MODERN METHODS AND PROSPECTS OF APPLYING ARTIFICIAL INTELLIGENCE TECHNOLOGIES IN PRESCHOOL INFORMATICS EDUCATION

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This article examines the modern methods and future prospects of integrating artificial intelligence (AI) technologies into the informatics education of preschool-aged children. The rapid digitalization of the educational sector in Uzbekistan and worldwide has created an urgent need to introduce foundational digital literacy at the earliest stages of learning. This paper analyzes the current landscape of AI-powered educational tools designed for young learners, evaluates age-appropriate pedagogical frameworks for introducing computational thinking, and discusses the opportunities and challenges facing preschool institutions in Uzbekistan. Practical recommendations are provided for the systematic adoption of AI-assisted learning environments in early childhood education settings.

Keywords: artificial intelligence, preschool education, informatics, digital literacy, computational thinking, early childhood education, Uzbekistan.

1. Introduction

In recent years education has changed significantly due to rapid technologies in the way education is delivered, with digital technologies becoming integral to teaching and learning at every level. Among the most significant developments in recent years is the emergence of artificial intelligence as a practical tool in education. While much of the academic discourse has focused on the application of AI in secondary and higher education, comparatively less attention has been devoted to its potential role in preschool education, particularly in the field of informatics.

Preschool education serves as the foundational stage of a child’s cognitive, social, and intellectual development. Research in developmental psychology consistently demonstrates that children between the ages of three and six are exceptionally receptive to new forms of learning, including those mediated by technology. In this context, the strategic introduction of age-appropriate AI tools can support the development of early computational thinking, logical reasoning, and problem-solving skills that form the basis of informatics education.

In Uzbekistan, the government has taken significant steps toward modernizing the education system, including the adoption of the Presidential Decree on the Development of Digital Economy and the National Strategy for the Development of Artificial Intelligence for 2024–2030. These policy frameworks create a favorable environment for exploring the integration of AI into all levels of education, including the preschool stage. This article aims to examine the modern methods by which AI technologies can be applied to preschool informatics education and to discuss the prospects for their broader adoption in Uzbekistan.

2. Literature Review and Theoretical Framework

The theoretical foundations for introducing digital technologies in early childhood education draw upon several key frameworks. Papert’s constructionism theory (1980) argues that children learn most effectively when they actively construct knowledge through interaction with digital environments. Vygotsky’s zone of proximal development suggests that intelligent tutoring systems can serve as scaffolding mechanisms that adapt to each child’s individual learning pace.

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Recent studies by Bers (2018) on the ScratchJr programming environment have demonstrated that children as young as four years old can engage meaningfully with computational concepts such as sequencing, repetition, and conditional logic when provided with appropriate visual interfaces. Similarly, research by Sullivan and Bers (2016) on tangible robotics platforms such as KIBO has shown that physical computing devices enable preschoolers to develop algorithmic thinking without the need for screen-based interaction.

In the context of Central Asian education systems, there is a growing body of literature addressing the digitalization of schools and universities; however, studies specifically examining AI applications in preschool informatics remain scarce. This gap in the literature underscores the importance of the present research.

3. Modern Methods of AI Application in Preschool Informatics Education

The application of AI in preschool informatics education can be categorized into several methodological approaches, each addressing different aspects of early learning.

3.1 Adaptive Learning Platforms. Adaptive learning systems powered by AI algorithms represent one of the most promising approaches for preschool education. These platforms use machine learning techniques to analyze a child’s interaction patterns, identify areas of difficulty, and automatically adjust the complexity and pace of instructional content. For preschool informatics, this means that a child who demonstrates proficiency in basic pattern recognition can be gradually introduced to more complex sequencing tasks, while a child who struggles with spatial reasoning receives additional practice activities. Examples of such platforms include Khan Academy Kids and Osmo, which incorporate AI-driven personalization to deliver age-appropriate content across multiple domains including basic informatics concepts.

3.2 Intelligent Tutoring Systems and Conversational AI. Conversational AI agents, including voice-activated assistants adapted for educational purposes, offer a natural and engaging interface for young children who have not yet developed reading skills. These systems can guide children through simple programming exercises, ask and respond to questions about basic computing concepts, and provide immediate feedback in a conversational manner. When designed with appropriate safeguards and age-specific content filters, these tools can serve as supplementary educational companions that reinforce concepts introduced by human educators.

