

Improvement of the pedagogical model based on artificial intelligence technologies

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Abstract: This article discusses the areas of improvement of the pedagogical model based on artificial intelligence (AI) technologies. The possibilities of automating, individualizing and increasing the efficiency of the educational process using intelligent systems are analyzed. Also, the concept of an improved pedagogical model based on the integration of fuzzy logic, neural networks and expert systems is developed.

Keywords: artificial intelligence, pedagogical model, intelligent system, improvement, neural network, fuzzy inference, digital education, adaptive system.

Introduction: One of the main tasks facing the modern education system is the organization of the educational process in a personality-oriented, flexible, and innovative manner [3], [7]. In this regard, pedagogical models created on the basis of artificial intelligence technologies bring the quality of education to a new level [5], [11].

However, existing models are often limited only to an assessment or recommendation system. Therefore, it is necessary to improve them based on a comprehensive approach, that is, to combine analytical, adaptive, and predictive functions [2], [9].

Main Part: Improving the pedagogical model based on artificial intelligence technologies allows for in-depth analysis of the educational process, identification of students' individual needs, objective assessment of their knowledge and skills, and automated, flexible, and personalized management of the learning process, which serves to significantly improve the quality of education [8], [10], [14].

For this purpose, an improved pedagogical model based on artificial intelligence technologies will be formed in this study. This model unites all stages of the educational process - data analysis, knowledge assessment, determination of individual educational directions, and forecasting of results - within a single intellectual system. As a result, the learning process will be automated, flexible, and personalized, and the quality and effectiveness of education will be raised to a new level [1].

