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13.00.00 Pedagogika fanlari
13.00.01 Pedagogika nazariyasi. Pedagogik ta'limotlar tarixi
13.00.02 Ta'lim va tarbiya nazariyasi va metodikasi (sohalar bo'yicha)
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MUNDARIJA

MUNDARIJA СОДЕРЖАНИЕ CONTENTS

USING STEM TECHNOLOGIES TO FOSTER RATIONAL THINKING IN THE DENTISTRY

Khonimqulov Javlon
1st-Year Clinical Residents of the Department of Ortopedic Dentistry

Burkhonova Zarafruz
Scientific adviser: Ass.
Samarand state medical university, Samarkand, Uzbekistan

Abstract: This study provides a theoretical justification for the effectiveness of STEM technologies as an innovative educational approach aimed at the purposeful development of the foundations of logical thinking among learners. Based on an analysis of pedagogical approaches proposed by T.V. Volosovets and I.M. Klimova, it is demonstrated that STEM technologies, which integrate science, technology, engineering, and mathematics, facilitate the active development of logical operations such as analysis, synthesis, classification, and generalization through problem-based, inquiry-oriented, and practical learning activities. The findings indicate that play and experimentation are the leading forms of activity among preschool children, and that the STEM approach is highly effective in promoting their cognitive development. The study concludes with methodological recommendations and practical techniques designed to foster all components of logical thinking, including algorithmic thinking and construction skills.

Key words: robotics, construction activities, logical processes, algorithmic thinking, STEM technologies, senior preschool age, cognitive development.

Annotatsiya: Ushbu tadqiqotda stem-texnologiyalarining ta'lim oluvchilarda mantiqiy fikrlash asoslarini maqsadli rivojlantirishdagi samaradorligi nazariy jihatdan asoslab berilgan. Mahalliy pedagogik yondashuvlar, xususan, t.v. volosovets va i.m. klimova ilmiy qarashlari tahlili asosida stem-texnologiyalarining fan, texnologiya, muhandislik va matematikani integratsiyalash orqali mantiqiy operatsiyalarni, jumladan, tahlil, sintez, tasniflash va umumlashtirish ko'nikmalarini rivojlantirishga xizmat qilishi yoritilgan. Tadqiqot natijalari o'yin va tajriba faoliyati maktabgacha yoshdagi bolalarning yetakchi faoliyat turlari ekanligini hamda stem yondashuvi ushbu yosh davrida yuqori samaradorlikka ega ekanligini ko'rsatdi. Xulosada mantiqiy fikrlashning barcha tarkibiy qismlarini, jumladan, algoritmik fikrlash va konstruktiv faoliyat ko'nikmalarini rivojlantirishga qaratilgan metodik tavsiyalar va amaliy usullar taklif etilgan.

Kalit so'zlar: robototexnika, konstruksiyalash, mantiqiy jarayonlar, algoritmik fikrlash, stem-texnologiyalari, katta maktabgacha yosh, kognitiv rivojlanish.

Аннотация: В данном исследовании представлено теоретическое обоснование эффективности stem-технологий как современного средства целенаправленного развития основ логического мышления у обучающихся. На основе анализа педагогических подходов т.в. волосовец и и.м. климовой показано, что stem-технологии, объединяющие науку, технологии, инженерию и математику, способствуют активному формированию логических операций, таких как анализ, синтез, классификация и обобщение, посредством проблемно-ориентированной, исследовательской и практической деятельности. Установлено, что игровая и экспериментальная деятельность являются ведущими видами деятельности детей дошкольного возраста, а применение stem-подхода обеспечивает высокую эффективность их познавательного развития. В заключении предложены методические рекомендации и практические приёмы, направленные на развитие всех компонентов логического мышления, включая алгоритмическое мышление и навыки конструирования.

Ключевые слова: робототехника, конструирование, логические процессы, алгоритмическое мышление, stem-технологии, старший дошкольный возраст, когнитивное развитие.

