

Education 4.0: Development of the Educational System in the Context of Artificial Intelligence

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Abstract

The main purpose of the article is to demonstrate the development of the Ukrainian educational system in the context of artificial intelligence. The object of research is the educational system itself. The scientific task is to present an approach to improving the efficiency of the Ukrainian educational system under the conditions of artificial intelligence. The research methodology involves the application of the IDEF0 method. As a result of the study, a model for the development of the Ukrainian educational system in the context of artificial intelligence is presented. The innovation of the research is shown in the form of the IDEF0 model for improving the Ukrainian educational system in the context of artificial intelligence. Future research prospects are aimed at assessing the threats of artificial intelligence to the modern educational system.

Keywords: Education, Education System, Artificial Intelligence, Pedagogy, Information, Modeling, IDEF0, Students.

INTRODUCTION

Education 4.0 refers to the new phase in the evolution of educational systems, characterized by the integration of advanced technologies, particularly artificial intelligence (AI), into learning environments. This concept is highly relevant today for several reasons: Firstly, the rapid advancement and proliferation of AI technologies necessitate an educational paradigm that can effectively incorporate these tools to enhance learning. AI can personalize education, adapting learning materials to the pace and style of each student, thereby improving engagement and outcomes. For instance, AI-driven platforms can analyze a student's progress and provide targeted assistance or additional resources, ensuring that all students have support tailored to their specific needs.

Secondly, Education 4.0 aligns with the demands of the modern workforce. Today's job market increasingly requires digital literacy and skills in managing and working alongside AI systems. By integrating AI into the educational system, schools can prepare students more effectively for future careers that will likely involve interacting with sophisticated technologies. This preparation includes not only the development of technical skills but also the cultivation of critical thinking and problem-solving abilities in technologically rich environments.

Thirdly, the application of AI in education can lead to greater efficiency in administrative tasks, freeing up educators to focus more on teaching and less on bureaucracy. AI can automate routine tasks such as grading, attendance tracking, and even early detection of learning disabilities, allowing for timely intervention. This shift can enhance the role of educators, enabling them to concentrate more on pedagogical strategies and direct student engagement. Fourthly, AI can significantly enhance the inclusivity of education. Educational tools powered by AI can be designed to accommodate diverse learning styles and needs, including those of students with disabilities. For example, AI can translate text to speech for visually impaired students or provide advanced calculative tools for those with dyscalculia, making education more accessible to everyone and adhering to principles of equity.

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Finally, the integration of AI into education prompts necessary discussions and policy developments regarding ethics, privacy, and the digital divide. It's important that as educational systems evolve, they do so in a way that respects student data privacy and ensures equitable access to technology. Addressing these issues head-on will help avoid potential negative consequences of technology use in education and ensure that Education 4.0 benefits all students regardless of their socioeconomic background.

Overall, Education 4.0 is not just a technological upgrade but a comprehensive re-envisioning of how education is delivered, making it more personalized, efficient, inclusive, and aligned with future societal needs. The main purpose of the article is to demonstrate the development of the Ukrainian educational system in the context of artificial intelligence. The object of research is the educational system itself. The scientific task is to present an approach to improving the efficiency of the Ukrainian educational system under the conditions of artificial intelligence.

LITERATURE REVIEW

In exploring the integration of artificial intelligence (AI) into educational systems, known as Education 4.0, a diverse array of literature provides a foundational understanding of this complex transformation. This review highlights several key contributions that establish the backdrop against which the development of AI-driven educational models is considered.

Alazzam et al. (2023) discuss the formation of innovative business models underpinned by AI, focusing on e-commerce to ensure economic security. Although the direct correlation to education is not explicit, the methodologies like IDEF0 discussed are pertinent for developing efficient systems that could be analogously applied to educational systems to enhance their operational efficiency and adaptability in the age of AI.

In a similar vein, Alazzam et al. (2023) explore state management and rational environmental use in the context of bioeconomy. The ecological focus, while primarily commercial, underscores the importance of sustainable practices that could translate into sustainability in educational planning and development, highlighting a systemic approach to integration that can be beneficial for structuring AI-driven educational systems.

Further extending the discussion on digital systems, Alazzam et al. (2023) delve into the development of information models for e-commerce platforms, emphasizing the need for legal compliance and socio-economic adaptability in digital systems. This research is directly applicable to Education 4.0, where educational platforms must align with digitalization standards and legal frameworks, ensuring that they are both innovative and compliant with regulatory standards (Alazzam et al., 2023).

