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Scientific And Pedagogical Foundations For Developing Students' Digital Competence Through Intelligent Educational Systems

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Abstract: This scientific article analyzes the scientific and pedagogical foundations of developing students' digital competence through intelligent educational systems. The study highlights the role of artificial intelligence, learning analytics, and adaptive learning technologies in the modern educational process, as well as their impact on the formation of students' digital competencies. Based on the analysis of scientific and theoretical sources, the pedagogical potential of intelligent educational systems is revealed. In addition, a model of an intelligent educational system aimed at developing digital competence is proposed. The obtained results contribute to improving the educational process in higher education institutions.

Keywords: Intelligent, education, systems, digital, competence, artificial, intelligence, learning, analytics, adaptive, pedagogy, education, quality.

Introduction: Globalization and digital transformation processes are placing qualitatively new demands on the education system, along with all other sectors of society. Today, the primary task of education is not limited to knowledge transmission, but also involves shaping individuals who are capable of functioning effectively in a digital environment, thinking independently, and adopting innovative approaches [8].

In particular, the development of students' digital competence in higher education has emerged as a pressing pedagogical issue. Digital competence encompasses the ability to search for, process, and analyze information, to use digital tools purposefully, and to interact effectively with intelligent technologies [10].

From this perspective, the integration of intelligent educational systems into the teaching and learning process is regarded as an effective means of developing students' digital competence. This article analyzes the scientific and pedagogical foundations of developing digital competence through intelligent educational systems.

LITERATURE REVIEW

Foreign scientific studies recognize intelligent educational systems as a key factor in the development of digital learning environments. Reports by UNESCO and the OECD emphasize that artificial intelligence technologies enhance education quality, enable the formation of individualized learning trajectories, and improve the efficiency of educational process management [1].

The learning analytics concept developed by G. Siemens and P. Long has revealed new opportunities for data-driven analysis of learning processes and for grounding pedagogical decision-making on empirical evidence [2]. Researchers such as R. Luckin and W. Holmes substantiate that the application of intelligent systems in pedagogy fosters students' independent learning skills and supports personalized learning approaches [3,4].

Studies conducted by scholars from CIS countries widely address issues related to digital learning environments, information technologies, and the

intellectualization of pedagogical processes. Although local research has examined digital pedagogy, distance education, and the use of electronic educational resources, the issue of developing digital competence through intelligent educational systems has not yet been sufficiently investigated in a systematic manner [7].

METHODOLOGY

This study was conducted based on a systematic and comprehensive methodological approach. The issue of developing students' digital competence through intelligent educational systems was theoretically analyzed as an essential component of the modern pedagogical process. In selecting the research methodology, leading scientific concepts in pedagogy, digital education, and educational intellectualization were taken as a foundation [6].

The study employed the following research methods: Analysis of scientific and theoretical sources, used to examine and generalize the views of foreign, CIS, and local scholars on intelligent educational systems and digital competence; Comparative and generalization methods, applied to identify common and distinctive features of various scientific approaches; Pedagogical modeling, used to design a model for developing students' digital competence through intelligent educational systems; Systematization and conceptual analysis, applied to ensure logical consistency in the interpretation of research findings [12].

The object of the study is the educational process in higher education institutions. The subject of the research is the process of developing students' digital competence through intelligent educational systems. Within the scope of the study, the pedagogical potential and impact of digital technologies, artificial intelligence, and learning analytics tools were analyzed [11].

The methodological framework of the research is based on competency-based, learner-centered, and systemic approaches. The competency-based approach focuses on the formation and development of students' digital competence, while the learner-centered approach emphasizes consideration of individual characteristics and educational needs of students [5]. The systemic approach ensures the consideration of intelligent educational systems as an integrated pedagogical system and highlights the interrelationships among its structural components [9].

