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THE TRANSFORMATION OF PRIMARY EDUCATION IN THE AGE OF ARTIFICIAL INTELLIGENCE: OPPORTUNITIES, RISKS, AND PEDAGOGICAL STRATEGIES

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Abstract. This article examines the transformation of primary education in the age of artificial intelligence (AI), its potential to improve educational quality, the risks that may arise, and effective pedagogical strategies. It discusses the role of AI-based digital tools in creating individualized learning pathways, analyzing pupils’ achievement levels, providing timely feedback, and supporting teachers’ work. At the same time, it considers risks associated with the age-specific characteristics of primary school pupils, information security, the digital divide, excessive dependence on technology, and possible limitations on creative and critical thinking.

Keywords: artificial intelligence, primary education, digital transformation, learner-centred instruction, pedagogical strategies, educational technologies, digital competence, information security.

In recent years, artificial intelligence has emerged as a transformative force bringing rapid changes to all levels of the education system. It makes teaching and learning more flexible, data-informed, and individualized. Broad digital changes in school education—including the introduction of electronic resources, online platforms, and intelligent technologies—are enriching primary education with new approaches. Primary education is particularly important because it lays the foundation for core competencies such as literacy, numeracy, social skills, and learning motivation. Consequently, the influence of AI at this level is especially significant. It creates opportunities to take pupils’ individual learning pace into account, support teachers’ daily work, and reconsider how classroom activities are organized. Therefore, AI in primary education should be viewed not merely as a technological innovation, but as a current pedagogical issue directly affecting educational content, practice, and organization.

Artificial intelligence (AI) refers to the ability of computer systems to perform tasks commonly associated with human intelligence, including data analysis, pattern recognition, prediction, natural language processing, and decision support. In education, AI is used to personalize teaching and learning, automate aspects of assessment, and adapt educational resources.

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Primary education is the initial stage of formal schooling, during which children develop literacy, numeracy, communication, socialization, and fundamental learning skills. This stage establishes the foundation for later academic development and has distinct pedagogical needs in terms of content, methods, and educational approaches.

Educational transformation is the systematic process of changing educational content, methods, tools, management, and assessment systems in response to social, technological, and labour-market demands. In the context of AI, this process is characterized by adaptation to digital environments, data-informed decision-making, and a stronger focus on learners.

Opportunities are the positive ways in which AI can improve the quality, efficiency, and reach of primary education. These include creating individualized learning pathways, providing timely feedback, saving teachers' time, increasing pupil engagement, and promoting inclusion.

Risks are potential negative pedagogical, ethical, and social consequences of using AI. They include breaches of data privacy, algorithmic bias, excessive dependence on technology, reduced learner autonomy, and a widening digital divide.

Pedagogical strategies are planned methods, techniques, and organizational approaches selected by teachers to achieve educational goals. In the age of AI, these strategies should ensure that technology is used for clear didactic purposes, while developing critical thinking, collaborative learning, information literacy, and pupil safety.

The study of AI in primary education is one of the important directions in contemporary educational research, as intelligent technologies are becoming increasingly embedded in learning environments and significantly affecting the content, format, and management of the learning process. It is particularly important to understand, on a sound research basis, how AI tools affect learning outcomes, motivation, individualized instruction, and cognitive development among younger pupils. The knowledge, skills, and habits formed at this stage provide a strong foundation for subsequent learning.

At the same time, this topic highlights the need for teachers and schools to use AI responsibly, align its capabilities with pedagogical objectives, and prepare for risks involving technological dependence, information security, equal opportunities, and ethical considerations. Thus, in-depth study of AI in primary education is important not only for identifying innovative approaches, but also for ensuring that the education system develops in a humane, safe, and effective way.

The purpose of this study is to provide a theoretical and analytical account of the impact of AI on primary education and to identify the new conditions it creates for educational content, teaching practice, and pupil development. Since primary education is a crucial stage in shaping a person's future learning trajectory, the introduction of AI should be examined not simply as a technological novelty, but as a phenomenon with important pedagogical, social, and methodological dimensions. This section outlines the general scope and relevance of the issue and addresses the central research

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question: how is AI changing primary education, and why does this change require careful academic analysis?