Bani-Meqdad et al. (2024) discuss the cyber-environment in relation to human rights, particularly the protection of intellectual property within sustainable development frameworks. This perspective is crucial for educational systems where the creation and distribution of digital content via AI technologies must respect intellectual property laws and contribute to a sustainable educational ecosystem.

Kryshtanovych et al. (2023) examine the digital transformation of educational institutions, providing a detailed model of stages in this transformation. Their research aligns closely with the principles of Education 4.0, offering insights into how educational systems can evolve to incorporate AI effectively, ensuring that such transformations contribute to the sustainable development of the region.

Collectively, these studies provide a broad yet detailed view of the theoretical and practical aspects of integrating AI into various systems, offering valuable lessons and methodologies that can be adapted for the educational sector. This literature establishes a solid foundation for understanding the complex dynamics and the potential pathways for developing Education 4.0.

METHODOLOGY

The methodology employed in this study centers around the application of the IDEF0 method, a function modeling methodology used to describe the decisions, actions, and activities of an organization or system.

IDEF0 was originally developed for manufacturing and systems engineering. Its adaptability makes it highly suitable for conceptualizing and refining systems within an educational context, particularly when integrating complex technologies such as artificial intelligence (AI). The methodology is applied through several structured phases:

The first step involves identifying and outlining the key functional requirements of the Ukrainian educational system in the context of AI. This includes determining the essential processes that need optimization or re-engineering to accommodate AI technologies effectively. These processes are mapped out to understand their inputs, outputs, controls, and mechanisms, laying the groundwork for comprehensive system analysis.

Using the IDEF0 method, a detailed model of the current educational system is created. This model visually represents all activities, sequences, and interactions within the system, highlighting how AI can be integrated into each component. The IDEF0 diagrams are used to show the existing educational processes, along with the proposed AI enhancements, to visually articulate where improvements can be made and how AI will influence each part of the system.

The model then serves as a basis for analyzing potential integration points for AI within the educational system. This phase assesses where AI tools and methodologies can be most effectively applied to improve efficiency, personalization, and outcomes. Particular attention is given to areas such as personalized learning paths, automated administrative tasks, and AI-driven analytics for educational outcomes.

With the AI integration points identified, the next step involves evaluating the potential performance of the system. Simulation techniques are employed to predict the behavior of the educational system under different scenarios of AI integration. This evaluation helps in understanding the impacts of AI on system efficiency, student engagement, and educational quality.

Finally, the IDEF0 model facilitates iterative refinement of the educational system. Feedback loops are incorporated to continuously improve the AI integration based on actual system performance and user feedback. This iterative process ensures that the system remains adaptable and optimally tuned to the evolving educational needs and technological advancements.

Through this methodological approach, the study aims to present a robust model for enhancing the Ukrainian educational system with AI, ensuring that it is both effective and future-ready. The use of IDEF0 provides a structured, systematic way to approach complex system changes, making it an ideal choice for educational system re-engineering in the context of emerging technologies like artificial intelligence.

RESEARCH RESULTS AND DISCUSSIONS

To enhance the development of educational systems in the context of artificial intelligence (AI), two comprehensive approaches can be proposed, each comprising four stages. These methods aim to systematically integrate AI into educational frameworks to improve efficiency, personalization, and adaptability.

A0. AI-Driven Personalization of Learning:

A1. Data Collection and Analysis. Gather comprehensive data on student learning styles, performance metrics, and educational content interaction. Implement tools to collect data from various sources including LMS (Learning Management Systems), educational apps, and feedback mechanisms.

A2. AI Model Development. Develop AI models that can analyze the collected data to identify patterns and learning preferences. Use machine learning techniques to create predictive models that adapt educational content according to individual student needs.

A3. Integration of AI into Educational Platforms. Seamlessly integrate AI models into existing educational platforms. Collaborate with developers to embed AI functionality into LMS, e-textbooks, and other digital learning tools.

A4. Continuous Improvement and Scaling continuously refine AI models and expand their application across different educational levels and subjects. Use ongoing data collection and AI analytics to improve model accuracy and functionality. A scalable, AI-driven personalization system that evolves with educational needs and technological advancements. (Fig.1).