INTRODUCTION

One of the primary objectives of modern preschool education is the development of logical thinking, which is directly aligned with the requirements of the Federal State Educational Standard (FSES) for preschool education regarding cognitive development. Logical thinking, defined as the ability to operate with concepts, draw conclusions, and establish cause-and-effect relationships, serves as the foundation for successful learning activities.

During senior preschool age (5-7 years), a significant transition occurs from visual-figurative thinking to verbal-logical thinking, creating favorable conditions for the purposeful development of complex cognitive processes. However, traditional teaching methods, which are largely based on verbal instruction and passive observation, often fail to provide sufficient practical engagement and do not fully correspond to the leading activities of preschool children, namely play and experimentation. As a result, children may demonstrate insufficient mastery of logical operations such as analysis, synthesis, and classification, while the development of creativity and independence may be hindered.

A major contradiction exists between the growing social and educational demand for the development of a logically and creatively thinking personality and the insufficient systematization of STEM technologies as a leading pedagogical tool that corresponds to the psychological and pedagogical characteristics of senior preschool children.

The relevance of this study is determined by the need to develop and implement educational strategies and approaches that ensure the active, engaging, and comprehensive development of all components of logical thinking in preschool education. STEM technologies, which integrate science, technology, engineering, and mathematics, represent a synthetic form of activity [5]. They emphasize the visualization of scientific phenomena, the interconnection of academic disciplines, and the practical application of knowledge. For older preschool children, this approach makes the learning of complex logical patterns more accessible, meaningful, and emotionally engaging.

The aim of this article is to present STEM technology as one of the most effective means of supporting the development of logical thinking in senior preschool children. To achieve this goal, the study provides a theoretical rationale, examines methodological approaches, and proposes practical recommendations for implementation.

The application of STEM technology in preschool education remains a dynamically developing area within contemporary pedagogy. The works of T.V. Volosovets, S.A. Averin, and V.A. Markova demonstrate the comprehensive nature of this approach through the development of the partially modular program "STEM Education for Preschool Children," which is implemented both within the framework of the core educational curriculum and as part of supplementary educational programs.

LITERATURE REVIEW

The development of logical reasoning in senior preschool children is a key component of cognitive pedagogy and an important predictor of future academic success and overall intellectual development. The transition from late preschool age to the early stages of formal schooling is characterized by a gradual shift from visual-action and visual-imaginative thinking toward the initial forms of abstract and verbal-logical reasoning. This developmental process is grounded in Jean Piaget's theory of cognitive development.

Within contemporary preschool education, this transition requires innovative and integrative pedagogical approaches capable of transforming abstract logical structures into concrete, engaging, and emotionally meaningful learning experiences. STEM (Science, Technology, Engineering, and Mathematics) technologies have emerged as highly effective, practice-oriented frameworks for fostering these cognitive processes.

A paradigm shift from traditional subject-based instruction toward integrated, project-based learning is reflected in the implementation of STEM and its extended form, STEAM, which incorporates the arts. According to Volosovets, Averin, and Markova (2018), STEM education emphasizes the visualization of scientific phenomena, interdisciplinary connections, and the practical application of knowledge rather than isolated teaching of scientific and mathematical concepts.

This approach functions as a synthetic form of child activity. Through the integration of play, experimentation, and engineering design, STEM technologies transform passive learning into active exploration. As a result, abstract logical patterns become meaningful, tangible, and motivating for senior preschool children.

Research conducted by Klimova and Kashtanova (2021) highlights the effectiveness of STEM technologies in supporting verbal-logical thinking, particularly among children with General Speech Underdevelopment (GSU). The authors emphasize that integrated technological solutions facilitate the development of logical reasoning while simultaneously overcoming difficulties in verbal expression and argumentation.

