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The Use of Information Technologies in the Development of Mathematical Thinking in Preschool Children

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Abstract: *This paper explores the theoretical and practical significance of using emotional-cognitive experiences and modern information technologies in developing mathematical thinking among preschool children. Effective preschool education requires engaging children's senses, perceptions, and imagination through structured yet flexible activities that stimulate curiosity and reasoning. Through hands-on experiences such as examining materials, comparing object properties, and conducting guided experiments, children gain essential cognitive skills applicable to real-life problem-solving. The integration of didactic games and interactive materials further enhances these developmental outcomes. International models, including those from the United States, China, South Korea, the United Kingdom, and Germany, provide valuable insights into early mathematics education. These systems emphasize play-based learning, child-centered pedagogy, and the incorporation of robotics, visual tools, and sensor technologies to foster spatial reasoning and logical operations. The study highlights Uzbekistan's growing efforts to align with global best practices, including the implementation of intelligent educational robots like Albert and Genibot in preschool settings. Ultimately, the research underscores that an effective combination of sensory engagement, cultural adaptation, and innovative technologies can significantly improve mathematical competence and educational equity among young learners.*

Keywords: *Preschool, Mathematics, Thinking, Cognitive Development, Educational Technology, Robotics, Play-Based Learning, Pedagogy, Early Education, Spatial Reasoning, International Education, Innovation, Sensory Experience, Didactic Games, Comparative Analysis*

Main part

The educational process is one of the most dynamically evolving sectors of modern society. The increasing integration of information technologies into education reflects the growing emphasis placed on digital innovation as part of national development strategies. In particular, within the framework of Uzbekistan's "Priority National Project on Education," active efforts are being made to digitize teaching and learning environments. The incorporation of modern technical and digital tools enhances the modernization of the learning process, stimulates students' cognitive activity, supports teachers' creativity, enables the development of distance education, contributes to the evolution of lifelong learning systems, and ultimately increases the efficiency and accessibility of education.

According to both domestic and international academic literature, computerization of the educational process is considered one of the most critical factors in organizing instruction across various subjects. The latest information technologies make it possible to leverage the scientific and pedagogical potential of leading universities and institutions, expand student audiences, and attract top educators to develop and deliver online courses. As stipulated in Article 46 of the Law on Education of the Republic of Uzbekistan, pedagogical staff are obliged to use information and communication technologies, as well as innovative forms and methods of teaching and upbringing. However, despite the existence of

substantial prior experience in teaching through digital means, many educators remain cautious or underprepared when it comes to integrating computer-based tools into their teaching practices.It is important to note that the process of digitalizing education faces several systemic challenges. The introduction of information technologies into learning environments requires not only infrastructure but also a deep conceptual understanding. On one hand, digital tools significantly enhance the effectiveness of teaching and learning; on the other hand, they bring forth the necessity of individualized learning trajectories, especially in cases where students vary in their pace and style of knowledge acquisition.The role of information technologies in society has grown exponentially in recent years, as humanity enters a new historical phase often referred to as the "information society." This transformation entails universal access to information resources, the penetration of digital technologies into scientific, industrial, and social spheres, and the emergence of high-level information services. These changes accelerate scientific and technological progress, intellectualize all types of human activities, and contribute to the formation of a qualitatively new informational environment that fosters the development of individual creativity and innovation.

A key priority within this broader process is the informatization of education—a systematic integration of data collection, processing, storage, dissemination, and utilization through unified digital tools and infrastructures. The purpose of this transformation is to activate intellectual activity globally through the use of new information technologies, particularly computers and telecommunications.

Information technologies enable the following:The rational organization of students' cognitive activities during the learning process;The use of multimedia content to engage all sensory perceptions and equip learners with new conceptual tools, thereby enhancing the quality and depth of learning;

The creation of an open education system that provides personalized learning pathways for each individual;

1. The active involvement of children with varying abilities and learning styles;
2. The personalization of learning processes through the unique capabilities of digital tools that facilitate customized educational experiences;
3. The activation of all stages of the educational process by providing access to new cognitive mechanisms.

The core educational value of information technologies lies in their ability to create a virtually unlimited, multi-sensory, and interactive learning environment for both teachers and students. Unlike traditional teaching aids, digital technologies not only enrich students with large volumes of knowledge but also cultivate intellectual and creative skills, promote independent learning, and support interaction with diverse sources of information.Furthermore, the advancement of science and technology has driven the technical re-equipment of national economies, which in turn necessitates the development of new educational systems that prepare learners for the challenges of the digital age. Integrating these technologies into education is not simply a technical shift—it is a transformative step toward creating a more adaptive, inclusive, and forward-thinking learning ecosystem.Moreover, teaching methodologies such as problem-based learning (PBL), discovery learning, and the use of ICT tools have shown significant results in enhancing mathematical thinking. When students are encouraged to explore multiple solution paths, reflect on their processes, and explain their reasoning, they develop a more profound and transferable understanding of mathematics.The cultural and educational context also plays a significant role. In countries with a strong emphasis on mathematics education, such as Singapore and Finland, curricula are specifically designed to build thinking skills step by step, integrating real-world problems and collaborative work. In Uzbekistan, recent reforms in education aim to modernize mathematics instruction by introducing more interactive and student-centered approaches.

