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EFFECTIVE COMPUTER MODELING IN EDUCATIONAL MANAGEMENT

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Abstract. *Mathematical modeling in education management is a modern innovative tool for increasing the efficiency of management of educational processes. It allows you to create quantitative models of real processes, predict the results of decisions and optimize management strategies.*

Mathematical modeling in education management is a relevant and important tool for optimizing management processes, increasing the efficiency of resource use, assessing the quality of education and predicting future changes. The use of these models helps authorities in the field of education, heads of educational institutions/institutions and projects to make more informed decisions that will contribute to the development of educational institutions and increase the quality of the provision of educational services.

The article presents the results of research on the effective use of mathematical modeling in educational management as a tool of innovative adaptive management. The specifics and peculiarities, advantages and challenges, typical cases of the application of mathematical modeling in educational management are studied. A taxonomy of applied problems and recommendations for effective implementation and further adaptive use of modeling in the management of educational institutions, organizations and projects have been developed.

Key words: *mathematical modelling, management, education*

Introduction.

The relevance and importance of the educational sector is determined by its key role in the development of society, the formation of human capital and ensuring economic growth. Education is a fundamental area that affects all other sectors of life, including science, technology, economy, culture and politics.

The importance of the educational sphere in the reformation of Ukraine is critical, since education acts as the basis for the development of human capital, which determines the country's potential in various spheres of social life, including economy, politics, science and culture. In the period of reforming the country, in particular after socio-political and economic crises, the role of education becomes key for stable and sustainable development [1].

The importance of improving and reforming the educational sector is determined by the needs of modern society, economic changes and global challenges. Education is a key tool for ensuring long-term development, social stability and innovation, so its constant renewal is a necessity for effective response to new conditions and challenges.

Educational management is a management system of educational institutions and processes aimed at ensuring effective functioning and development of education [2]. It covers planning, organization, control, management of resources, as well as making strategic decisions to achieve educational goals [3]. Educational management is a multifaceted field that includes management both at the level of individual educational institutions (schools, universities, colleges), and at the national or international levels.

Thus, innovations in educational management are a key factor in improving the quality of education and the effectiveness of management of educational institutions [4, 5]. Modern changes in the economy, technology, and society require educational institutions to quickly adapt and implement new management approaches that ensure sustainable development and competitiveness of educational services, especially in the post-pandemic period COVID-19 [6].

Considering the above, mathematical modeling in educational management is an important innovative tool for increasing the efficiency of management of educational institutions, optimizing resources and making informed decisions based on data analysis. This is an approach that uses mathematical, computer and statistical models to simulate and analyze various processes and phenomena in the field of education. Thanks to modeling, it is possible not only to improve management processes [7], but also to provide an innovative approach to the development of the educational system.

Main text.

Mathematical models in educational management help managers analyze the current situation in educational institutions, assess risks, develop strategies to achieve better results and make informed decisions.

1. Basics of modeling in educational management.

Modeling in educational management involves the creation of abstract models that reflect real processes occurring in educational management systems. This allows you to analyze the interaction of various factors and make effective management decisions.

1.1. Types of models in educational management.

- Simulation models: Simulate real processes in order to study their dynamics and behavior in different conditions. They allow you to "play" scenarios to test the effectiveness of management decisions.

- Optimization models: Help to find optimal management strategies taking into account available resources and limitations [8, 9, 10]. The author's example of evolutionary calculations for solving the the optimization problem of compiling the training load and training schedule is shown in Figure 2.

- Economic and mathematical models: Used to optimize financial and material resources in the education system [11, 12, 13].

- Analytical models: Used to predict results based on available data and trends. They help to assess the likely consequences of implementing new policies or changes in the governance structure (example of trained descriptive cluster model is presented on Figure. 1 below).

1.2. Key elements of modeling.

- Input data: Information about the current state of the educational institution, resources, personnel qualifications, student performance, etc. In modern conditions, this is, as a rule, incoming Big Data [14, 15, 16, 17].

- Algorithms and advanced, intelligent methods of analysis and analytics: Used to process input data and predict possible results [18, 19].

- Scenarios: Different options for the development of events, which allow you to compare the results when certain parameters are changed.

