teacher in applying STEAM technologies in the educational process is highlighted, some examples of developing intrinsic motivation among primary school students are provided, and methods of integrating mathematics with other sciences are demonstrated. Factors enhancing the intrinsic motivation of younger students are also listed.

Keywords: STEAM technologies, primary school, intrinsic motivation, interdisciplinary integration, mathematical example, task.

Introduction. The reforms being implemented in the education sector of Uzbekistan are aimed at improving its quality. According to the Law of the Republic of Uzbekistan "On Education", the key factors include: enhancing teachers' qualifications, introducing modern methodologies, and integrating innovative technologies into the learning process for children. This contributes to the development of students' intellect as well as the preparation of competitive specialists. [1]

Today, it is important not only to develop primary education, which serves as the foundation for further learning, but also to provide support to students at subsequent stages of their educational journey. The younger school age is characterized by the acquisition of basic knowledge, and the quality of knowledge transfer depends on the teacher's ability to apply modern technologies and methods during classroom activities. The primary task of educators is to awaken students' interest in science and to develop their ability to critically perceive and effectively use information.

The introduction of educational STEAM technologies in schools helps children quickly navigate large volumes of information, apply acquired knowledge in practice, and also reveals their creative potential.

STEAM technology represents a combination of engineering-technical and artistic-aesthetic directions of education with mathematics, aimed at developing the intellectual and personal abilities of children.

The use of STEAM in the educational process implies the gradual introduction of access to technologies through which the educational process can be organized, taking into account the needs of modern children. A distinctive feature of STEAM education is that all lessons within this methodology involve the application of theoretical knowledge in practice, which allows students to consolidate the material and understand the essence of the subject studied. [15]

Literature Review. Scientific and pedagogical research in the field of STEAM education has been conducted by scholars such as T.Anisimova, T.Volosovets, A.Dorofeeva, N.Sologub,

A.Avazboev, M.Jamaldinova, M.Baidjanov, Kh.Karimov, R.Bekbaev and R.Davidova. For instance, researcher T.Anisimova focused on the innovative aspects of STEAM education in industry [2]; T.Volosovets studied the application of this approach in preschool and primary education [3]; A.Dorofeeva analyzed the state of STEAM education abroad [4]; N.Sologub investigated the features of implementing the STEAM approach in teaching natural sciences [5]; A.Avazboev and M.Jamaldinova revealed the essence of STEAM education technologies. In turn, M.Baidjanov, Kh.Karimov, R.Bekbaev, and R.Davidova considered STEAM education in the context of its integrative nature, paying attention to the theoretical and methodological foundations of this field [7].

Focusing on the principles of STEAM learning, one can highlight the aspect that this type of education enables students to solve practical problems on a broad scale, not relying solely on one discipline. The fundamental principle of STEAM technologies is interdisciplinary integration. By introducing and applying this principle in schools, students gain the opportunity to solve real-life practical problems. For example, textbooks in mathematics, natural sciences, and technology for primary school directly include tasks that cover possible real-life situations encountered by students in their daily activities.

The ability to apply STEAM technologies in the educational process depends on the teacher. The goal of using this approach is to develop students' skills in solving practical problems. It is in the primary grades that the abilities and skills are formed which serve as the foundational components for learning in the upper grades. By solving practical problems, students develop an interest in engineering, construction, art, and technology.

The potential of applying STEAM technologies lies in the fact that a primary school teacher can become a coordinator for their students, guiding and motivating them to choose a profession based on their interests. The preparation of qualified teachers in STEAM subjects is of great importance; such teachers should be capable of regularly and effectively increasing the interest and knowledge level of both boys and girls through modern innovative teaching methods. In primary grades, the teacher can reveal the students' sense of intrinsic motivation.

The term "intrinsic motivation" refers to a person's desire to engage in an activity for the sake of the activity itself and the internal satisfaction it brings, rather than for external rewards or incentives. When a person is intrinsically motivated, they experience joy, interest, and personal fulfillment from completing a task, studying, or working, which contributes to deeper and more conscious assimilation of knowledge and skill development.

Intrinsic motivation is a self-driven desire to achieve something: success in studies or in the future, self-improvement, and building relationships with others. When a person or child possesses intrinsic motivation, they move toward their goal independently.

Key features of intrinsic motivation include:

- Focusing on the process of the activity itself rather than external outcomes.
- A desire to learn and develop out of curiosity and interest.
- Increased resilience to difficulties and obstacles.
- Independence and responsibility for one's actions.