The rapid development of AI is changing the content, organization, and didactic approaches of primary education. In today's classrooms, AI technologies can automate parts of the learning process, adapt assignments, monitor pupils' activities in real time, and make assessment more accurate and timely. At the same time, these developments directly affect the age-specific characteristics, psychological needs, and independent-learning skills of primary school pupils. As a result, the teacher's role is also changing: rather than serving only as a source of knowledge, the teacher increasingly guides and manages learning and ensures that digital tools are used appropriately for pedagogical purposes. From this perspective, it is important to analyse not only the opportunities offered by AI in primary education, but also its risks and the pedagogical responses needed to address them.

AI creates broad opportunities to make primary education more flexible, individualized, and effective. Adaptive learning systems can offer tasks suited to each pupil's level of knowledge, learning pace, and difficulties, reducing the limitations of teaching everyone at the same pace. Intelligent tutoring tools can respond to pupils' questions immediately and support them in revisiting explanations, completing exercises step by step, and consolidating knowledge. Automated feedback systems can identify errors promptly and give pupils an opportunity to correct them in good time. This is especially important when developing foundational skills such as reading, writing, and mathematics.

Through data-informed teaching, teachers can analyse both class-wide and individual results and identify pupils who need additional support at an early stage. This can help prevent learning difficulties from becoming more serious. In practice, these technologies can support differentiated instruction, targeted work with pupils who achieve at different levels, and a balance between collaboration and independent learning. As a result, AI may strengthen not only literacy and numeracy skills, but also pupils' interest, confidence, and intrinsic motivation to learn.

The use of AI in primary education also raises serious risks and limitations. It should therefore be treated not simply as a technological innovation, but as a practical matter requiring careful pedagogical supervision. Excessive reliance on AI tools may reduce direct interaction between teachers and pupils, emotional support, and opportunities to develop social skills. Human relationships are particularly important for children of primary-school age.

Overdependence on technology may also weaken essential competencies such as independent thinking, creative exploration, and solving problems without digital assistance. Another significant issue is unequal access to digital tools. A lack of devices, internet access, or appropriate software in some regions, families, or schools may widen existing educational inequalities.

Data security and privacy are also critical concerns. The improper storage or unauthorized use of children's personal information may have serious consequences. Algorithmic fairness presents another challenge: systems based on incomplete or biased data may assess some pupils inaccurately, reinforce

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stereotypes, or provide unfair recommendations. Finally, content that is unsuitable for children's age or stage of development can undermine the educational and developmental goals of primary schooling. For these reasons, teachers, school administrators, and education policymakers should reduce such risks through continuous monitoring, critical evaluation, and cautious governance.

The findings discussed in this article indicate that AI can renew primary education and help organize learning in a more individualized, flexible, and effective way. Tasks adapted to pupils' needs, rapid assessment, and tools that support teachers' decision-making may improve educational quality. However, these benefits are accompanied by risks such as threats to data security, the digital divide, excessive reliance on technology, and weakened pedagogical oversight. AI should therefore be used in primary education in a way that balances its benefits with a human-centred approach, pedagogical supervision, and ethical standards.

The key pedagogical priorities for responsible integration of AI include strengthening learner-centred teaching approaches suited to children's developmental characteristics and using AI not merely as a technology that supplies ready-made answers, but as a tool that supports reasoning, creativity, and problem-solving. For teachers, this means organizing learning activities that develop digital literacy, the ability to critically evaluate AI-generated results, and ethical responsibility.

For curriculum developers, it is necessary to integrate technological competencies across subject areas, adapt assessment criteria, and establish clear principles for safety and privacy. School leaders should create an environment that supports pedagogical innovation, with attention to professional development, methodological collaboration, and equitable access to resources. Overall, the most promising strategy is to introduce AI carefully and systematically as a means of improving educational quality without displacing human interaction, educational values, or pedagogical oversight.

The introduction of AI into primary education offers opportunities to make learning more flexible, learner-centred, and analytically informed. AI tools have considerable potential to identify pupils' individual needs, support learning activities, and reduce teachers' workload. Nevertheless, risks such as information-security breaches, algorithmic bias, excessive screen dependence, and reduced human interaction must not be overlooked. The future of primary education therefore depends on understanding AI not as an all-purpose solution, but as a tool integrated with clear didactic goals.

In this approach, teachers' professional judgement, ethical responsibility, and pedagogical flexibility remain decisive. Educational innovation can be truly effective only when it is aligned with children's developmental needs, age-related characteristics, and social and emotional well-being. Responsible integration of AI must therefore preserve the central role of the teacher and ensure that technology serves the child's learning and development.

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