RESULTS

The conducted scientific and theoretical analysis demonstrated that intelligent educational systems significantly expand the possibilities for organizing modern higher education in a learner-centered, adaptive, and efficient manner. Such systems contribute to the consistent development of students' digital competence by adapting educational content to individual learning needs, levels of prior knowledge, and learning pace. As a result, the educational process shifts from traditional approaches toward increasing student engagement, fostering independent learning skills, and enhancing learning motivation.

Intelligent educational systems based on artificial intelligence enable the presentation of learning materials in accordance with students' individual characteristics, automatic regulation of content complexity, and identification of learning difficulties that arise during the educational process. This, in turn, facilitates deeper knowledge acquisition, effective information processing, and the development of decision-making competencies in digital environments.

The application of learning analytics technologies allows for continuous monitoring of students' learning activities, knowledge acquisition indicators, and developmental dynamics. These technologies support evidence-based management of the pedagogical process, the formation of individualized learning trajectories, and the optimization of teachers' instructional practices. The analysis results indicate that learning analytics plays a crucial role in developing key components of students' digital competence, including information searching, analysis, evaluation, and practical decision-making.

Based on the analysis of scientific sources and conceptual frameworks, a pedagogical model aimed at developing students' digital competence through intelligent educational systems was designed. The proposed model consists of several interrelated components that ensure the integrity and coherence of the educational process.

The target component of the model defines the development of students' digital competence as a priority objective. This component focuses on preparing specialists who are capable of functioning effectively in digital environments, working with information, and purposefully applying modern technologies in professional activities.

The methodological component includes adaptive learning, problem-based learning, and project-based instructional methods. When integrated with intelligent educational systems, these methods contribute to the development of students' independent thinking, creative approaches, and practical skills.

