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MODELS OF EDUCATION QUALITY ESTIMATION BASED ON FUZZY CLASSIFICATION

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Abstract. The article considers the use of intelligent technologies in the educational process. The estimation of education quality model is based on fuzzy logic.

Keywords: education; quality; estimation.

INTRODUCTION

The issue with quality of personnel training at universities was introduced at time of transition to market relations by the following reasons: deficit of graduates, lack of professionals able to work under market relations, high demand of specialists by consumers, decreased motivation to mastery of technical knowledge and the acquisition of the engineering profession, the reduction of state budget financing of educational and research activities, etc.

In the framework of the Bologna process in according with the principles of autonomy of educational institutions, the responsibility for providing quality of vocational education rests on the educational institutions themselves Therefore, research in the field of management of educational process in high school are also associated with problems of improving the quality and competitiveness of education. Evaluating the quality of education devoted to the works of the following foreign and Russian researchers: R. Barnett, P. Jacobsson, D. F. Westerheijden, V. S. Avanesov, V. I. Baydenko, M. B. Guzairov, N. A. Selezneva, A. I. Subetto, M. P. Karpenko, etc. In order to improve the quality of education being developed and introduced innovative new educational programs, standards and techniques to meet the requirements of potential employers and professional educational needs of the student. The quality of education is characterized by a variety of quantitative and qualitative parameters. Application for assessment of the quality characteristics determines the use of intelligent technologies for processing.

This article discusses approaches to estimation the quality of higher education, methodological and information support of decision support in estimation the quality of education, based on fuzzy logic. This article is a logical continuation of the following works [1–6].

APPROACHES TO ESTIMATION THE QUALITY OF HIGHER EDUCATION

Considering the life cycle of a specialist, the following checkpoints: the decision to start training of specialists, completion of the organizational preparation with the development of regulatory documents, identification of necessary resources and educational technology, set of entrants and the beginning of training, control of the implementation of the educational route and its adjustment to the graduates the labor market with an estimate of the quality of training and appropriate regulatory documentation improvements, educational technology, resources. In this case, the quality of education could be considered as a special process towards a positive result on the "exit", the process of improvement in the educational process; consistency with the objectives that represents executing queries, requirements and expectations of customers, the transformation, indicating the changes to be improved, providing opportunities for students.

The trend of providing greater autonomy to educational institutions in many countries associated with the development of internal and external quality estimation system. European standards and guidelines for internal and external quality guarantee in higher education include characteristics relating to quality: students' progress and performance level, the demand for graduates in the labor market; student satisfaction training programs, the effectiveness of teaching, the student body and its analysis, the available training resources and their cost, the main indicators of activity of the institution [7–9].

In the construction of national and regional systems estimation quality of education the basic principle advocates a combination of internal and external estimations quality of education. These systems are based on the following main components

of the educational process: learners (students), training (teachers), the content of education (educational and methodical literature), and resource support (organizational, logistical, informational and financial) [10].

DESCRIPTION OF MODEL

The implementation of the proposed method requires expert support, since the analyzed information flows have a lot of quantitative and qualitative parameters, which are need to be estimated.

The experts identify simple indices which are specific to the educational process, and with the help of linguistic data analysis assess them. Then needs to be defined the weight of simple indices. They help to determine weight of complex quality indices. Estimation of complex indices are similar to estimation of simple indices.

The result of the application of this method is to obtain the values of integrated index of education quality. These calculations are transferred to the decision maker for further analysis and processing. The final stage of the model will be the decision how to change and improve the educational process.

Structural diagram model of estimation is shown in Fig. 1.

Feature of the proposed method is to allow experts to make a classification of simple and complex indices [11].