3.3 Visual and Block-Based Programming Environments. AI-enhanced visual programming platforms extend the capabilities of traditional block-based coding environments by incorporating intelligent hints, automated error detection, and progress-adaptive challenge levels. Tools such as ScratchJr, Code.org’s pre-reader courses, and Kodable leverage AI techniques to provide personalized learning pathways. These environments allow preschool children to engage with fundamental informatics concepts—including algorithms, sequences, and loops—through colorful, game-like interfaces that maintain engagement and motivation.

3.4 Educational Robotics and Tangible AI. Physical robotic platforms such as Bee-Bot, KIBO, and Cubetto provide tangible, hands-on interaction with computational thinking concepts. When augmented with AI capabilities, these robots can adapt their responses based on a child’s input patterns, offer progressive challenges, and generate performance analytics for educators. The tactile nature of robotic interaction is particularly well-suited to preschool learners, as it aligns with the developmental preference for kinesthetic learning at this age.

15. Prospects and Challenges in the Context of Uzbekistan

The Republic of Uzbekistan has demonstrated a strong commitment to the digital transformation of its educational sector. The establishment of the Ministry of Digital Technologies and the adoption of targeted programs for AI development provide an institutional framework within which preschool AI integration can be pursued. Several factors present both opportunities and challenges for the implementation of AI technologies in preschool informatics education in Uzbekistan.

Opportunities. First, the growing network of state and private preschool institutions across Uzbekistan creates a broad infrastructure for piloting AI-based educational programs. Second, the increasing availability of affordable tablet devices and internet connectivity in urban and suburban areas makes digital learning tools more accessible. Third, the government’s emphasis on STEM education and digital skills development aligns naturally with the introduction of informatics concepts at the preschool level. Fourth, international partnerships and donor-funded programs offer potential channels for technical assistance and capacity building in this domain.

Challenges. Despite these opportunities, several challenges must be addressed. The shortage of qualified preschool educators trained in both pedagogy and digital technologies remains a significant barrier. Many existing AI educational tools are designed for English-speaking audiences, and Uzbek-language content for preschool informatics is extremely limited. Concerns regarding screen time and its effects on young children’s development require careful consideration in program design. Additionally, rural preschool institutions often lack the basic technological infrastructure necessary for deploying AI-based learning environments.

6. Recommendations

Based on the analysis presented in this article, the following recommendations are proposed for the effective integration of AI technologies into preschool informatics education in Uzbekistan:

1. Develop national curriculum guidelines that incorporate age-appropriate informatics and computational thinking objectives for preschool education, with explicit reference to AI-assisted teaching methodologies.

2. Invest in the professional development of preschool educators, providing training programs that equip teachers with the skills to effectively use AI-based educational tools in their classrooms.

3. Support the development of Uzbek-language AI educational applications specifically designed for preschool learners, ensuring cultural and linguistic appropriateness.

4. Establish pilot programs in selected preschool institutions to test and evaluate various AI-based informatics education methods, with systematic collection of performance data to inform future policy decisions.

5. Adopt a balanced approach that combines screen-based and tangible AI tools, ensuring that technology use in preschool settings remains within recommended limits and is supplemented by traditional pedagogical activities.

7. Conclusion

The integration of artificial intelligence technologies into preschool informatics education represents a significant opportunity to build strong digital foundations for the next generation of learners. Modern AI methods—including adaptive learning platforms, conversational AI, visual programming environments, and educational robotics—offer diverse and complementary approaches to introducing computational thinking at the earliest stages of education.

While challenges related to teacher training, content localization, infrastructure, and appropriate use remain, the policy environment in Uzbekistan is increasingly supportive of digital innovation in education. By taking a systematic, evidence-based approach to the integration of AI in preschool informatics, Uzbekistan can position itself as a leader in early childhood digital education within the Central Asian region.

Future research should focus on conducting longitudinal studies to measure the impact of AI-assisted preschool informatics education on children’s cognitive development and academic readiness, as well as on developing standardized assessment tools for evaluating computational thinking skills in young learners.