



A MODEL FOR DEVELOPING STUDENTS' CREATIVE AND METACOGNITIVE THINKING BASED ON ARTIFICIAL INTELLIGENCE IN PRIMARY EDUCATION

Termez State Pedagogical Institute
PhD in Philosophy, Acting Associate Professor
Muminova Umida Qarshiyevna
umuminova622@gmail.com

Abstract. *This article explores the development of primary school students' creative and metacognitive thinking through the effective use of artificial intelligence technologies. The relevance of the study is determined by the need to foster learners' independent thinking and their ability to regulate and evaluate their own learning processes in modern education. The didactic potential of AI is analyzed, and its impact on students' cognitive development is theoretically substantiated. The concepts of creative and metacognitive thinking are clarified, and key pedagogical factors supporting their development are identified. Based on this, an innovative, learner-centered and adaptive pedagogical model is proposed. The results demonstrate that the integration of AI technologies enhances higher-order thinking skills and improves the overall effectiveness of primary education. In addition, the study highlights the role of AI in providing personalized feedback and supporting differentiated instruction. It also emphasizes the importance of integrating reflective tasks to strengthen students' metacognitive awareness. The proposed model encourages active student engagement through interactive and technology-enhanced learning environments. Furthermore, the findings suggest that systematic use of AI tools contributes to sustainable improvement in learning outcomes and supports the modernization of primary education practices.*

Keywords: *artificial intelligence, primary education, creative thinking, metacognitive thinking, metacognition, learning activity, reflective approach, individual learning trajectory, adaptive learning, pedagogical model, innovative technologies, cognitive development, educational effectiveness, independent thinking.*

In the modern education system, priority is given not only to students' acquisition of knowledge, but also to their ability to independently process, analyze, and generate new ideas. In my opinion, particularly at the primary education level, the proper organization of these processes has a direct impact on students' subsequent intellectual development. This is because cognitive activity in primary school learners is still in the process of formation, and at this stage there is a high potential for developing essential skills such as independent thinking, self-awareness, and self-assessment of learning activities. Today, the education system is undergoing fundamental transformations under the influence of global changes. The rapid advancement of digital technologies, especially the integration of artificial intelligence tools into the learning process, necessitates a reconsideration of traditional teaching approaches. As observed, artificial intelligence technologies enable the personalization of learning, real-time analysis of students' performance, and the provision of adaptive learning materials tailored to individual needs. This, in turn, increases students' engagement and strengthens their motivation for learning. Furthermore, AI-supported educational environments create opportunities for continuous monitoring of students' progress and timely pedagogical intervention. They also facilitate the development of higher-order thinking skills by encouraging problem-solving, inquiry-based learning, and reflective

practices. In addition, such technologies support differentiated instruction by addressing diverse learning styles and abilities within the classroom. Studies have shown that AI-based learning environments are effective tools for enhancing students' cognitive activity and overall learning outcomes [1].

In my view, one of the key challenges of the modern education system is the development of higher-order thinking competencies in students. Traditional teaching methods are largely oriented toward reproductive activities, where learners act mainly as passive recipients of ready-made knowledge. However, contemporary educational demands require students to become active, independent, and creative thinkers. Therefore, the development of creative thinking has gained particular importance in today's pedagogical context. Creative thinking enables learners to generate original ideas, approach problems from new perspectives, and make flexible decisions in diverse and dynamic situations. At the same time, it can be observed that the effective development of creative thinking largely depends on the formation of metacognitive thinking. Metacognitive thinking refers to a learner's ability to be aware of, plan, monitor, and evaluate their own thinking processes. This allows students to consciously select appropriate learning strategies, identify their mistakes, and take steps to correct them. Moreover, metacognitive skills foster self-regulated learning and enhance students' responsibility for their own educational outcomes. They also support deeper understanding by encouraging reflection and critical analysis of one's cognitive activities. Research studies emphasize that metacognitive competencies are a crucial factor directly influencing students' academic success and overall learning effectiveness. [2]. In my

opinion, the integrated development of creative and metacognitive thinking should be considered one of the key priorities of primary education. These two processes are closely interconnected and mutually reinforcing: while creative thinking generates new ideas, metacognitive thinking enables learners to analyze, evaluate, and refine those ideas. From this perspective, their combined development significantly enhances students' intellectual potential and supports more effective learning outcomes. Modern pedagogical approaches indicate that artificial intelligence technologies provide favorable opportunities for fostering both types of thinking. It can be observed that AI-based platforms allow teachers to assign individualized tasks, monitor students' learning activities, provide immediate feedback, and adapt the instructional process to learners' needs. This, in turn, contributes to the formation of a reflective approach in students. Furthermore, AI tools make it possible to design problem-based learning environments where students are encouraged to explore, experiment, and find innovative solutions. Such tasks stimulate creative thinking while simultaneously engaging metacognitive processes, as learners reflect on their strategies and outcomes. As a result, the integration of AI technologies into primary education not only supports cognitive development but also promotes deeper, more conscious, and self-regulated learning.

