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ALGORITHM FOR QUALITY ASSURANCE OF STUDENT LEARNING WITH A LACK OF INFORMATION

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Abstract

The article is devoted to assessing the quality of student learning at the university. At the present time the number of students receiving distance learning is increasing. There are experts believe that with distance learning the quality of education decreases. Therefore, it is important both to assess the quality of education and to improve the quality of student learning, both in full-time study and in distance learning. To solve this problem, it is necessary to develop algorithms for assessing the quality of student learning. When developing such algorithms, difficulties arise, in particular, due to the fact that information about the knowledge, skills and abilities of students is not complete, distorted, and contradictory. Therefore, an algorithm for assessing the quality of student learning with a lack of information is proposed. Based on this algorithm a program was written in PascalABC.NET for a cluster of high-performance parallel computing. Calculations on parallel computing systems can reduce the computational time by almost half. Various indicators have been used to characterize teachers, students and means of education. Based on these indicators, the following factors were determined: the quality of teachers, the quality of students and the quality of means of education. Based on the factors, the quality of education is determined. A modification of this algorithm was developed. The algorithm allows us to estimate by what values the input parameters should be changed in order to achieve a given level of quality.

Keywords: Student learning, quality, algorithm, lack of information.

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1. Introduction

When studying the problem of assessing the quality of student learning, it is important both to assess the quality and give recommendations for its improvement (Guba, 2019; Guba et al., 2018). Experimental methods for assessing the quality of training encounter significant difficulties, caused mainly by a lack of information, material and time costs (Liu & Liu, 2017; Teeroovengadum et al., 2019). Therefore, along with experimental methods, it is desirable to use mathematical tools and build models for assessing the quality of training that would not require large material and time costs. The most important of the main methods for assessing the quality of training are expert methods (Abrahamyan, 2014, 2015; Fedorov & Abrahamyan, 2014). These methods are usually expensive and require relatively much time and money (Hsieh & Huisman, 2016; Tomusk, 2016). Therefore, it would be desirable to have a method that would quickly and efficiently carry out a preliminary assessment of the quality of student learning. After which it would be possible to refine the quality of training by more expensive methods in terms of time and resources.

2. Problem Statement

At present time an increasing number of students are switching to distance learning. The quality of education in distance learning is lower than in full-time study. Therefore, it is important both to assess the quality of training and to ensure the required quality of training, both in full-time study and in distance learning.

3. Research Questions

To solve the problem, it is necessary to develop an algorithm for assessing the quality of student learning with a lack of information, write a program that implements this algorithm, select the input parameters of the program, conduct calculations on a computer, and analyze the results.

4. Purpose of the Study

The purpose of the study is to build a mathematical model for assessing the quality of student learning and its implementation on a cluster of high-performance parallel computing, computer calculations and analysis of the results.

5. Research Methods

The main research method is mathematical modelling with the subsequent implementation of the algorithm on a computer in the form of a program written in PascalABC.NET.

The developed algorithm allows us to estimate the numerical values of the following factors:

- quality of teachers,
- quality of students,
- quality of means of education,

- quality of education

The algorithm includes the following items:

1. The formation of the names of indicators and factors,
2. The formation of numbers of indicators of determining factors,
3. The choice of the names of indicators, their numerical values and order relations between them,
4. The formation of factors determined by selected indicators,
5. The formation of order relations between indicators determining factors,
6. Determination of the numerical values of factors, their average values, dispersion and standard deviations,
7. Determination of the quality of education,
8. Output results,
9. If the result is not satisfied, then go to item 2. If the result is satisfied, then program shutdown.

6. Findings

The calculations were carried out for teachers, students and means of education (material support of the educational process) in the specialty "Computer Science".

The following indicators were selected with the following normalized values:

1. Physical health (0.8).
2. Social and mental health (0.5).
3. Pedagogical experience (0.6).
4. The presence of a degree (0.8).
5. Possession of basic competencies (0.6).
6. Possession of professional competencies (0.6).
7. Multimedia computer classes (0.5).
8. Textbooks (0.8).
9. Software (0.8).

We sort the selected indicators by importance: 6, 5, 8, 7, 9, 2, 1, 3, 4 and enter the order relation between themas follows:

- 6 is a bit more important than 5,
- 5 is more important than 8,
- 8 is more important than 7,
- 7 is a bit more important than 9,
- 9 is much more important than 2,
- 2 is more important than 1,
- 1 is much more important than 3,
- 3 is a bit more important than 4.

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This means that weights$P_6 >= P_5 > P_8 > P_7 >= P_9 >> P_2 > P_1 >> P_3 >= P_4$.

The calculations were carried out for the following factors:

Factor 1. “The quality of teachers” is determined by indicators with numbers: 1, 2, 3, 4, 5.

Factor 2. “The quality of students” is determined by indicators with numbers: 1, 2, 5, 6, 7, 8, 9.

Factor 3. “The quality of means of education” is determined by 7, 8, 9.

To calculate the numerical values of factors based on the numerical values of indicators, convolution is used, the essence of which is as follows.

Let there be a tree consisting of k+1 levels. At the zero level there is one indicator, and at the 1,2, 3, ..., k-th levels there is more than one indicator. Usually, as the level number increases, the number of indicators increases. Each of the indicators of the (n-1)-th level is determined by a finite set of indicators of the n-th level.

