

The Implementation of Stem Education in The Higher Education System

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Abstract

This article discusses the implementation of STEM education in Uzbekistan, which will make a significant contribution to the scientific and technological development of the country. This system prepares students to increase global competitiveness, adapt to modern professions, and develop innovative thinking. By implementing STEM education in higher education institutions, students will become specialists with practice-based, multidisciplinary knowledge. The basic principles of STEM education differ from traditional educational models, since in it the educational process is not limited to theoretical knowledge, but is aimed at developing students' practical and creative activities. Thus, STEM education, based on the requirements of the 21st century, gives a great impetus to the scientific, technological, and economic development of Uzbekistan.

Keywords: STEM, Innovation, Competitiveness, Integration, Globalization, Education

In today's era of globalization and digital technologies, the STEM approach (STEM – Science, Technology, Engineering, Mathematics) has become one of the key priorities in education systems worldwide. In Uzbekistan's higher education system as well, the implementation of this approach is considered one of the most pressing issues. The main reasons for this can be seen in the following:

- **Training competitive specialists** – The global market is increasingly demanding specialists who are capable of producing high-tech products, think analytically, and are able to solve complex problems.
- **Foundation of an innovative economy** – The economies of developed countries are achieving sustainable innovative growth primarily through the training of highly qualified personnel in STEM fields.
- **Rapid advancements in science and technology** – Fields such as artificial intelligence, digital transformation, biotechnology, engineering, and energy are directly linked to the advancement of STEM education.

- **Advantages of an integrated approach to education** – STEM enhances interdisciplinary connections. For example, chemistry is taught in combination with elements of mathematics, computer science, or engineering, which makes the learning process more applicable to real-world situations.
- **Fostering creativity and critical thinking** – STEM education develops not only technical knowledge but also essential 21st-century skills such as problem-solving, generating innovative ideas, and independent critical thinking.

STEM education, unlike traditional education, is based on an interdisciplinary and practical approach.

For this reason, practical steps have been taken to implement the STEM model in the education process in Uzbekistan. According to data from sources, the number of children aged 3-7 in the Republic of Uzbekistan is 2,930,844. Of these, 74%, or 2,169,538 children, attend kindergarten. In preschool educational institutions, 500 children are receiving STEM-based training, which accounts for 0.02% of all children in the country.

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According to the statistics for 2024, more than 6.5 million students are receiving education in general secondary education institutions in Uzbekistan. Additionally, over 1.5 million children are enrolled in preschool education institutions, and more than 300,000 students are studying in higher education institutions. These figures demonstrate the expanding education system in our country and the growing interest of the population in education.

Information is available about the number of specialized schools in Uzbekistan that focus on in-depth teaching of subjects and their specialization in specific fields. In 2020, there were 420 schools and boarding schools in the Republic of Uzbekistan specializing in in-depth teaching, of which [https://yuz.uz]:

- 243 specialize in exact sciences;
- 41 specialize in natural sciences;
- 23 specialize in social sciences;
- 32 specialize in philological sciences;
- 81 specialize in foreign languages.

A total of 58,470 students is receiving education in these schools.

It is planned that starting from the 2025/2026 academic year, the educational process based on the STEM model will be organized in the specialized school.

However, at present, the educational process based on the STEM model has not been organized in all of these schools. In specialized schools where the STEM model has been implemented, more than 1,632 students are receiving education. This number constitutes only 0.03% of the students receiving education in specialized schools with the STEM model in the Republic of Uzbekistan.

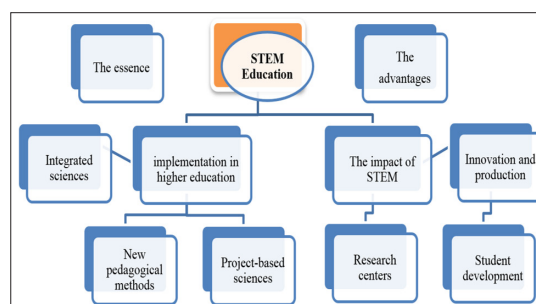
In the Republic of Uzbekistan, some higher education institutions are focused on developing students' knowledge and skills in the STEM field, and educational-methodical manuals are being developed to implement STEM education. Such initiatives are steps aimed at the development of STEM education in higher education.

The content of the STEM education model is an essential component of many projects currently being implemented, but it is largely dependent on the creation of a new subject-spatial environment for the entire education system, as well as the updating of its content, software, and methodological support. However, the lack of STEM laboratories in many institutions makes it difficult to provide children with sufficient knowledge. The goal of STEM education technology is to develop children's intellectual abilities by engaging them in scientific and technical creativity using modern information and communication technologies. STEM technology is used in countries like the United States, Russia, and Germany. The age of 3-7 years in preschool children is a crucial stage of development. Educators working with preschool children understand how important it is to arouse curiosity about knowledge in young children, teach them to perceive information from various sources and use it, and help them independently find answers to questions about the surrounding world. It is important to develop the ability of preschool children to act independently and cooperate with peers and adults. Thus, teachers and educators have a question:

what methods and technologies should be used to develop preschool children? STEM education technology was developed in America. American researchers, through experiments, took into account the abilities of some school graduates and decided to combine subjects such as science, technology, engineering, and mathematics, leading to the formation of the STEM system in this way (Science, Technology, Engineering, Mathematics). Later, the ART abbreviation was added, and now STEM is fully formed [1].