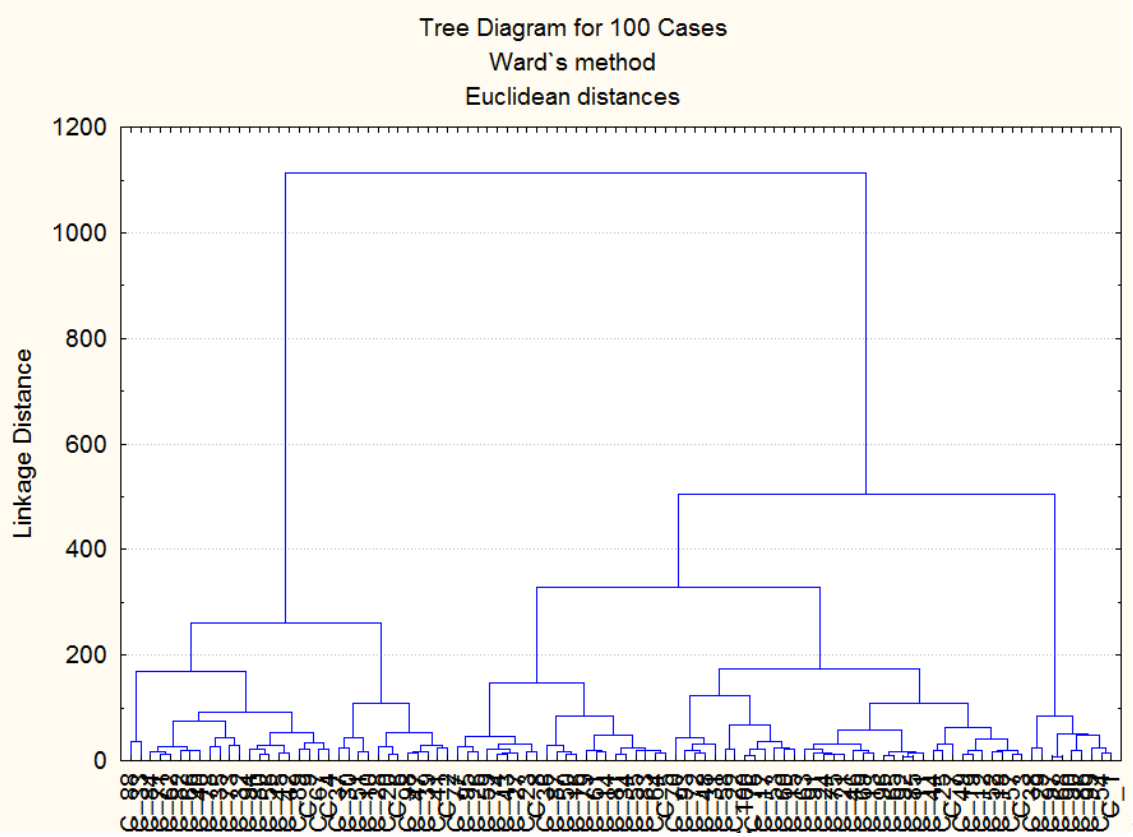

Figure 1 - Example of trained analytical descriptive model (hierarchical cluster analysis of educational service recipients and of the results of their preliminary testing)

A source: Developed by authors

2. Modeling as a decision-making tool in educational management.

The models allow analyzing both individual aspects of the activity of an educational institution and the entire complex of interrelated processes. With the help of such models, managers can evaluate the influence of various factors on the effectiveness of the educational process and management activities.

2.1. Resource management.

- Financial modeling: Allows you to allocate budgets to different programs and assess the financial consequences of changes in the funding strategy.

- Modeling of staffing needs: Models can predict the needs of teaching staff depending on the number of students or changes in educational programs.

2.2. Optimization of educational processes.

- Analyzing student/student/graduate student performance: Creating models to predict performance based on various factors, such as social status, level of training, availability of resources, etc.

- Curriculum Modeling: Allows you to evaluate the effectiveness of different curriculum options and programs to maximize learning outcomes.

3. Examples of the use of modeling in educational management.

3.1 Simulation modeling for forecasting the demand for education:

- Task: Forecasting the number of applicants based on demographic data, changes in politics and economic conditions.

- Model: Using a simulation model to estimate how changes in government policy or the labor market will affect the demand for certain specialties or levels of education.

3.2. Modeling for making decisions about personnel changes.

- Task: Assessment of the impact of optimizing the number of teachers on the quality of education and financial results.

- Model: The economic-mathematical model allows you to determine the optimal number of teachers, which corresponds to the budget and maintains a high level of education quality.

4. Advantages and challenges of modeling in educational management.

4.1. Advantages:

- Improving management efficiency: Models help managers of educational institutions to optimize resources and improve the quality of management decisions.