Consider the concept of convolution for the i-th indicator of the (n-1)-th level. Let N be a sufficiently large number. According to Khovanov (1986, 1996, 1998) one can take N=20. Then

$$P_1=0,\ P_2=1/N,\ P_3=2/N,\ ....\ ,\ P_{N+1}=N/N=1$$

are weighting coefficients for

$$f_i=P_1K_1+P_2K_2+\ ...\ +P_mK_m,$$

where K_j (j=1, ..., m) are the indicators, m is the number of indicators. The values of f_i are determined for i=1, ..., F. If the index K_a is approximately the same or slightly more important than the indicator K_b, then this means that $P_a>=P_b$. If the indicator K_a is more important than the indicator K_b, then this means that $P_a>P_b$. If the index K_a is significantly more important than the index K_b, then this means that between P_a and P_b there is at least one P_c such that $P_a>P_c>P_b$. In addition, normalization conditions are assumed to be fulfilled

$$P_1+P_2+\ ...\ +P_m=1,$$

for i=1, ..., F (Bestugin et al., 2019; Kopyltsov, 2019).

Since for each indicator of the (n-1)-th level we get several f_i values, we can determine their average value f^* (convolution) dispersion and standard deviation, where N_0 is the number of f_j found (Kopyltsov et al., 2018; Novikova, 2019).

At the first stage, three indicators were convolved: the quality of teachers, the quality of students, and the quality of means of education. It is assumed that teachers are more important than students, and students are more important than means of education. Introducing the numerical values of the quality of teachers, the quality of students and the quality of means of education, it was found that the quality of education is 0.61.

As you can see, the parallelization of the computing process on a cluster of high-performance parallel computing can be done at the stages of calculating factors. We implemented this in PascalABC.NET by running three parallel workflows. Compared to sequential startup, the runtime during parallel start has been reduced by about half. If we choose more indicators or factors, then the time required for the calculations is required less.

A modification of the algorithm is considered. Suppose that at the initial moment of time the state of the educational process is characterized by indicators L_1, L_2, ..., L_m with values D_1, D_2, ..., D_m and the

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quality of training *D*. The expert wants to improve the quality of training so that the numerical value quality of education was in a certain neighbourhood *U* (*U-eps*, *U+eps*), where *U* is a certain number from the interval [0,1], *eps* is a small positive number. It is assumed that the expert has the means to correct the educational process, i.e. he can act by various means on indicators L_1, L_2, ..., L_m.

Then, by convolving the selected criteria L_1, L_2, ..., L_m, the expert receives value V for the quality of training. If V is in (*U-eps*, *U+eps*) then V is the desired one. Otherwise we take others values of the indicators. This process make on V is in (*U-eps*, *U+eps*). Thus, as a result, we have a set of indicators, upon convolution of which we obtain a set of values of the quality of training. The final decision is made by an expert. This algorithm permits to make a correction of the quality of training.

The calculations performed on a cluster of high-performance parallel computing showed the following. With the above values of indicators and order relations between them, the quality of training is 0.61. Suppose that an expert wants to raise the quality of training to 0.66. Then the indicators should change. Calculations performed on a computer showed that the closest values to 0.66, which is 0.661, are achieved with the following values of indicators: 0.8; 0.8; 0.6; 0.8; 0.8; 0.6; 0,0; 0.9; 0.9. Comparing the new values of indicators with the initial indicators, we can see that the values of indicators with numbers 1, 3, 4, 6 have not changed, and the values of indicators with numbers 2, 5, 7, 8, 9 have changed. This means that in order to improve the quality of education from 0.61 to 0.66, you need to change the value of the criterion "Social and mental health" from 0.5 to 0.8 (increase by 60%); the values of the criterion “Possession of basic competencies” change from 0.6 to 0.8 (increase by 33.3%); values of the criterion "Multimedia computer classes" from 0.5 to 0.9 (increase by 80%); values of the “Textbooks” criteria from 0.8 to 0.9 (increase by 12.5%); values of the “Software” criteria from 0.8 to 0.9 (increase by 12.5%).

This means that in order to improve the quality of education from 0.61 to 0.66, you need to increase the numerical values of the corresponding indicators, and to increase them you need material costs. Namely, to increase:

- indicator 2 (social and mental health), for example, it is necessary to develop sports and fitness complexes, improve the conditions of sanatorium-resort provision, etc.;
- indicator 5 (possession of basic competencies), for example, additional optional courses, elective courses, etc.;
- indicator 7 (multimedia computer classes) it is necessary, for example, to purchase modern equipment, computers, etc.;
- indicator (textbooks) is necessary, for example, to update the library fund, to acquire electronic textbooks, etc.;
- indicator 9 (software), for example, it is necessary to acquire modern licensed software, develop copyright programs, etc.

7. Conclusion

Thus, an algorithm has been built that allows us to assess the quality of teachers, the quality of students, the quality of means of education and the quality of education with a lack of information. This algorithm is implemented as a program written in PascalABC.NET and tested on a cluster of high-performance parallel computing. A modification of this algorithm has been developed that allows you to estimate the material costs that are necessary to improve the quality of training by a predetermined amount. This algorithm is also implemented as a program written in PascalABC.NET and tested on a cluster of high-performance parallel computing. The proposed algorithm for assessing the quality of training and its modification can be applied both to assess the quality of training and to assess the quality of the provision of medical services, the quality of software, etc.

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