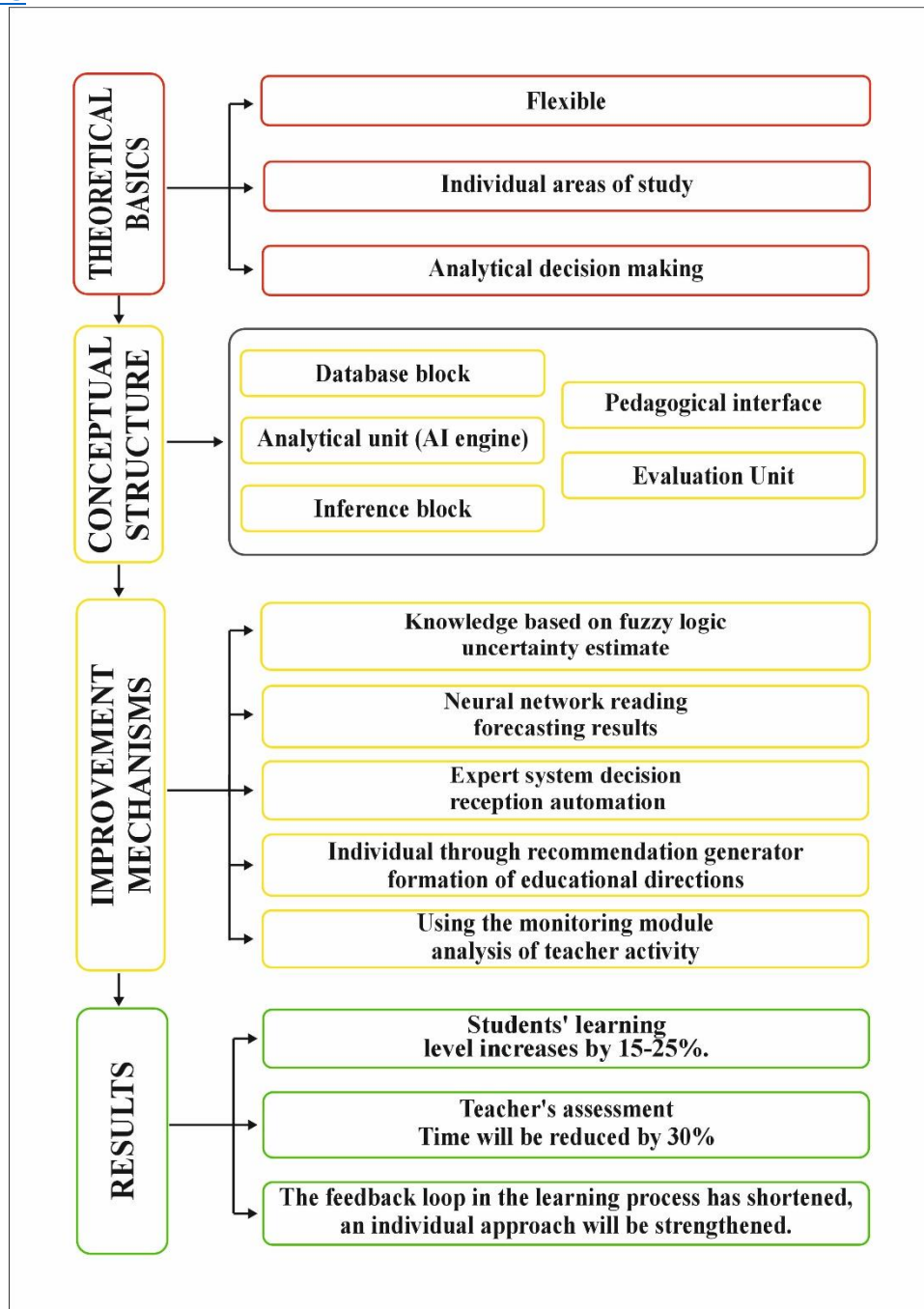


Figure 1. Improved pedagogical model based on artificial intelligence technologies

Research methodology: includes a comprehensive approach aimed at scientific analysis, design, modeling, and practical testing of the process of improving the pedagogical model based on artificial intelligence technologies. This methodology, developed on the basis of the mutual integration of modern pedagogical and information technologies, makes it possible to intellectualize the educational process in a digital environment.

This study substantiates the theoretical and practical aspects of the application of artificial intelligence technologies - fuzzy logic, machine learning, neural networks, expert systems, and analytical modules - in the pedagogical process. Also, the mechanisms of information processing, analysis, and management at each stage of the educational process are modeled using scientific approaches.

Theoretical foundations of improving the pedagogical model. The theoretical foundations for improving the pedagogical model are based on reviewing the content, structure, and management mechanisms of the educational process based on scientific approaches and integrating it with modern information and communication technologies and artificial intelligence [3], [9]. This process stems from the need to organize education based on personality-oriented, flexible, and intellectual systems.

First of all, the pedagogical model is a system that expresses the interrelationship between the components of the educational process: goal, content, method, means, and result. The theory of its improvement is aimed at managing education, modeling the process of knowledge acquisition, and analyzing the cognitive development of students.

Making the learning process flexible is the process of adapting the education system to the individual needs, abilities, level of preparedness, and learning pace of students [6].

The theoretical basis for making the learning process flexible is based on the principles of a personality-oriented and differentiated approach. With the help of artificial intelligence technologies, it is possible to organize this process more effectively. For example, a pedagogical model built on fuzzy logic or neural networks automatically analyzes the student's level of mastery and recommends corresponding tasks, tests, or educational material [4].

The formation of individual educational directions corresponding to the needs of the student is an approach aimed at adapting the educational process to the level of knowledge, interests, needs, and development prospects of each student.

The theoretical basis of this approach is based on the principles of personality-oriented education and adaptive pedagogy. Its essence lies in the fact that the learning process is organized not on the basis of an identical approach to all students, but on the basis of the individual cognitive capabilities and speed of assimilation of each student.

Allowing the teacher to make analytical decisions is one of the most important advantages of the pedagogical model based on artificial intelligence technologies. This approach allows the teacher to deeply analyze information about the educational process, accurately assess the level of students' knowledge and the dynamics of their assimilation, and make informed effective pedagogical decisions.

