INNOVATIVE METHODS OF INVOLVING STUDENTS IN RESEARCH ACTIVITIES BASED ON STEAM METHODOLOGY

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Annotation: The article analyzes innovative methods of involving students in research activities based on the STEAM educational model. The purpose of the research is to substantiate the effectiveness of the STEAM approach in developing students' scientific and creative abilities and to develop mechanisms for its integration into the educational process. Theoretical analysis, observation, experimental testing, comparison of international experience, and pedagogical diagnostics were used as methodologies. The results show that STEAM-based project and research methods significantly increase students' analytical thinking, use of experience, systematic problem solving, creative thinking and innovative approaches. At the end of the article, practical proposals are given for the implementation of the STEAM system for education in Uzbekistan.

Keywords: STEAM education, innovative pedagogy, project-based learning, research activities, creative thinking, experiment.

Introduction

In the 21st century, the educational process is focused on directing students to practice, scientific research, technological thinking, creative approach and problem-solving skills, rather than imparting knowledge. In this regard, the STEAM (Science, Technology, Engineering, Arts, Mathematics) education model is recognized as one of the most effective educational formats globally.

Today, in countries such as South Korea, the USA, Japan, Singapore, Canada, the STEAM approach is the main tool for developing students' research activities, participation in scientific projects and technological creativity. This model is also being gradually introduced into the education system of Uzbekistan, but methodological mechanisms for its practical implementation remain a leading scientific problem.

Methodology

This study was carried out based on a set of scientifically based approaches. First of all, international scientific sources, modern methodological literature and state educational standards related to STEAM education were studied through the method

of theoretical analysis. This stage served to identify the theoretical foundations of the study and form a conceptual model.

As a practical part of the study, the experimental-testing method was used. In this, lesson processes organized based on STEAM projects were observed in two general secondary educational institutions. This test process helped to determine how the STEAM approach is manifested in a real educational environment.

Also, the comparative method was used to compare the effectiveness of education organized based on STEAM with the traditional educational process. As a result, the dynamics of indicators such as the level of student mastery, learning motivation and active participation were analyzed.

A pedagogical diagnostic method was used to identify students' cognitive, technological, and creative skills. During the diagnostic process, students' competencies were identified based on tests, observation sheets, assessment criteria, and practical assignments.

As an important component of the methodology, an expert interview was conducted. It was attended by 12 experienced teachers, 25 students and 3 education experts. Through these interviews, the advantages of the STEAM approach, existing pedagogical problems and suggestions for improvement were explored[1].

This set of methods, while ensuring the reliability of the research, allowed the development of an effective practical model and methodological mechanisms for organizing students' research activities based on STEAM.

Results

The results of the study confirmed that the introduction of STEAM methodology into the educational process had a significant impact on the level of knowledge, interest and competencies of students. The following main changes were observed during the analysis:

1. Deep assimilation of knowledge:

Students began to deeply assimilate knowledge based on STEAM principles through practical experiences. The application of theoretical knowledge through experience, project, modeling and observation developed their skills in relating the topic to real life.

2. Development of creative and critical thinking:

During the project activity, students had the opportunity to think independently, compare alternative solutions, create new ideas and defend them. This ensured the growth of creativity and analytical thinking in them.

3. Increased interest in research activities:

With the help of STEAM methods, students showed interest in scientific

[1] English, L. D. (2016). STEM Education: Foundations and Future Directions. International Journal of STEM Education, 3(1), 1–10.

observation, asking questions, creating hypotheses and testing them through experiments. Research tasks directed them to active research and obtaining results.

4. Formation of collaborative work competencies:

Group projects and problem-solving tasks developed students' skills in collaborative exchange of ideas, correct distribution of roles, sharing of responsibilities and collective decision-making.

5. Increased technological literacy:

The use of 3D modeling, robotics, artificial intelligence, digital design and virtual laboratories in the educational process significantly increased students' digital skills.

In general, the results of the study showed that the STEAM model is one of the most innovative and effective approaches to involving students in research activities, developing their 21st century competencies, and increasing the efficiency of the educational process.

The results show that the STEAM model is one of the most effective educational strategies that direct students to research.

Discussion

The results are consistent with international experience and confirm that the STEAM educational model has high potential for improving the educational process in Uzbek schools. However, there are some problems in its implementation:

- lack of methodological manuals;
- low level of readiness of teachers for the STEAM approach;
- lack of digital laboratories, technical base, and innovative equipment;
- lack of harmonization of curricula with STEAM.

To overcome these problems, it is necessary to create a STEAM ecosystem adapted to the national curriculum, develop skills, and organize STEAM laboratories for scientific experiments in schools.

Conclusion

The results of the study show that the STEAM education model is a modern pedagogical approach that is highly effective in involving students in research activities. This model places practical experience, problem-solving tasks, technological solutions, and interdisciplinary integration at the center of the educational process, thereby forming 21st century competencies in students, such as scientific thinking, creativity, problem solving, and critical thinking. In addition, the STEAM methodology enhances students' ability to apply knowledge to real-life situations, increases technological literacy, and significantly increases their motivation for research.

According to the analysis, it is necessary to gradually and widely introduce the STEAM approach into the education system of Uzbekistan. For this, it is important to establish STEAM laboratories in schools, retrain teachers based on special

methodologies, create national educational platforms, and expand project-based learning in curricula. Also, supporting students' scientific projects in the national and international arena can further increase interest in STEAM education.

In general, the STEAM education model is a promising and effective educational strategy that serves to develop the education system of Uzbekistan in an innovative direction and prepare young people as competitive personnel in line with the requirements of the global labor market.

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