Development and Research of the Analytical Hierarchy Method Algorithm for Evaluating the Quality of Academic Staff Work

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Abstract: The paper discusses the possibility of using the hierarchy analysis method to evaluate the quality of academic staff's activity in higher education institutions. Based on the review of the literature on the presented topic, we determined that the quality of teaching by teachers is not controlled at the appropriate level. The teacher performance evaluation algorithm is based on the hour hierarchy analysis method. A hierarchical model of teachers' work and an analytical hierarchy method algorithm based on current academic performance and attendance of students have been developed. An example of the evaluation of the quality of work of lecturers-teachers by means of a hierarchical model is presented.

Conclusions are made that the proposed approach provides an objective assessment of the quality of the daily work of lecturers, which is related to the current academic performance and attendance of students, and not only the results of the intermediate final assessment.

Keywords: Analytical hierarchy method. academic staff. Criterion. alternative. identify.

1. Introduction

An organization's management system is unthinkable without clearly established institutionalized principles in one form or another. Because in the functioning of all levels of management, the general importance is given to the staff, for this purpose, higher educational institutions carry out quality control of teacher management processes. The tasks of quality control of the teacher's work are the objective assessment of the level of performance of professional duties in order to determine ways to further improve the quality of the educational process [1].

The problem of finding objective and reliable criteria that fully determine the effectiveness of teachers' work has always been in the center of attention of the organizers of the educational process and the university community. The role of a teacher is multifaceted, according to official information, it includes educational and methodical, research and organizational work. It is possible to identify quite a number of quantitative indicators that characterize each type of teacher's activity, the use of which is taken into account when determining the rating assessment of his work, however, an excessive number of indicators complicates the system for calculating the rating of teachers and does not always contribute to the increase in the objectivity of their work assessment. Based on the above, the presented topic is very relevant [1,2].

The Analysis Hierarchy Method (AHP) is a systematic procedure for hierarchically representing the components that define the essence of the above-mentioned problem. The method involves decomposing the problem into simpler constituent parts and post-processing the decision maker's (GMP) judgment sequence by pairwise comparison and determining the relative degree of interaction of the elements. The hierarchical analysis method includes procedures for synthesizing multiple judgments, prioritizing criteria, and finding alternative solutions. The values obtained in this way represent estimates on a scale of ratios and correspond to some numerical estimates. The lecturer-teacher evaluation algorithm can be based on Saaty's analysis hierarchy method (AHP) [2].

We conducted a review of the literature on the presented topic:

[3] The paper provides an assessment of the quality of teachers' work in the classroom using the AHP method. In the evaluation process, there is unclear information, to avoid which reliable and accurate evaluation of their work is needed. The proposed approach is justified and has the ability to deal with uncertainty.

[4] Naromi noted that for the evaluation and development of educational institutions, the work of lecturers is evaluated every semester, but the obtained results are not optimal. This is due to the absence of an effective method of determining the results. The evaluation process is carried out by students filling in a questionnaire. This study aims to analyze the results of the questionnaire, which is carried out by a combination of Analytic Hierarchy Process (AHP) method and Ranking Weight (SAW) method.

[5] In the paper, author Rafikul Islam uses Analytic Hierarchy Process (AHP) to evaluate employee performance according to the following criteria: quantity/quality of work, planning/organization, teamwork/cooperation, communication and external factors. Each of these criteria is divided into 3 sub-criteria. The overall employee rating is determined using the AHP absolute measurement procedure.

[6] The paper describes the use of Analytic Hierarchy Process (AHP) to evaluate the performance of student management team members. An individual's contribution to a team effort is determined.

[7] The main purpose of the research in the paper is to fill an important knowledge gap in the development and planning of the English language curriculum in relation to joint group decision-making. Analytic Hierarchy Process (AHP) was used to determine the relative importance of course criteria to fit English as a second language into an optimal one-week curriculum for elementary school students.

[8] The aim of the research in the paper is to use multi-criteria decision-making (MCDM) methods, namely Analytic Hierarchy Process (AHP), to select the best pedagogical method that can develop labor market requirements.

Based on the review of the literature on the presented topic, we determined that despite the diversity of the evaluation criteria of lecturers-teachers, the quality of students' teaching is currently not at the desired level. For this purpose, for the evaluation of the quality of the teaching process, an analytical hierarchy method is proposed based on the results of the current academic performance and attendance of students, which represents the scientific novelty of the presented paper.

The aim of the paper is to develop an effective algorithm for evaluating the academic staff's activity.