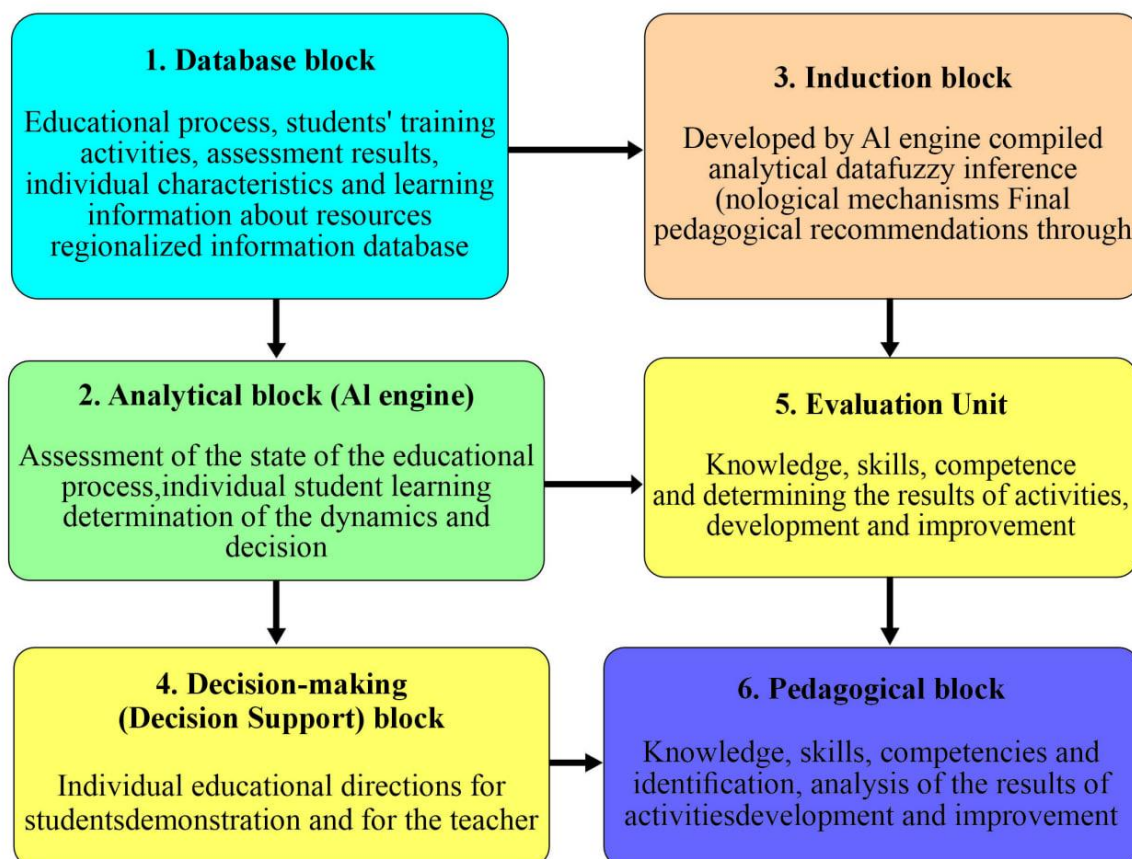
The intelligent learning system collects data on student activity, test results, participation, and development trends in real time and processes them through analytical modules. As a result of this process, the teacher will have the following opportunities:

- Identify the student's weaknesses and strengths in assimilation;
- Individual adaptation of the curriculum;
- Ensuring an objective approach to assessment and incentives;
- Making decisions based on forecasting and preliminary analysis of learning outcomes to do.

Artificial intelligence systems (e.g., fuzzy logic, data analysis, neural

networks) allow the teacher to make evidence-based decisions while minimizing the influence of the human factor. This increases the effectiveness of managing the educational process, scientifically supports the professional activity of the teacher.

Conceptual structure of the improved pedagogical model. The conceptual structure of the improved pedagogical model is formed on the basis of a multi-level systematic approach, combining the content, technology, and management systems of the educational process in a single intellectual environment. Its main goal is to organize the educational process in a digital, flexible, analytical, and personality-oriented way.



The database block is the main information core of the improved pedagogical model, serving for the collection, storage, processing, and analysis of information generated at all stages of the educational process. This block ensures the stable operation of the intelligent system, the accuracy and continuous updating of data.

The purpose of the block: creation of an integrated information base on the educational process, students' learning activities, assessment results, individual characteristics, and educational resources, as well as the formation of input data necessary for the operation of artificial intelligence algorithms.

Main components:

1. Student database - stores students' personal information, knowledge level, academic history, and activity indicators.
2. Educational resource base - a collection of textbooks, tests, assignments, multimedia materials, and interactive modules.

3. Assessment results base - intermediate, current, and final grades of students, analysis results, and statistical indicators.
4. Database of experimental and analytical data - a set of experimental and analytical data assessing the effectiveness of the educational process.
5. The rule and algorithm base includes fuzzy rules, decision-making models, and inference mechanisms necessary for an artificial intelligence system.

Functions of the block:

- Data collection and structural organization;
- Indexing information by categories and ensuring prompt search;
- Support the decision-making process by transferring data to the analysis unit;
- Formation of analytical reports in real time for teachers and system users;
- Ensuring data security, integrity, and confidentiality.