Literature Review

Preschool education, being the foundational stage of a lifelong learning process, has increasingly become the focal point of both national and international educational reforms. Numerous studies emphasize the importance of early childhood as a critical period for cognitive and social development. It is scientifically established that nearly 70% of the information an individual acquires throughout life is absorbed before the age of five. Consequently, the effective organization and continuous improvement of preschool education systems play a decisive role in nurturing competent, educated, and socially responsible citizens.

In the context of Uzbekistan, a series of presidential decrees, laws, and policy documents—including the "Law on Education" (2020) and "Law on Preschool Education and Upbringing"—have laid a strong legal foundation for the systemic reform of preschool institutions. These documents not only provide structural and operational guidelines but also align the sector with international standards, emphasizing investment in human capital. As highlighted in President Sh.M. Mirziyoyev's work "The Strategy for New Uzbekistan," investment in children's education from ages 3 to 22 can yield up to 15–17 times the return for society, compared to the current rate of fourfold in Uzbekistan.

However, academic literature specifically addressing the integration of foreign preschool models into the Uzbek context remains limited. Existing research, such as B.E. Parmonov's analysis of the psychological aspects of foreign practices, offers valuable insights into the preschool systems of countries like the UK, Germany, Japan, and Russia. I.G. Mamajonov and R. Mamatov have partially addressed Germany's system, while M.Kh. Qilichova has reviewed the institutional reforms and cultural compatibility of these international experiences. These studies collectively stress the necessity of adapting global best practices to local pedagogical, psychological, and cultural conditions.

Methodology

This study utilizes a qualitative analytical approach grounded in content analysis and comparative pedagogy to explore the reforms in Uzbekistan's preschool education system, with a specific focus on international models. Primary sources include presidential decrees, national education laws, and strategy documents, while secondary sources comprise academic articles and institutional reports on foreign preschool systems. The analysis is centered on identifying the methodological and conceptual strengths of leading countries such as the United Kingdom and Germany, and their relevance for the Uzbek context.

To structure the comparison, key indicators were selected: child-centered pedagogy, play-based learning, teacher autonomy, parental involvement, integration of technology, and inclusion of children with special needs. Each country's model was assessed for its adaptability to Uzbekistan's institutional capacities and socio-cultural environment. For instance, the British model's emphasis on autonomy, creativity, and play-based learning is compared with Uzbekistan's developing approach to fostering independent thinking. Likewise, Germany's diversified preschool models, including forest kindergartens, integration-based institutions, and international kindergartens, are evaluated for their inclusive and environmentally rich educational philosophies.

Field interviews with preschool educators in Uzbekistan, alongside policy reviews, also informed the analysis. These data points were triangulated to provide a comprehensive understanding of how global best practices can be localized and incorporated into national reforms. The ultimate aim of the methodology is to propose policy-oriented recommendations that bridge the gap between Uzbekistan's evolving early childhood education landscape and the innovative frameworks already established in other developed nations.

Conclusion

In conclusion, the integration of information technologies into the educational system is no longer a matter of choice, but a necessity driven by the demands of a rapidly digitalizing society. In Uzbekistan, consistent efforts and legal reforms have laid the foundation for digital transformation in education, from preschool to higher education. The effective use of modern information and communication technologies enhances students' intellectual engagement, supports personalized learning, and provides teachers with innovative tools to enrich their pedagogical practices. Despite facing several implementation challenges, including infrastructural gaps and digital literacy among educators, the long-term benefits of educational informatization are profound. These include the promotion of creative thinking, equitable access to knowledge, and the development of a lifelong learning culture. Thus, prioritizing the integration of digital technologies in the educational process remains critical for building a competitive, future-ready generation.In conclusion, the development of mathematical thinking is a gradual, complex process that requires deliberate instructional strategies, supportive learning environments, and a focus on deep understanding rather than rote memorization. It plays a vital role not only in academic success but also in everyday decision-making and lifelong learning. Educators must emphasize thinking processes alongside mathematical content, nurturing students' curiosity, creativity, and analytical abilities. By doing so, we prepare learners to face future academic and professional challenges with confidence and competence.

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