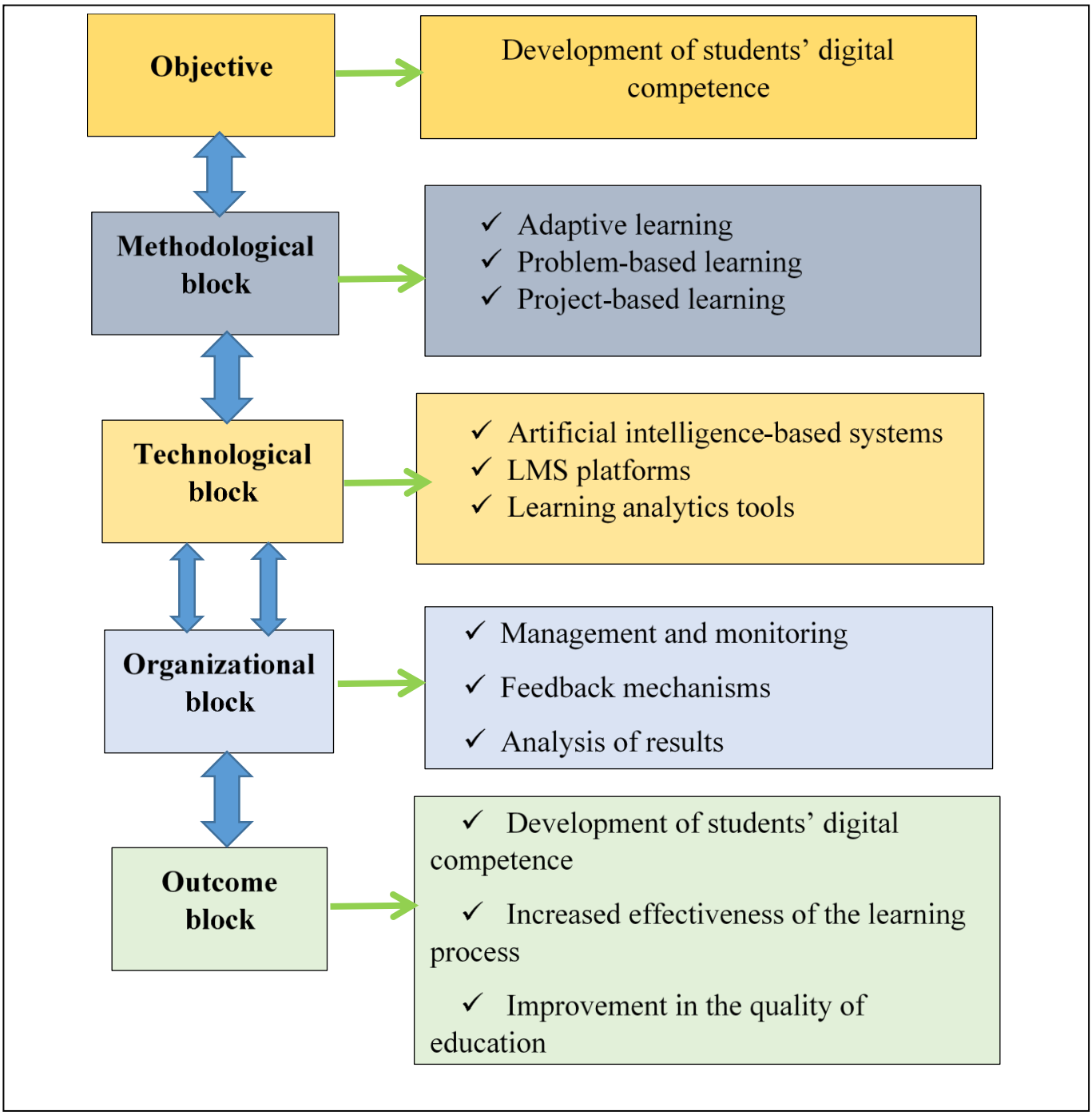

Figure 1. Model for developing students' digital competence based on intelligent learning systems

The technological component encompasses artificial intelligence-based systems, learning management systems (LMS), and learning analytics tools. These technologies form the technical foundation for organizing, monitoring, and analyzing educational processes within digital learning environments.

The organizational component involves educational management mechanisms, monitoring procedures, feedback systems, and outcome evaluation. This component plays a vital role in ensuring the continuous and sustainable functioning of intelligent educational systems.

The outcome component reflects the formation of students' digital competence, increased efficiency of the learning process, and improvement in education quality. This component enables the assessment of the model's practical effectiveness.

Overall, the analysis and results scientifically substantiate that educational processes organized on the basis of intelligent educational systems demonstrate high pedagogical effectiveness in developing students' digital competence. The

proposed model has significant methodological and practical value for implementing digital transformation processes in higher education institutions and serves as a theoretical foundation for further scientific research.

CONCLUSION

In conclusion, intelligent educational systems represent an effective pedagogical tool for the development of students' digital competence. The research findings demonstrate that artificial intelligence and learning analytics technologies contribute to learner-centered education, support independent learning, and enhance the overall quality of education. Educational processes organized on the basis of these technologies activate students' learning activities and enable the systematic development of competencies related to information processing, analytical thinking, and effective decision-making in digital environments.

The results obtained during the study indicate that the effective use of intelligent educational systems requires methodologically sound instructional design and a high level of digital and pedagogical preparedness among educators. Therefore, the implementation of intelligent technologies in higher education institutions should not be limited to technological modernization alone but should be carried out in close integration with the improvement of pedagogical approaches and teaching strategies.

In this regard, the following recommendations are proposed: the phased implementation of intelligent educational systems in higher education institutions; the enhancement of professional development programs aimed at strengthening educators' digital and analytical competencies; and the expansion of adaptive learning and learning analytics-based monitoring mechanisms within the educational process. These measures are expected to increase the effectiveness of developing students' digital competence.

The scientific conclusions and recommendations presented in this article provide a methodological foundation for modernizing educational processes through intelligent educational systems, strengthening students' digital preparedness, and making informed practical decisions aimed at improving educational quality. The research findings are of particular relevance for academic conferences, pedagogical practice, and further scientific investigations.

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