- Forecasting consequences: Using models allows you to predict the consequences of various decisions, which reduces risks.

- Adaptability: Modeling can be adapted to solve both strategic and tactical problems in the education system.

4.2. Challenges:

- Data quality: Building accurate models requires high-quality and reliable data. Insufficient or inaccurate data can lead to erroneous conclusions [20, 21].

- Complexity of modeling [22, 23]: Creating models that adequately reflect the complexity of educational systems requires special knowledge in the field of mathematical modeling and education.

- Implementation problems [24]: Despite the effectiveness of the models, their integration into educational management practice may face resistance due to the need for changes in processes and approaches.

5. Below we will analyze in detail and systematically the main aspects of the use of mathematical modeling in the field of educational management and offer their taxonomy.

5.1. Optimization of resources.

Mathematical models can be used to optimize the allocation of financial, human and material resources in educational institutions. For example, with the help of linear programming models, it is possible to optimize the schedule of classes or the allocation of the budget for various educational needs.

5.1.1. Models of linear programming.

Linear programming allows you to find the optimal solution that maximizes or minimizes a certain function (for example, minimizing costs or maximizing the use of resources) taking into account constraints (financial, time, personnel).

5.1.2. Personnel management models.

Modeling helps managers of educational institutions effectively plan the work schedule of staff, distribute the workload among teachers and employees, which ensures optimal operation of the institution.

5.2. Prediction of results.

Forecasting is an important component of educational management, and mathematical models help predict future trends in educational institutions, such as enrollment numbers, student performance, or changes in the labor market. The example of trained predictive ANN model is presented on Figure. 2.

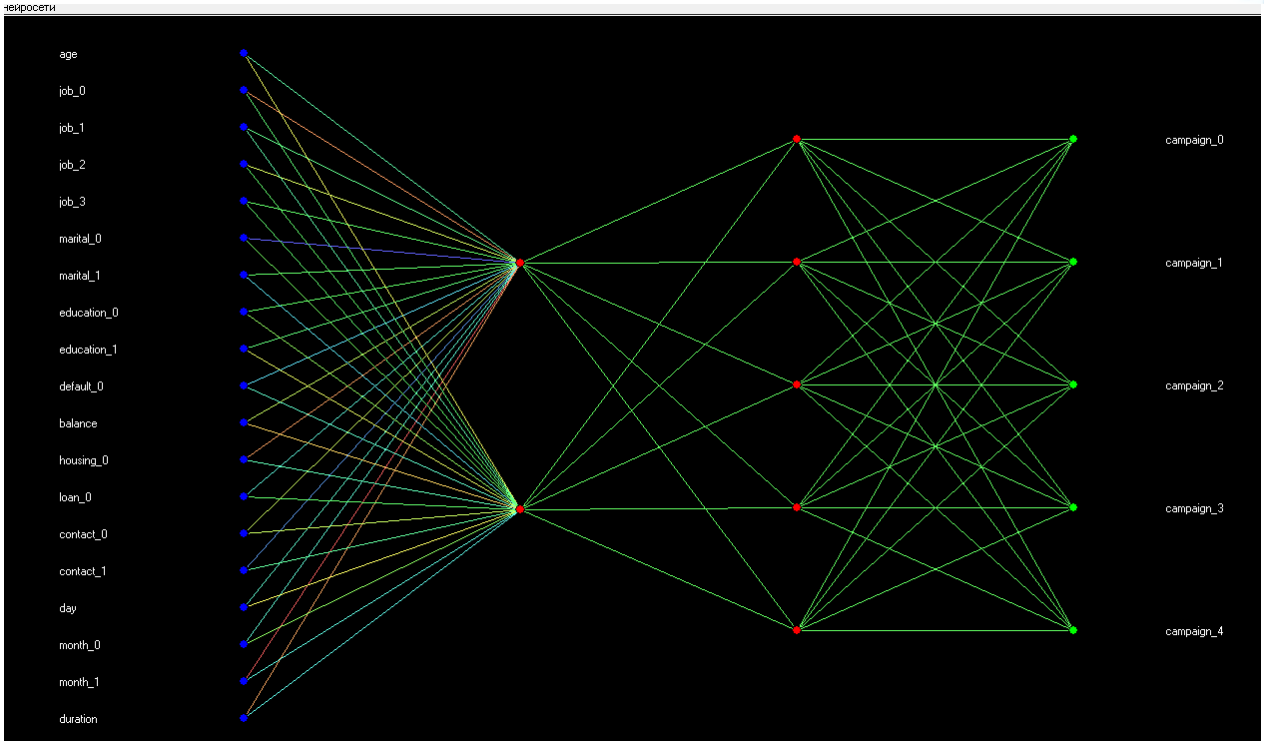

Figure 2 - Example of trained predictive ANN model for personalizing of marketing companies of four developed educational programs among potential consumers of second higher education

A source: Developed by authors

5.2.1. Statistical models.

Statistical methods, such as regression analysis, make it possible to predict the academic performance of students based on previous data, which allows for better planning of the educational process and student support.

