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EUROPEAN OPEN
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FROM IDEAS TO SOLUTIONS: INNOVATIONS IN SCIENCE AND TECHNOLOGY

FEBRUARY 17-19, 2025, LONDON, UNITED KINGDOM

EUROPEAN OPEN SCIENCE SPACE

Proceedings of the 1st International Scientific and Practical Conference

"From Ideas to Solutions: Innovations in Science and Technology"

February 17-19, 2025

London, United Kingdom

Collection of Scientific Papers

United Kingdom, 2025

UDC 01.1

Collection of Scientific Papers with the Proceedings of the 1st International Scientific and Practical Conference «From Ideas to Solutions: Innovations in Science and Technology» (February 17-19, 2025. London, United Kingdom). European Open Science Space, 2025. 145 p.

ISBN 979-8-89704-957-8 (series)
DOI 10.70286/EOSS-17.02.2025

The conference is included in the Academic Research Index ReserchBib International catalog of scientific conferences.

The conference is registered in the database of scientific and technical events of UkrISTEI to be held on the territory of Ukraine (Certificate №23 dated 6.01.2025).

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ISBN 979-8-89704-957-8 (series)

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THE ESSENCE AND FEATURES OF STEAM EDUCATION: ANALYSIS OF RESEARCH AND PRACTICE

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In the modern educational space, more and more attention is being paid to an interdisciplinary approach to learning that ensures the development of key competencies of the 21st century in students. One of these approaches is STEAM education (Science, Technology, Engineering, Arts, Mathematics), which combines natural science, technology, engineering, arts and mathematics knowledge to form an integrated approach to learning.

STEAM education is an evolutionary development of the STEM approach, supplemented by the «A» component (Arts). This expansion is driven by the need to integrate creativity and critical thinking into the teaching of technical and natural sciences.

The analysis of key studies has made it possible to identify the main principles on which the STEAM approach is based, namely: integration, where academic disciplines are studied not separately but as interconnected components of a unified system; project-based learning, in which learners work on real-world projects, fostering the development of practical skills; problem-based learning, which emphasizes solving real-world problems and cultivates the ability to make independent decisions; and creativity and innovation, highlighting the importance of the artistic approach in developing non-standard thinking (Fig. 1).

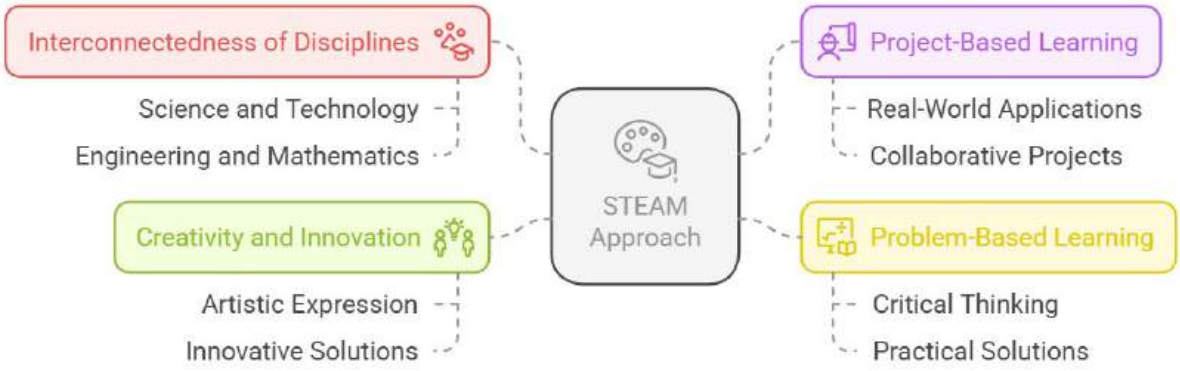


Figure 1. Principles of the STEAM Approach

Scientific works on STEAM education point to a number of features that distinguish the STEAM approach from traditional approaches. The researchers Bequette J. W. and Bequette M. B. prove that art plays an important role in STEAM education, as it promotes the development of creative thinking, which is necessary for

solving complex technical problems [1]. Liao C. M. confirms that adding artistic components to STEM subjects increases the interest of students and improves their learning outcomes [6].