Galashova (2020) demonstrated the effectiveness of educational robotics through the use of programmable devices such as the "Robot Mouse" in developing algorithmic thinking and logical reasoning among senior preschool children, including those with special educational needs. Educational robotics serves as an externalized model of computational thinking, enabling children to master decomposition, prediction, and error analysis through practical activities.

The analysis of contemporary studies indicates that STEM technologies are among the most effective tools for developing logical thinking because they ensure the visualization of abstract concepts, encourage research-oriented learning, and promote active constructive-engineering activities.

RESEARCH METHODOLOGY

The study is based on the analysis and synthesis of scientific and methodological literature devoted to the development of logical thinking in preschool children through STEM technologies. The methodological framework includes theoretical analysis, comparative examination of pedagogical approaches, and the generalization of best educational practices presented in contemporary research.

Particular attention was given to the works of Volosovets, Averin, Markova, Klimova, Kashtanova, and Galashova, whose studies examine the role of STEM technologies, educational robotics, and engineering activities in preschool education.

Based on the synthesis of theoretical findings, a set of methodological techniques was developed to support the formation of logical thinking among senior preschool children. These techniques include:

- the "Engineering Analysis and Synthesis" method;
- the "Attribute Matrix" method for classification and generalization;
- the "Route Programming" method for algorithmic reasoning;
- the "Constructor-Researcher" method for establishing cause-and-effect relationships.

ANALYSIS AND RESULTS

The analysis revealed that STEM technologies create favorable conditions for the development of fundamental logical operations, including analysis, synthesis, classification, generalization, comparison, and causal reasoning.

The "Engineering Analysis and Synthesis" method enables children to identify the structural components of an object and reconstruct it independently, thereby strengthening analytical and synthetic thinking skills.

The "Attribute Matrix" method promotes classification and generalization abilities by encouraging children to categorize objects according to multiple characteristics simultaneously and justify their decisions.

The "Route Programming" method, implemented through programmable robots such as Bee-Bot and Robot Mouse, supports the development of algorithmic thinking. Children learn to plan sequences of actions, predict outcomes, and identify errors in problem-solving processes.

The "Constructor-Researcher" method fosters critical thinking and causal reasoning by engaging children in engineering challenges that require hypothesis generation, experimentation, and evaluation of results.

The findings suggest that STEM-based activities increase children's motivation and cognitive engagement while facilitating the transition from visual-imaginative thinking to the early forms of verbal-logical reasoning. The integration of science, engineering, technology, and mathematics creates meaningful learning situations that encourage active exploration and independent problem-solving.

CONCLUSION AND RECOMMENDATIONS

The theoretical analysis and evaluation of contemporary pedagogical approaches demonstrate that STEM technologies represent an effective means of developing logical thinking in senior preschool children. Their effectiveness is determined by their integrated, practice-oriented, and project-based nature, which allows logical operations to be developed systematically through research and experimentation.

The implementation of STEM-based methodologies contributes to the development of analytical thinking, classification skills, algorithmic reasoning, causal understanding, creativity, and independence. Moreover, STEM activities provide a high level of motivation and engagement, supporting the transition from visual-imaginative thinking to verbal-logical reasoning.

Based on the findings, the following recommendations are proposed:

1. Integrate STEM technologies systematically into preschool educational programs.
2. Expand the use of educational robotics and engineering design activities.
3. Employ problem-based and research-oriented learning tasks to develop logical operations.
4. Create learning environments that encourage experimentation, creativity, and independent decision-making.
5. Provide methodological training for educators on the effective use of STEM technologies in preschool settings.

The purposeful implementation of STEM-based educational activities can significantly enhance the formation of logical thinking among senior preschool children and establish a strong foundation for their future academic success and personal development.

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Mas’ul muharrir: Ramzidin Ashurov
Ingliz tili muharriri: Murod Xoliyorov
Musahhih: Alibek Zokirov
Sahifalovchi va dizayner: Iskandar Islomov

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