Researchers believe that knowledge in these subjects, specifically in these fields, will help students become highly qualified specialists in the future. In the STEM laboratory, children strive to gain solid knowledge and immediately have the opportunity to apply it practically. STEM education aims to develop creative thinking, innovative approaches, and knowledge based on practical experience by integrating the fields of science, technology, engineering, arts, and mathematics [2].



The role of STEM in the higher education system of the Republic of Uzbekistan is based on its integrated and creative approach. This approach prepares students to solve modern problems and address issues related to new technologies and scientific research. The STEM system helps elevate higher education to a new level, meeting the demands of today. The implementation of STEM education in Uzbekistan's higher education system makes a significant contribution to the country's scientific and technological development. This model is a crucial factor in shaping innovative thinking among young people, adapting to modern professions, and developing the national economy. Therefore, the application of STEM principles in the higher education system should be considered a priority [3].

1. **The main principles and content of STEM:** STEM education aims to develop creative thinking, innovative approaches, and knowledge based on practical experience by integrating the fields of science, technology, engineering, arts, and mathematics. It helps develop critical thinking, problem-solving, and interdisciplinary and complex thinking skills in higher education.
2. **The development of STEM in Uzbekistan:** In the higher education system of Uzbekistan, developments and courses in the STEM field are aimed at preparing students to

become highly qualified specialists in a modern scientific and practical environment. Higher education institutions in Uzbekistan are giving special attention to STEM education, as this system helps develop the skills necessary for specialists to implement future innovative projects.

3. **Integration of STEM in Education:** The implementation of STEM in higher education is reflected in several areas: Integrated subjects, the combination of physics, mathematics, and technology with art and engineering. For example, the role of art in engineering projects and the importance of design. Project-based learning: Students learn through solving problems in practice. This, in turn, develops students' creative and technical abilities.

New pedagogical methods: In STEM education, not only theoretical knowledge but also practical and creative approaches are required to solve problems. For example, in higher education, project work, laboratory activities, internships, and scientific-practical research are conducted.

4. **STEM Curricula and Projects:** In Uzbekistan, specially developed STEM-based curricula and projects provide students with knowledge in accordance with current requirements. For example, implementing projects based on STEM education in the fields of energy and energy efficiency, conducting scientific-practical research in areas such as solar energy, veterinary science, biotechnology, and others. Integrating art and engineering in projects involving 3D printing machines or robotics. In this process, students design devices and systems based on requirements and creative solutions.

5. **STEM-related activities in higher education institutions**
Research centers: Scientific research centers covering each area of the exact sciences within STEM education have been established. For example, research is being carried out in the fields of science and engineering, renewable energy sources, and information technologies.

Production and project implementation: The STEM education system facilitates the introduction of new technologies in higher education institutions by directing students toward conducting scientific research and implementing innovative projects.

6. **Impact on Students' Professional Development:** In STEM education, higher education institutions play an important role in the development of students as young innovators, researchers, and professionals. This system provides students with the opportunity to achieve success simultaneously in technical, scientific, and creative fields.

Conclusion In conclusion, it can be stated that the integration of STEM education into the higher education system of the Republic of Uzbekistan is based on interdisciplinary and creative approaches that meet the demands of the modern world. The role of STEM in shaping a new educational paradigm is becoming increasingly vital, as it equips students not only with

theoretical knowledge but also with practical skills, problem-solving abilities, and innovative thinking [4].

By incorporating science, technology, engineering, and mathematics—along with elements of art and creativity—STEM education fosters a comprehensive learning environment. This approach enables students to effectively address complex real-world challenges, adapt to rapidly evolving technological landscapes, and participate in scientific inquiry and research-based activities.

Moreover, the implementation of STEM in higher education institutions contributes to building a future-oriented workforce. It helps develop a new generation of highly qualified professionals who are capable of driving innovation, supporting national economic growth, and actively engaging in the global knowledge economy.

The continued development and expansion of STEM programs, research centers, and project-based learning across universities in Uzbekistan signify a strong commitment to educational modernization. This strategic direction not only enhances academic quality but also ensures that graduates are prepared to tackle the challenges of the 21st century with confidence and competence.

Therefore, prioritizing STEM education in Uzbekistan's higher education system is not only a timely decision but also a long-term investment in the country's scientific, technological, and socio-economic advancement.

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