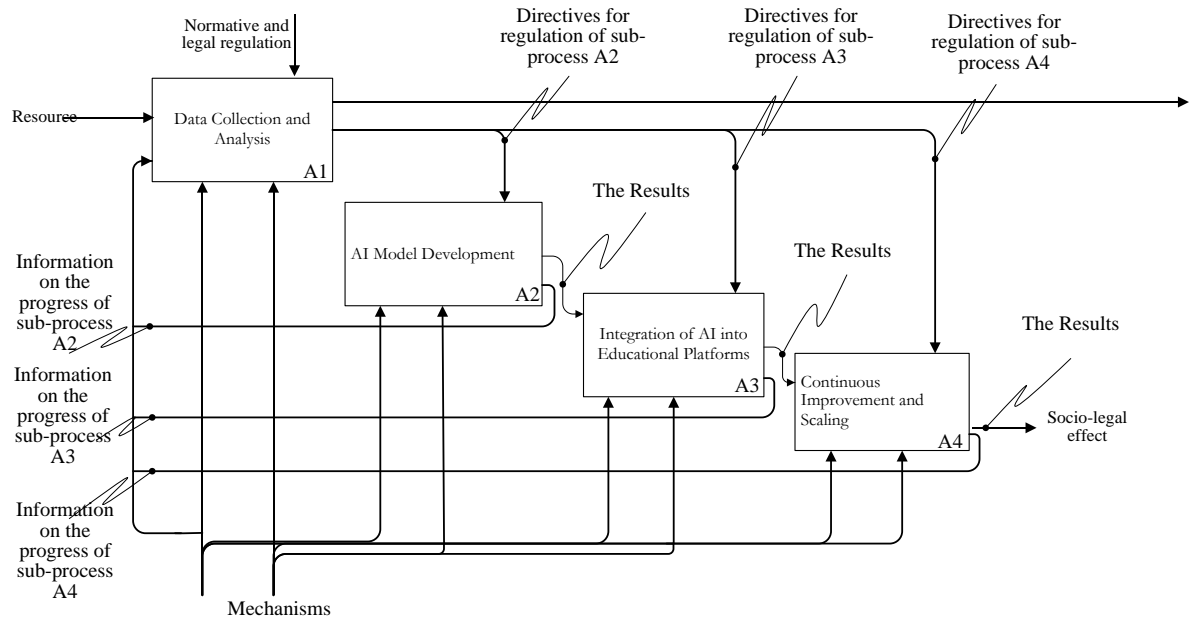


Figure 1. Model IDEFO

AI-Enhanced Administrative Efficiency:

Identification of Administrative Bottlenecks. Identify key administrative processes that can benefit from automation and AI optimization. Conduct audits of existing administrative tasks to pinpoint inefficiencies and areas prone to errors or delays.

Development of AI Solutions. Develop AI tools designed to automate and optimize identified administrative processes. Create or adapt AI algorithms for tasks such as scheduling, resource allocation, attendance tracking, and grading.

Implementation and Integration. Implement AI solutions into the administrative framework of educational institutions. Deploy AI tools within the administrative systems, ensuring compatibility and minimal disruption to existing processes.

Monitoring and Optimization. Monitor the effectiveness of AI implementations and optimize them for greater efficiency and accuracy. Regularly review AI tool performance, collect feedback from staff, and make adjustments as necessary (Fig.2).