As noted by Bybee R. W., the STEAM approach allows students to realize the relationship between different fields of knowledge and apply an interdisciplinary approach to solving practical problems [2]. Maeda J.'s research emphasizes that STEAM helps students develop not only technical skills, but also the ability to find creative solutions [7].

In their research, scientists Wang X., Su Y., Cheung S. K. S., Wong T., Kwong T. demonstrate that the use of augmented and virtual reality in STEAM learning significantly improves the level of learning by allowing students to interact with abstract concepts in a virtual environment [10].

According to Piaget J., the active involvement of students in the process of creating projects contributes to the formation of a deep understanding of the material [9]. Harris A. and de Bruin L.'s research also emphasizes that project-based learning in STEAM education helps students develop critical thinking, analysis, and problem-solving skills [4].

In his works, Yakman G. proves that STEAM education develops entrepreneurial competence in students through an emphasis on creativity, initiative, and teamwork [11].

The development of STEAM education has been widely reflected in scientific studies that emphasize its effectiveness in preparing students for the modern labor market.

For example, Bybee, R. W. argues that the interdisciplinary approach of STEAM education develops students' systemic thinking skills and ability to innovate [2].

In their works, Bequette J. W. and Bequette M. B. emphasize that art in the STEAM approach expands the possibilities of visualizing scientific concepts [1].

Liao C. M. in her research emphasizes that STEAM education promotes the development of collaboration skills, which is critical in the modern digital environment [6].

The research of Harris A. and de Bruin L. proves that STEAM education can significantly increase students' motivation to learn through creative approaches to teaching [4].

Thus, the analysis of scientific research confirms that STEAM education is an effective method of preparing students for the challenges of modern society. It contributes to the formation of critical thinking, development of creativity and interdisciplinary cooperation skills.

Given the current trends in the digital transformation of education, STEAM education continues to develop in the following areas: the introduction of artificial intelligence for personalized learning [10], the use of gaming technologies to increase the engagement of students [3]; expanding the use of VR and AR to simulate real environments [5, 8], and the creation of inter-university STEAM laboratories that will facilitate international cooperation (Fig. 2).

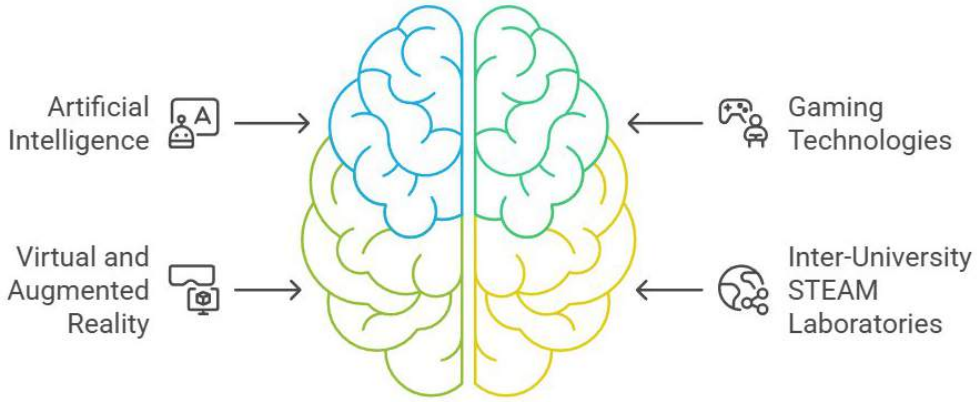


Figure 2. Transforming STEAM Education

Thus, STEAM education is an effective approach to learning that provides comprehensive preparation of students for future professional activities. Integration of art into science and engineering disciplines contributes to the development of creative and critical thinking. The analysis of scientific research confirms that STEAM education has significant potential in the digital educational environment and can play a key role in training highly qualified specialists who are confidently stepping into the third millennium.

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"From Ideas to Solutions: Innovations in Science and Technology"
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London, United Kingdom

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