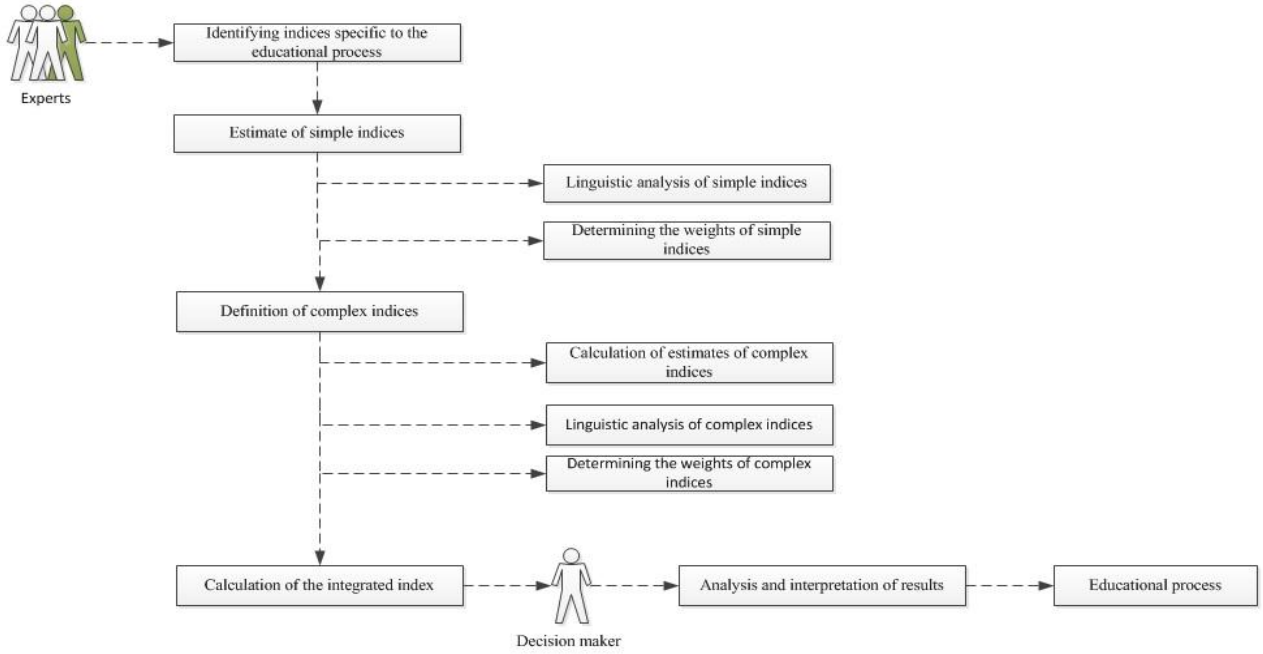

Fig. 1. The model structure for decision support in estimation the quality of education

MODEL EVALUATION QUALITY OF EDUCATION. STATEMENT OF THE PROBLEM

Consider the following designations:

1) Each specialty is characterized by a set of complex quality indices:

$$Y_n = (Y_1,...,Y_n), \quad (1)$$

where n is a quantity of complex quality indices.

The complex index are characterized by a set of simple indices:

$$X^{Y_n} = \left(x_1,...,x_g\right), \quad (2)$$

where g is a quantity of simple indices in the complex index.

2) R is a weight vector of simple indices X^Y:

$$R = \left(r_1, r_2,..., r_j,..., r_k\right), \quad (3)$$

Weight r_j represents the position and the level of significance of a simple index $x_j^{Y_i}$ in the associated complex index Y_i.

The estimation of indices Y_i are carried out using the function $f^*(X,R)$, which defines the order of the conjunction of simple indices (X^{Y_i}) considering their weight (R).

3) W is a weight vector of complex indices Y_n

$$W = (w_1, w_2, ..., w_i, ..., w_n), \quad (4)$$

Weight w_i represents the position and the level of significance of a complex index Y_i in the integrated index Q_{edu}.

Q_{edu}.= f (Y, W) is integrated index of education quality, where f is a function that specifies the order of the conjunction of complex indices (Y_i) to the integrated index considering their weight (W).

Thus with considered designations and reasoning is required:

- To determine the complex indices using the conjunction $f^*(X, R)$.
- To determine the integrated index of education quality using the conjunction f (Y, W).

METHOD OF RESEARCH

Let's consider g is a quantity of simple indices $x_j \in X$, characterizing the index $Y_i \in Y$. Linguistic analysis of simple indices is carried out on the basis of Table 1. In table λ_{jl} is equal to 1 if an expert supposes that it is the current level of simple index, and 0 in all other cases [12].

Table 1

Linguistic analysis of simple indices

X_g	The level of simple index				
	Very low	Low	Average	High	Very high
x_1	λ_{11}	λ_{12}	λ_{13}	λ_{14}	λ_{15}
x_2	λ_{21}	λ_{22}	λ_{23}	λ_{24}	λ_{25}
…	…	…	…	…	…
x_g	λ_{g1}	λ_{g2}	λ_{g3}	λ_{g4}	λ_{g5}

Determining the weights of simple indices is carried out with the use of one of three methods. If all indices are equal to each other – the method of equal significance is used. If indices may be ranked in descending order – the Fishburne's method is used. In other cases indices are compared in pairs using Saaty's method [14] (Fig. 2).