In my view, the use of artificial intelligence in primary education remains one of the areas that is not yet sufficiently supported by methodological foundations. Although technological capabilities are increasingly applied in practice, clearly defined pedagogical models and mechanisms that ensure their effectiveness are still недостаточно developed. Therefore, the development of a scientifically grounded

approach in this field is considered a pressing issue. Taking these considerations into account, the present study aims to design a pedagogical model focused on the development of primary school students' creative and metacognitive thinking based on artificial intelligence. This model is intended to provide a systematic framework for enhancing students' cognitive activity, fostering independent thinking, and developing skills such as self-regulation, self-monitoring, and reflection, while also improving overall educational effectiveness.

The development of creative and metacognitive thinking in primary education is recognized as one of the priority directions of modern pedagogy. In particular, the integration of artificial intelligence technologies into the learning process is elevating this field to a new level. AI-based educational models take into account individual learner characteristics and support the deepening of students' thinking processes. Through such an approach, students not only acquire knowledge but also develop an awareness of how they learn (metacognition) and the ability to generate new ideas (creativity). Consequently, the integration of AI technologies contributes to a more holistic and effective development of learners' intellectual potential and prepares them for the demands of a rapidly evolving digital society [3]. An artificial intelligence-based educational model primarily relies on adaptive learning systems. These systems generate individualized tasks based on students' knowledge levels, learning pace, and interests. As a result, each learner develops according to their own capabilities, which, in turn, strengthens metacognitive control—enabling students to analyze and regulate their own thinking processes [4]. At the same time, AI tools expand opportunities for creating problem-based situations, thereby

stimulating creative thinking. One of the key components of this model is the organization of reflective activity. Through AI platforms, students are provided with opportunities to analyze their own responses, identify errors, and make corrections. This process fosters the development of “thinking about thinking” skills, which are central to metacognition. The advancement of metacognitive activity, in turn, contributes to the consolidation of knowledge and its effective application in new contexts [5].

In addition, AI-based interactive tools play a significant role in developing creative thinking. For instance, gamified tasks, simulations, and visual models created with the help of artificial intelligence broaden students’ imagination and engagement. Through such tools, learners are encouraged to approach problems from multiple perspectives, which promotes the development of divergent thinking and enhances their creative potential [6]. At the same time, artificial intelligence systems also enable the assessment and encouragement of students’ creative responses.

The proposed model consists of the following components:

- **Diagnostic stage** – identifying students’ initial knowledge level, thinking characteristics, and interests.
- **Adaptive instruction stage** – creating individualized learning trajectories based on artificial intelligence.
- **Activity stage** – engaging students in problem-based tasks, creative assignments, and reflective exercises.
- **Analysis and evaluation stage** – monitoring students’ performance and providing recommendations for further development.

The implementation of this model also leads to a fundamental transformation in the role of the teacher. The teacher is no longer merely a transmitter of knowledge but acts as a facilitator, guide, and analyst. Artificial intelligence, in turn, supports the teacher in deeply analyzing students' learning activities, ensuring individualized instruction, and making effective pedagogical decisions. Furthermore, special attention should be paid to issues of information security, data privacy, and ethics when implementing this model. Protecting students' personal data, ensuring the responsible use of AI technologies, and maintaining pedagogical control are of critical importance. In conclusion, the model for developing creative and metacognitive thinking based on artificial intelligence in primary education contributes to the formation of students' independent thinking, problem-solving abilities, and self-regulation skills. This creates a solid foundation for educating intellectually capable individuals who can meet the demands of a rapidly evolving digital society.

Conclusion. The development of primary school students' creative and metacognitive thinking based on artificial intelligence is one of the most актуал направления of modern education. Based on the findings of this study, it has been identified that the integration of AI technologies into the educational process not only enhances students' knowledge levels but also significantly improves their ability to think independently, analyze problem situations, and generate creative solutions. It is also revealed that an adaptive learning environment supported by artificial intelligence, which takes into account individual learner characteristics, contributes to the formation of students' self-regulation and self-assessment skills. This, in turn, plays a crucial role in the development

of metacognitive competencies. In my opinion, the effective use of artificial intelligence in primary education elevates the teacher's professional role to a new level. The teacher moves beyond the traditional role of knowledge transmitter and becomes a facilitator, guide, and analyst who manages students' individual learning trajectories. This transformation not only increases the effectiveness of the educational process but also prepares students for the demands of a digital society. Furthermore, it can be argued that the successful implementation of AI-based models in practice requires a comprehensive approach that integrates pedagogical strategies, technological infrastructure, and information security considerations. These factors play a decisive role in ensuring the quality and sustainability of education in the context of ongoing digital transformation.

In conclusion, the use of artificial intelligence in primary education serves as an effective tool for developing students' creative and metacognitive thinking. It has been identified that such an approach fosters essential skills such as independent thinking, reflective practice, and the application of innovative strategies in learning. Moreover, AI-supported learning environments encourage students to become active participants in their own learning process, enhancing their ability to analyze, evaluate, and improve their cognitive activities.

In my view, it is therefore important to further expand scientific research in this field and to promote the implementation of practical experiences and evidence-based models in educational practice. Such efforts will contribute to improving the quality of education, strengthening students' intellectual potential, and preparing them more effectively for the challenges of a rapidly evolving digital world.

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