Motivation is a key element of the structure of educational activity, and for a primary school student's personality, intrinsic motivation serves as a fundamental indicator of their development. It manifests in the student's enjoyment of the learning process itself and the personal significance they attach to their achievements.

In the mathematics textbooks by I.V.Repyova for primary school, the content of problems in each topic is connected by an overarching theme. The content of these cross-cutting themes is intertwined with natural science, and the problems are linked to nature and the surrounding world, thereby helping the student appreciate the importance of the subject studied. For example,

in Part IV of the mathematics textbook for the second grade, there is a cross-cutting theme titled "Mountain Tourism in Uzbekistan." There is an oral task: What do the expressions next to the pictures mean? [14, p. 10]

4 · 2

4 · 1

When solving such examples, the teacher has the opportunity to broaden students' horizons while simultaneously reviewing multiplication tables and explaining the illustration — what is depicted on it. In this case, there is an integration of mathematics with the surrounding world, where the teacher also informs students about the hills, tents, and mountains shown in the picture.

A problematic issue is that not every primary school teacher applies STEAM technologies in the learning process. Many educators consider teaching from only one perspective, focusing mainly on the core part of the topic. This is explained by the fact that schools do not yet have a developed system for STEAM-based education. However, lessons offer opportunities for the gradual introduction of tasks that allow the integration of several subjects within one problem, thereby expanding students' thinking.

Example 1: Mathematics + Art (Geometry)

Task:

Draw a picture using different shapes: circles, squares, and triangles. Count how many of each shape you have. For example, 3 circles, 5 squares, and 2 triangles. Which shape do you have the most of?

While solving this task, students find drawing more interesting than writing. They will try to draw the shapes neatly if the teacher encourages them for good design. Talented students should be identified and praised, informing them about professions related to art. A student motivated intrinsically can develop an interest in this field.

Example 2: Mathematics + Engineering

Task:

Build a tower out of blocks. If you have 4 blocks and stack them on top of each other, how many blocks will be in the tower? If you add 3 more blocks, how many will there be in total?

Example 3: Mathematics + Science

Task:

Measure the length of the table in centimeters. If the length of the table is 120 cm and the width is 60 cm, calculate the surface area of the table (length × width). How many square centimeters does the table occupy?

Example 4: Mathematics + Ecology

Task:

There are 10 apple trees and 15 pear trees in the garden. How many trees are there in total? If 5 more apple trees are planted, how many apple trees will there be?

Example 5: Mathematics + Art (Patterns)

Task:

Create a pattern using colored circles: red, blue, green, red, blue, green... What color will the 10th circle be in the sequence?

These tasks help children see the practical application of mathematics in real life and develop critical thinking, creativity, and problem-solving skills.

Intrinsic motivation in students when using STEAM technologies in education is formed and strengthened by several key factors. Let's consider how this happens:

1. Interest and Engagement through Practical Activities

STEAM education focuses on project-based and research work where students independently create, experiment, and solve real-world problems. This naturally sparks interest, as children see the meaning and results of their activities rather than just performing abstract exercises.

2. Freedom of Choice and Creativity

STEAM projects often provide opportunities to choose topics, materials, or methods to solve a problem. This autonomy fosters a sense of responsibility and an internal desire to succeed in areas that interest the student.

3. Interdisciplinary Approach and Holistic Understanding

Combining science, technology, engineering, art, and mathematics helps students see the connections between subjects, making learning more meaningful and motivating. Students understand how knowledge is applied in life and technology.

4. Development of a Sense of Competence

By solving real and creative problems, children gain experiences of success, which strengthens their self-confidence. This positively influences intrinsic motivation—the desire to learn for the sake of the process and achieving results.

5. Collaboration and Social Interaction

Working in teams helps students exchange ideas and learn from peers, creating a supportive atmosphere and additional incentive for learning.

6. Feedback and Recognition

STEAM projects often include opportunities to showcase work (exhibitions, presentations), receive praise, and constructive criticism, which supports the internal drive for development.

Conclusion. Thus, intrinsic motivation in the use of STEAM technologies develops through active participation, creative approaches, awareness of the significance of one's actions, and support from teachers and peers. The STEAM approach provides children with the opportunity to systematically explore the surrounding world, gain a deeper understanding of the logic behind phenomena, identify their interconnections, and discover new, unusual, and exciting things. The anticipation of encountering something new stimulates curiosity and active learning; the need to independently choose an interesting problem, develop methods, and create an algorithm for its solution, as well as critically evaluate the results, fosters engineering thinking. Collaborative group work promotes the development of teamwork skills. All this provides the child with a qualitatively new level of development and expands their future opportunities.

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