5.2.2. Models for forecasting demographic changes.

With the help of demographic models, it is possible to predict changes in the number of students in connection with changes in the population or socio-economic conditions, which allows you to better prepare for challenges in planning educational programs and infrastructure.

5.3. Evaluation of the effectiveness of educational programs.

Mathematical modeling is used to evaluate the effectiveness of educational programs, develop quality indicators, and monitor learning outcomes.

5.3.1. Performance analysis models.

Correlation analysis models make it possible to assess the relationship between various factors (for example, teaching methods and student results) and the effectiveness of educational programs.

5.3.2. Models for evaluating the quality of teaching.

Methods of multivariate analysis can be used to evaluate the quality of teaching based on feedback from students, success and other factors that affect the overall productivity of teaching activities.

5.4. Modeling of management processes.

Models of management processes allow describing the interaction of various elements of the educational system, predicting their behavior and finding optimal ways of management.

5.4.1. Dynamic models.

Dynamic models are used to simulate processes that develop over time, such as changes in the level of knowledge of students or the development of professional competence of teachers.

5.4.2. Simulation modeling.

Simulation models allow you to reproduce the functioning of an educational institution in the conditions of various scenarios. This helps determine how key indicators (such as student success or faculty employment) will change depending on different management decisions.

5.5. Risk management.

Mathematical models can also be used for risk management in educational institutions. This includes modeling possible scenarios and determining strategies to minimize negative consequences. The author's example of using the Apriori algorithm of association rule search (in the Unexpected Regularities search mode) for risk management of educational services is shown in Fig. 3.

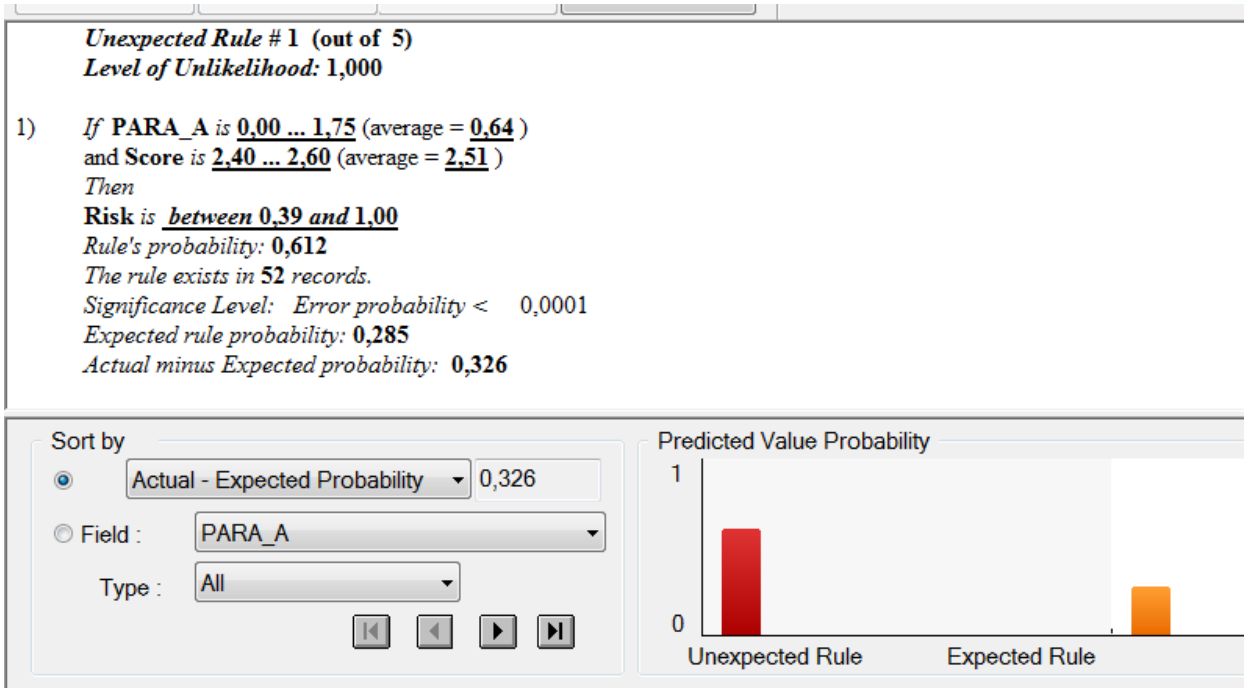

Figure 3 - Example of using the Apriori algorithm of association rule search (in the Unexpected Regularities search mode) for risk management of educational services