The values of complex indices are determined by the formula:

$$Y_i = \sum_{i=1}^{s} u_i \sum_{j=1}^{g} r_j \lambda_{jl}, \quad (5)$$

where $i = 1,...m$; $u_1 = 0{,}1$, $u_2 = 0{,}3$, $u_3 = 0{,}5$, $u_4 = 0{,}7$, $u_5 = 0{,}9$.

Recognition of the level of complex index is carried out on the basis of constructed fuzzy five-level classifier, shown in Fig. 3.

The degree of estimation confidence in this case is calculated according to Table 2.

The weights of the complex indices for further estimation are defined similarly to the weights of simple indices.

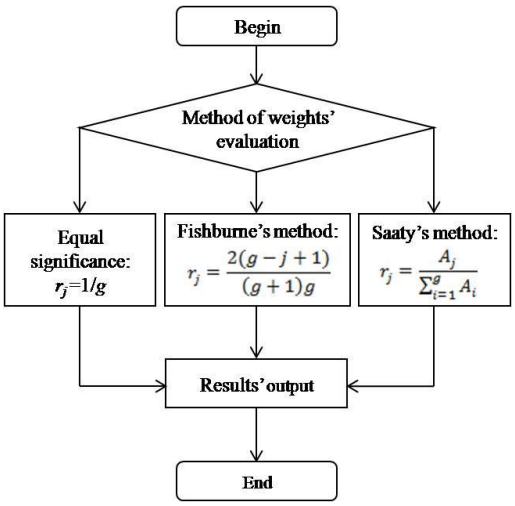

Fig. 2. Determination of the weights of simple indices

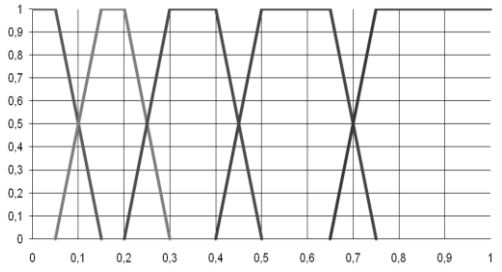

Fig. 3. Fuzzy classifier for complex indices and integrated index of education quality

Table 2

Recognition of the level of complex indices

Range of values	Classification of level of quality indices	Membership function
$0 \le Y_i \le 0.05$	Very low	1
$0.05 < Y_i < 0.15$	Very low	$\mu_1 = 10\,(0.15 - Y_i)$
	Low	$1 - \mu_1 = \mu_2$
$0.15 \le Y_i \le 0.2$	Low	1
$0.2 < Y_i < 0.3$	Low	$\mu_2 = 10\,(0.3 - Y_i)$
	Average	$1 - \mu_2 = \mu_3$
$0.3 \le Y_i \le 0.4$	Average	1
$0.4 < Y_i < 0.5$	Average	$\mu_3 = 10\,(0.5 - Y_i)$
	High	$1 - \mu_3 = \mu_4$
$0.5 \le Y_i \le 0.65$	High	1
$0.65 < Y_i < 0.75$	High	$\mu_4 = 10\,(0.75 - Y_i)$
	Very high	$1 - \mu_4 = \mu_5$
$0.75 \le Y_i \le 1.0$	Very high	1

Further, the intermediate coefficients Z_k and the integrated index Q_{edu} are calculated

$$Z_k = \sum_{i=1}^{N} w_{ik} \mu_{ki} \le 1, \quad (6)$$

where $\mu_{ki} \in [0,1]$ is the value of membership function of the i-th complex index to level k.

The integrated index of education quality is calculated with the use of the following formula:

$$Q_{\text{edu}} = 0{,}075\, Z_1 + 0{,}3\, Z_2 + \\ + 0{,}5\, Z_3 + 0{,}7\, Z_4 + 0{,}925\, Z_5. \quad (7)$$

The linguistic classification of the integrated index of education quality level is similar to the classification of the level of complex indices [14].

CONCLUSION

The article has proposed a method for estimating the quality of education based on of intelligent technologies.

The authors explain need for the participation of the expert committee in estimating the quality of education, since the estimated parameters are both quantitative and qualitative.

The data obtained during the application of a technique will allow decision makers to agree on introducing adjustments to the educational process and the improvement of educational programs.

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