The analytical block (AI engine) is the central mental (intellectual) component of the improved pedagogical model, which ensures the processing, analysis of information collected in the database, and the development of well-founded pedagogical decisions. This block operates as a management mechanism based on artificial intelligence technologies and serves to organize the learning process in a flexible, personality-oriented, and result-oriented manner.

Main functions:

1. Analysis of information obtained from the database based on fuzzy logic, neural networks, and machine learning algorithms.
2. Assessment of students' level of mastery, activity indicators, and development trends through mathematical modeling.
3. Formation of an individual educational direction for each student using a recommendation system.
4. Providing the teacher with analytical reporting and visual analysis results in real time.
5. Support for the possibility of automatic processing of information generated in the system and self-learning.

The inference block is the central part of the improved pedagogical model, which makes logical decisions and forms conclusions, and forms final pedagogical recommendations, assessments, and decisions based on analytical data developed by the AI engine (analytical block) through fuzzy inference mechanisms.

The pedagogical interface is a block of the improved pedagogical model, responsible for communication and interaction with the user. It acts as an interactive, visual, and analytical management environment that ensures the exchange of information between the teacher, student, and intellectual system.

The evaluation block is the main component of the improved pedagogical model, serving to determine, analyze, and improve effectiveness, ensuring a scientific assessment of the effectiveness of the educational process, the level of assimilation of students' knowledge, and the overall performance of the pedagogical model.

Evaluation criteria:

1. Knowledge component - the level of theoretical and practical knowledge;

2. Skill component - the ability to apply it in practice;
3. Motivational component - activity of interest and participation in the educational process;
4. Creative component - the ability to think independently and innovate;
5. Communicative component - participation in collective work, communication culture.

Improvement mechanisms are a set of continuous development processes aimed at increasing the effectiveness of the pedagogical model, constantly updating the system, and adapting it to the needs of the user. These mechanisms ensure the self-renewal of the system based on artificial intelligence, analytical modules, feedback, and assessment results in the educational process.

Main mechanisms:

1. The mechanism of analytical improvement is the constant processing of data collected in the analytical block, measures are developed to identify and optimize shortcomings in the educational process based on statistical analysis. This process is automated using artificial intelligence algorithms.
2. Feedback mechanism - the system updates its recommendations based on feedback, assessments, and activity results provided by the student and teacher. Thus, the model adapts to real conditions and provides personality-oriented learning.
3. Flexible learning mechanism - the system automatically adapts educational materials depending on the individual needs of each student, the pace of assimilation, and the learning style. This process is based on the principles of adaptive learning.
4. Self-learning mechanism - Artificial intelligence modules independently improve their algorithms based on new data collected in the learning process. As a result, the predictive accuracy of the system and the quality of pedagogical recommendations increase.
5. Based on the results of the evaluation and analysis of the reconfiguration mechanism - the evaluation block, the model's performance indicators are determined. If shortcomings are identified, the system is algorithmically reconfigured, training modules are updated, and the recommendation system is improved.
6. Integrated improvement mechanism - the system is integrated with other digital educational platforms, online testing systems, or LMS (Learning Management System). This ensures the continuous operation of the learning process in the digital ecosystem.

Advantages. The improved pedagogical model, based on artificial intelligence technologies, allows for flexible, individual, and analytical management of the educational process. With the help of this model, the learning process is organized in accordance with the needs of the student, and the teacher makes decisions based on specific analyses. The assessment system is based on objective and numerical criteria, which reduces subjectivity related to the human factor. The model is constantly updated through self-improvement mechanisms and serves to improve the quality and effectiveness of education.

Result: As a result of the implementation of the improved pedagogical model, the educational process will become a scientifically based, flexible, and effective system. With the help of artificial intelligence technologies, interaction between the teacher and the student is strengthened, the assessment process becomes objective and transparent, and the trajectory of individual development of students is clearly defined. As a result, the quality of education increases, the teacher's analytical decision-making capabilities expand, and the entire educational process is improved based on digital, analytical, and innovative management.

Conclusion: The improved pedagogical model is a modern educational system that combines the principles of artificial intelligence technologies, analytical analysis, and flexible learning. This model serves to individualize the educational process, ensure objectivity in assessment, and increase the teacher's analytical decision-making potential. The mechanisms of self-renewal and improvement of the system ensure the continuous growth of the quality of education. Therefore, the introduction of an improved pedagogical model will bring the educational process to the stage of digital transformation and will serve as an important factor in the development of students' competencies and increasing effectiveness.

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