A source: Developed by authors

5.5.1. Sensitivity analysis.

Sensitivity analysis models help determine how changing one or more parameters will affect the overall results. This allows the administration to better prepare for unforeseen situations.

5.5.2. Scenario modeling.

The use of scenario modeling allows you to develop different options for the development of events and plan appropriate measures to reduce risks (for example, in case of financial instability or demographic changes).

5.6. Planning the development of educational institutions.

Mathematical modeling models can help in long-term planning of the development of educational institutions, development of strategic plans and evaluation of their effectiveness.

5.6.1. Models of strategic planning.

Mathematical modeling is used for planning the expansion or modernization of educational institutions, forecasting the need for new personnel, equipment and financing.

5.6.2. Models for infrastructure assessment.

Infrastructure planning models help to optimize the use of resources, develop a plan for the construction or modernization of premises, taking into account the growth in the number of students and teachers.

Summary and conclusions.

Education is a critically important element in the process of reforming Ukraine. It not only forms highly qualified personnel and supports economic development, but also contributes to the democratization of society, ensuring social equality and integration of Ukraine into the world community. Reforming the education system is the basis for creating a modern, prosperous and stable state capable of adapting to the challenges of globalization and changes in the world economy

The authors claim that the relevance and importance of education as a field lies in its decisive influence on all aspects of the development of society and the economy. Education is the basis for the formation of human capital, promotes technological innovation and social change, ensures sustainable economic development and national security. In today's world, investing in education is investing in the future, which allows us to adapt to the challenges and opportunities of a globalized society.

The authors confirm that improvement and reform of the educational sector are necessary in order for the education system to meet the modern challenges and needs of society. The reforms should ensure the quality of education, equal access to it, training of qualified personnel for the modern economy, as well as stimulate innovation and social mobility. Investing in education is an investment in the future that has a long-term impact on economic development, technological advancement, and societal well-being.

Taking into account the above in the main part of this publication, it is clear that management in the field of education is a complex management system that includes

planning, organization, resource management and decision-making aimed at achieving high quality educational services. Given the constant changes in society and technological progress, educational management requires adaptability, innovative thinking and active participation of all interested parties in the process of development of educational institutions.

Thus, it is substantiated that innovations in educational management are an important tool for ensuring the competitiveness of educational institutions, improving the quality of education and adapting to modern challenges. The introduction of digital technologies, an adaptive approach to management, the development of leadership and inclusiveness, as well as strategic planning are key directions for successful reform and development of the education sector.

This article presents the results of research on the effective use of mathematical modeling in educational management as a tool of innovative adaptive management, in particular: the specifics and features, advantages and challenges, typical cases of the use of mathematical modeling in educational management are investigated; developed a taxonomy of applied problems and recommendations for effective implementation and further adaptive use of modeling in the management of educational institutions, organizations and projects.

It has been proven that mathematical modeling in educational management is a powerful innovative tool for increasing the efficiency of management of educational institutions. It allows not only to better understand the current state of the system, but also to forecast its future development and the potential consequences of management decisions. Thanks to simulation, educational institutions can optimize the use of resources, improve educational processes and improve the quality of educational services.

Discussion.

As a prospective direction of their future research, the authors actualize the following debatable thesis: deep machine learning in education management is also a necessary innovative method that can improve the processes of operational management of educational institutions, optimize the current work of the education

system, and contribute to improving the quality and systematicity of education. Deep Learning is a subset of machine learning that uses neural networks with many layers to process and analyze large amounts of data [25, 26]. Deep machine learning offers wide opportunities for managing education, improving its quality and efficiency. It can be used to analyze big data, automate processes, personalize learning, evaluate teaching quality, make strategic decisions, and predict the results of educational reforms. The use of these innovative technologies will contribute to the modernization of the educational system, its adaptation to modern challenges and ensuring the competitiveness of graduates in the global labor market.

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