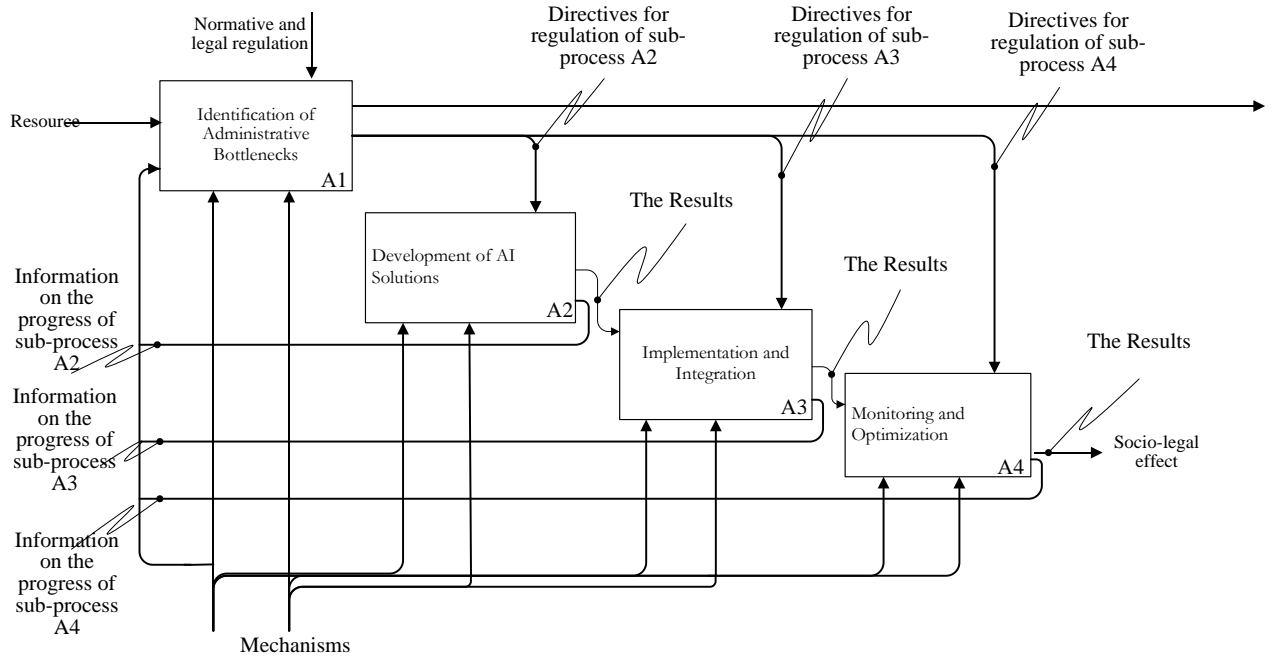


Figure 2. Second Model IDEF0

Each of these approaches addresses different aspects of educational system development in the AI context, targeting either the enhancement of learning experiences or the optimization of administrative operations, thereby contributing to a more effective and modern educational environment.

Alazzam et al. (2024) discuss methodological approaches to choosing business management strategies amidst changes in commercial activities. Similar to our study, their work emphasizes the importance of structured methodologies (like IDEF0) in adapting to new technologies and environments. While Alazzam et al. focus on commercial activities, our research applies a similar systematic approach to the educational sector, demonstrating how structured methodologies can facilitate strategic integration of AI, thereby enhancing operational efficiency and adaptability.

Aliksieienko et al. (2022) explore the use of modern digital technologies in developing educational environments for sustainable regional development. Their findings align closely with our study, particularly in how digital technologies can be leveraged to enhance the educational system. Both studies highlight the transformative potential of digital tools, but our research uniquely contributes by specifically modeling AI integration using IDEF0, providing a clear framework for implementation.

The study by Alazzam et al. (2023) on blockchain in electronic contracts explores innovative digital applications outside the educational sector. It underscores the transformative impact of digital technologies on traditional systems—a theme that resonates with our work on AI in education. Both studies demonstrate how cutting-edge technology can revolutionize established practices, suggesting that methodologies developed in one domain can be effectively adapted to others, including education.

Kryshtanovych et al. (2022) and Bazyliuk et al. (2019) provide insights into the philosophical and institutional dynamics of adapting to new technologies. These studies offer a deeper understanding of the systemic changes required for technology integration, which complements our focus on the practical implementation of AI within the educational system. Our research extends these discussions by providing a specific, actionable model for integrating AI into educational processes.

Finally, discussions by Saleh et al. (2020) and Kopytko and Sytkin (2023) on the legal and security aspects of digital technologies, including cryptocurrency and economic security, highlight critical considerations that

must also be addressed when integrating AI into educational systems. These studies remind us of the importance of considering legal and ethical issues as part of comprehensive technology integration strategies, an area our future research will explore more thoroughly.

CONCLUSIONS

This article has sought to demonstrate the potential and realized development of the Ukrainian educational system within the burgeoning context of artificial intelligence (AI). Through an extensive exploration and application of the IDEF0 method, a structured and systematic approach to integrating AI technologies has been proposed and examined. The research successfully developed a model using the IDEF0 method, which clearly delineates the processes and interactions within the educational system that can benefit from AI. This model serves not only as a blueprint for the current educational system's transformation but also as a guideline that other systems could adapt or follow.

The application of AI, as conceptualized in the model, shows significant promise for enhancing the efficiency of the Ukrainian educational system. By automating routine tasks, personalizing learning experiences, and optimizing administrative procedures, AI has the potential to substantially reduce time and resource wastage, allowing educators and administrators to focus on more critical educational goals. The innovative use of the IDEF0 method in this context highlights a novel approach to addressing educational challenges. This methodology not only facilitates a clear visualization of system functionalities and their enhancements through AI but also ensures that every step of integration is purposeful and aligned with broader educational objectives.

In conclusion, this study marks a significant step forward in the conceptualization and potential transformation of the Ukrainian educational system through AI. By leveraging the structured IDEF0 method, it offers a detailed and implementable model that not only addresses current inefficiencies but also sets a path for continual adaptation and improvement in the face of evolving technological landscapes. As AI continues to advance, it is imperative that educational systems not only keep pace with these changes but also actively shape them to fulfill educational mandates more effectively and equitably.

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