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THE ROLE OF STEAM TECHNOLOGY IN DEVELOPING COGNITIVE COMPETENCES OF PRESCHOOL EDUCATIONAL STUDENTS

Uchqunova Adiba Roziq kizi
Shahrisabz Davlat Pedagogika Instituti magistranti
E-mail: adibauchqunova@xmail.com
Orcid: https://orcid.org/0009-0005-2414-7685

Abstract

In this article, the significance of STEAM technologies in the process of forming and developing cognitive competencies among preschool education learners, as well as their methodological possibilities and practical effectiveness, is analyzed. The advantages of enhancing children's thinking, observation skills, problem-solving abilities, and creativity through the STEAM approach are highlighted.

Keywords

STEAM technology, cognitive competencies, preschool education, thinking development, observation skills, problem-solving abilities, creativity, methodological approach, innovative education, integrative learning, practical activities, inquiry-based learning, constructive thinking, project-based activities, child development.

Introduction

In today's world, the processes of globalization, technological advancement, and digital transformation require new approaches from the education system. In particular, the preschool education stage holds special significance as the period during which the initial intellectual foundation of an individual is formed. A child's development at this stage has a direct impact on their success in subsequent stages of education. Therefore, enriching the preschool education system with modern pedagogical approaches and organizing the educational process in an innovative, interactive, and practice-oriented manner is one of the most pressing tasks of today.

Methods: This study examines the effectiveness of STEAM technologies in developing cognitive competencies of preschool children through a theoretical–analytical and observational research approach. The research methodology is based on the analysis of scientific and pedagogical literature, synthesis of psychological and pedagogical theories, and practical observations conducted in preschool educational institutions.

The study relies on key pedagogical approaches such as constructivism, active learning, problem-based learning, and project-based learning. These approaches emphasize that children acquire knowledge not in a ready-made form, but through their own activities, experiences, and interactions with the environment.

Observations were carried out in preschool groups where STEAM-based activities were systematically implemented. Children's participation in experiments, construction tasks, artistic activities, simple engineering projects, and problem-solving situations was analyzed. Particular attention was paid to children's cognitive processes, including perception, thinking, memory, imagination, attention, speech activity, and problem-solving skills.

The theoretical framework of the study is supported by the ideas of renowned psychologists such as Jean Piaget, Lev Vygotsky, and Jerome Bruner, who emphasized the role of hands-on activities, experiential learning, and social interaction in early cognitive development. Personal pedagogical observations also served as an important empirical source for evaluating the effectiveness of STEAM technologies in preschool education.

Results and Discussion: The results of the study show that preschool children are naturally curious, active, observant, and eager to experiment. They tend to explore surrounding

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phenomena independently, understand cause-and-effect relationships, and draw practical conclusions through their own activities. Therefore, the application of programs, methods, and technologies aimed at developing cognitive competencies at this age is particularly important.

Cognitive competencies include intellectual processes such as perception, thinking, memory, imagination, speech activity, and problem-solving. The earlier and more effectively these competencies are formed, the easier children adapt to subsequent stages of education, demonstrating greater independence in thinking, exploratory activity, creativity, and analytical abilities.

In recent years, interest in STEAM technologies has significantly increased in the field of education. STEAM (Science, Technology, Engineering, Art, Mathematics) is an integrated educational approach that combines science, technology, engineering, art, and mathematics to promote comprehensive cognitive development. Unlike traditional teaching methods, STEAM integrates play, experimentation, construction, project work, and creative activities into a unified learning system.

The introduction of STEAM technologies in preschool educational institutions transforms the learning process into an engaging, active, and outcome-oriented experience. Children independently conduct experiments, observe results, identify mistakes, correct them, and draw conclusions. This process plays a crucial role in cognitive development. Additionally, STEAM activities contribute to the development of social competencies such as teamwork, communication, and the ability to justify one's ideas.

STEAM is an integrative educational model that unites five disciplines into a single system. Its pedagogical essence lies in helping children perceive the world not through isolated subjects, but through understanding the interconnections between phenomena. As a result, children develop systematic thinking, cause-and-effect analysis, problem-solving skills, creativity, technical thinking, and mathematical logic.

STEAM-based learning combines theoretical knowledge with practical activities such as experimentation, construction, and modeling. This approach activates logical thinking, enhances observation skills, fosters creativity, and develops the ability to understand cause-and-effect relationships. When children's natural curiosity is properly guided through STEAM, they gain a deeper understanding of their environment and develop independent reasoning skills.

STEAM activities are well suited to preschool education, as young children learn most effectively through play and experimentation. For example, engineering thinking develops through construction sets, creativity is enhanced through artistic activities, mathematical thinking is strengthened through counting and measuring, and scientific understanding is expanded through experiments involving water, soil, and air.

Discussion: Cognitive competencies represent a complex set of psychological processes, including perception, memory, attention, thinking, imagination, logical analysis, speech, and problem-solving activities. Preschool age is a critical period for the formation of these competencies, as children actively perceive the world, compare observations, ask questions, process information mentally, and draw independent conclusions.

Play, experimentation, physical activity, and sensory experiences play a vital role in cognitive development. STEAM technologies effectively support this process through several key directions. First, perception develops through experimentation and observation. Children directly observe natural phenomena such as water evaporation, plant growth, and magnetic properties, which helps them form accurate perceptions. Research by Piaget, Vygotsky, and Bruner confirms that object-based actions enhance thinking, real-life experiences strongly influence imagination, and knowledge is reinforced through experimentation.

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Second, STEAM activities promote logical thinking and problem-solving skills. Projects require children to make decisions, compare alternatives, identify errors, and correct them. Activities such as building bridges with construction sets, navigating simple robotics tasks, and analyzing factors influencing plant growth strengthen analytical thinking, comparison skills, and strategic planning.

Third, mathematical thinking develops through practical activities such as measuring, counting, comparing, and identifying shapes. These tasks allow children to acquire mathematical concepts through real-life application rather than abstract instruction.

Fourth, creativity and imagination are enhanced through the “Art” component of STEAM. Children express their ideas through designing models, selecting colors, and creating new constructions using various materials. This process fosters imagination, aesthetic thinking, creativity, and innovative approaches.

Fifth, STEAM contributes to the early formation of technological literacy. By working with simple robotics, construction kits, and digital tools, children acquire essential technical skills needed for future learning.

The effective implementation of STEAM technologies in preschool education depends on several factors: integrative lesson design, alignment with play-based activities, opportunities for independent exploration, and the guiding role of the teacher as a facilitator rather than a direct instructor. Based on personal pedagogical observations, children in STEAM-based groups demonstrate higher levels of questioning behavior, creative problem-solving, and collaborative skills.

Conclusion: The integration of STEAM technologies into preschool education plays a significant role in the systematic and in-depth development of children’s cognitive competencies. This approach nurtures curiosity, thinking abilities, and technical and creative potential from an early age. Therefore, the widespread application of STEAM methodologies in preschool institutions is a crucial factor in fostering intellectually developed and independent-thinking individuals. The present study provides a comprehensive analysis of the role, advantages, and practical significance of STEAM technologies in shaping preschool children’s cognitive competencies based on advanced international practices, pedagogical perspectives, and practical activities.

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