

## MATHEMATICAL MODELING AS A MEANS OF CONTROL AND EVALUATION OF THE QUALITY OF THE EDUCATIONAL PROCESS

Currently, the competitiveness of a specialist depends on the quality of the educational process in a higher education institution. In the field of higher education management, the basic principles of international standards and recommendations for quality assurance in the European space should be taken into account. These basic documents emphasize the need to organize an educational process control system to ensure its quality in higher education.

Amendments to the Law on Higher Education make it necessary to adapt the learning process to the needs of social-economical development. The empowerment of higher education institutions as a result of their autonomy in creating the concept of teaching and all the aspects of its implementation, provided the basic requirements of the law are met, also stimulate creative efforts aimed at improving the quality and efficiency of education.

The most important area of academic research is the construction and research of mathematical models that describe the different aspects of the educational process. Different mathematical apparatus can be used to construct models: queuing theory, linear, nonlinear, and dynamic programming.

Pedagogical research involves obtaining some quantitative and qualitative results, to varying degrees, characterizing the educational process. As the output data are the results of measuring the individual parameters of the educational process.

From the completeness and objectivity of the initial data depends on the reliability of the results of the conducted research. Obtained by a single method as a result of passive or active pedagogical experiments, the data can serve as a source of information for the construction of mathematical models that relate to any level of hierarchy: university - faculty - department - discipline.

The ranking of higher education institutions on the basis of many indicators aims to compare universities with each other. In this case, groups of single-profile higher education institutions are evaluated, and there are such criteria values that play a stimulating role. To determine the criterion values it is necessary to have a sufficiently wide statistical base.

Currently, the collected data are analyzed, as a rule, by heuristic methods, which in general allows purposeful improvement of the educational process.

At the same time, it is advisable to supplement the existing system of analysis of the collected data by creating a set of mutually agreed mathematical models that describe the individual aspects of the educational process and allow to obtain objective information with a given degree of certainty about the influence of individual factors and to predict their impact on the efficiency and quality of the educational process. It is advisable to develop such a set of models, at least at two levels: discipline and department. The results of the simulation, together with the data that were not used in the simulation, are generalized and based on the recommendations for improving the educational process are made.

Let the current state of the learning process be determined by a set of  $m$  numbers:  $d_1, d_2, d_3, \dots, d_m$ . This set is conveniently presented as a vector

$$D = \begin{pmatrix} d_1 \\ d_2 \\ \dots \\ d_m \end{pmatrix} \in \mathbb{R}^m.$$

Many of the components of a vector of the current state  $D$  are difficult, and sometimes simply impossible, to determine at a particular point in time.

The mathematical model of the description involves the formation for practical use of a set of measured data  $Y \in \mathbb{R}^m$ , the values of which are assumed available to researchers at a selected point in time.

When managing the quality of the learning process, you can consider as components of the vector  $Y$  as some of the observed components of the vector  $D$ , and functions from one or more components of the vector  $D$ , and the values of the observed values can be determined not only by the current state variables, but also by their previous values

Examples of observable values are the current estimates of a particular student or the average score for a group, or the average score of a student or group for the entire period of study.

If we denote by  $D_t(\cdot)$  – the trajectory in the state space of a given system from initial state  $D_0$  to the current state  $D_t$ ,  $Y_t$  – the current state of the

observation vector,  $W_t$  - unknown external factors, then the mathematical model for determining the current observations takes the form:

$$Y_t = G_t(Z_t(\cdot), W_t)$$

where  $G_t(\cdot, \cdot)$  is some function of trajectory and unknown external factors, which may still depend on time. Assessment of the quality of decision making involves the introduction of quantitative characteristics that are determined by the learning process.

It can be a binary value of type "Yes – No", characterizing the chosen management strategy as good or bad.

In general, quality assessment can be multi-criteria and more variant:

$$\Phi(D_t(\cdot), U_t(\cdot)) = \begin{pmatrix} \Phi_1(D_t(\cdot), U_t(\cdot)) \\ \Phi_2(D_t(\cdot), U_t(\cdot)) \\ \vdots \\ \Phi_m(D_t(\cdot), U_t(\cdot)) \end{pmatrix} \in \mathbb{R}^n,$$

where  $U_t(\cdot)$  is the chosen management strategy,

$\Phi_i(D_t(\cdot), U_t(\cdot))$ ,  $i = 1, 2, K$ ,  $n$  functions - quality functionals.

The classification of indicators characterizing the quality of the educational process determines the classification of quality functionals.

For instance, the functional assessment of the contingent of university entrants. Let us denote  $X_1$  - the quality index of the educational process in the studied university, and  $Y_1$  - the quality index of the educational process in this university in comparison with the quality of the educational process with previous years  $q$ , then comparative estimates can be calculated as follows:

$$X_1 = \frac{N}{m} \sum_{k=1}^5 \frac{E_1^k}{\sum_j E_{1j}^k}, \quad Y_1 = \frac{q}{m} \sum_{k=1}^5 \frac{E_1^k}{\sum_i E_i^k},$$

where  $m$  - is the number of non-zero values  $E_1^k$ ,

$E_1^1$  - the proportion of applicants who have entered the university on preferential terms,

$E_1^2$  - the proportion of students who have completed secondary education with medals or honors degrees,

$E_1^3$  - the proportion of entrants who were enrolled in an educational institution as a result of external testing,

$E_1^4$  - average number of students enrolled in preparatory courses,

$E_1^5$  - number of schools, lyceums, colleges that have cooperation agreements with the university.

If  $X_1 > 1$ ,  $Y_1 > 1$ , then the excess of the level of potential of university entrants is above the average level of a set of one-profile universities and above the average value of this indicator in recent years  $q$  in the university where the research is conducted.

Controlling the quality of the educational process is a significant enough step in Ukraine's move to the European as well as the world's educational market. Ukraine's education system is virtually indistinguishable from the multi-level education systems of the leading countries of the world, and includes all its branches: from pre-school education to postgraduate studies and a system of continuous staffing.

That is why the problem of quality control of education in the direction of its improvement, improvement is one of the most important issues today.

Quality control of the provision of educational services can be divided into two areas: external control and internal control.

External control should include all means of control by the state: programs, industry standards that form the requirements for training, the availability of licensing programs, control by the Ministry of Education, certification and certification of universities, and more. It is worth noting that such control is an integral and very important part of education.

The process of forming an evaluation of the internal quality control of the educational process by the higher education institutions requires considerable attention. This makes it possible to identify weaknesses on their own and to examine and diagnose them for the purpose of further adjustment, which is confirmed in the documents of the Bologna System of Education, which states that, in accordance with the principles of autonomy, responsibility for the quality of higher education is a matter for each university separately.

The considered structure of the research will allow to make more informed decisions on improvement of educational process at all levels, that will provide purposeful accounting of change of factors, in particular, connected with transition to studying of new achievements of science and will reduce the influence of decisions which do not contribute to the increase of efficiency and quality of educational process.

## References

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