2. Main Part

The hierarchical model for evaluating the teacher's work can be represented as follows (Fig. 1): at the top level is the global goal (the quality of the teacher's work); continues to the criteria - academic performance and student attendance; further to the sub-criteria describing specific indicators of the teacher's work.
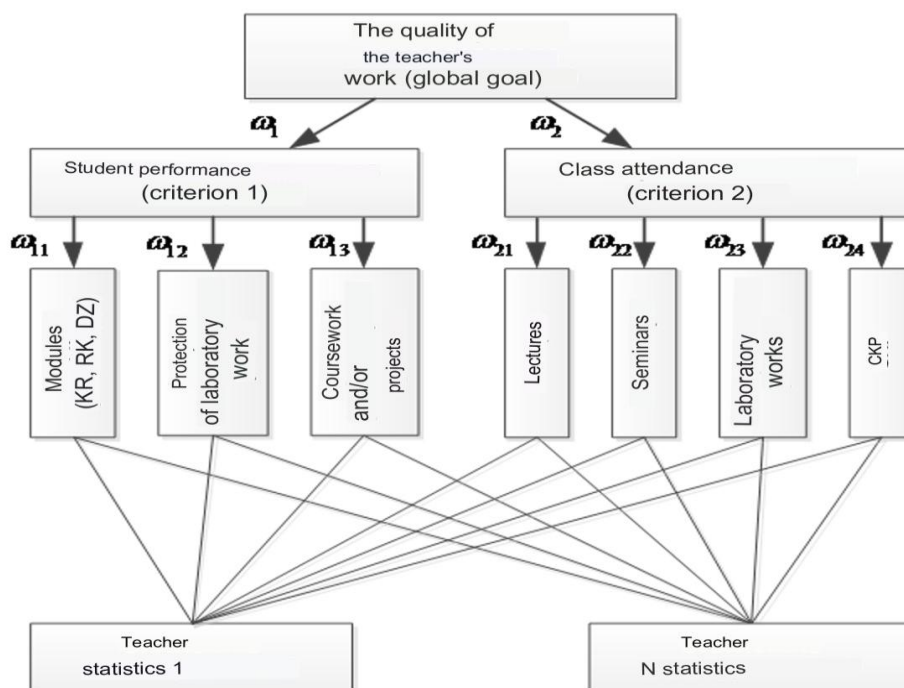

Fig. 1 Hierarchical model of academic staff performance evaluation

Figure 1 indicates: modules - control work (CR), midterm controls (RC), homework assignments (DZ), SKR - independent controlled work of students; w1, w2 are criteria weights; w11,…, w24 – weights of subcriteria.

After the formation of a hierarchy of assessment criteria (performance and attendance) and subcriteria (for academic performance - modules, laboratory work defense, term papers / projects; for attendance - lectures, practical classes (seminars), laboratory work, TFR), criteria weights are set and in accordance with they evaluate alternatives - teachers who carry out the educational process.

The weights of the criteria are set on the basis of an expert assessment carried out, for example, by representatives of the departments of the university. To do this, it is necessary to carry out a pairwise comparison of the criteria with each other in terms of their importance - their contribution to the global goal.

Based on the expert's judgments, matrices of pairwise comparisons are constructed at each level in relation to each criterion of a higher level.

When comparing two objects according to some criterion, the expert uses a predetermined nine-point scale (Table 1). The choice of such a school is due to the following reasons [1,2]:

- Qualitative differences are significant in practice and have an element of accuracy when the values of the compared indicator for both options are of the same order of magnitude or when they are close relative to the property used for comparison.
- Of people ability to produce qualitative differences is well represented by five definitions: equal, weak, strong, very strong, absolute. Trade-offs can be made between adjacent definitions when greater accuracy is required.

Table 1
Nine-point scale used in the hierarchy analysis method

Degree of importance	Definition	Explanation
1	Equal Importance	Two actions contribute equally to the achievement of a goal
3	Some predominance of the significance of one action over another (weak significance)	Experience and judgment give a slight preference for one action over another.
5	Substantial or strong significance	Experience and judgment strongly favor one action over another.
7	Very strong or obvious significance	The preference for one action over another is very strong. His superiority is almost clear.
9	Absolute significance	Evidence for preferring one action over another is highly preferred
2, 4, 6, 8	Intermediate values between adjacent scale values	A situation where a compromise solution is needed

The results of pairwise comparisons are presented in the form of the so-called pairwise comparison matrix:
$A^1 = \{a_{ij}^1\}$ – assessment of the degree of significance of the object (option, criterion) Ki over the object (option, criterion) Kj.

The matrices are compiled as follows: the compared goal (or criterion) is written at the top, the compared elements are written in the rows and columns of the matrix [1, 2]. As a result, square diagonal matrices are obtained, which have the property of inverse symmetry. The value aij is interpreted as:

$$a_{ij} = \frac{\omega_i}{\omega_j}, i,j = \overline{1:n,}$$

Where n is the number of compared criteria; wi, wj are criteria weights.

Let's give an example of evaluating the quality of work of academic staff by means of a hierarchical model.

We present the comparative criteria of the quality of the teacher's work according to the importance of success and attendance of students (Table 2).

Table 2
Table of pairwise comparisons of attendance and academic performance:

Criteria	Attendance	Academic Performance
Attendance	1	1/7
Academic Performance	7	1

Let us determine the compared variants of subcriteria by attendance: lectures, practical classes (seminars), laboratory work, TFR (Table 3).

Table 3
Table of pairwise comparisons by attendance:

Attendance	Lectures	Seminars	Laboratory works	TFR
Lectures	1	1/5	1/5	3
Seminars	5	1	1/3	5
Laboratory works	5	3	1	7
TFR	1/3	1/5	1/7	1

Table 4
presents the compared options for sub-criteria in terms of progress: modules (terminal controls, tests, homework), defense of laboratory work and execution under the guidance of a course design teacher.
Table of pairwise comparisons of performance:

Academic Performance	Modules (RK, KR, DZ)	Protection LR	Coursework/projects
Modules (RK, KR, DZ)	1	3	1/3
Protection LR	1/3	1	1/5
Coursework/projects	3	5	1

After filling in the tables of pairwise comparison, it is necessary to calculate the weight coefficients of the criteria and subcriteria. To do this, the values of the geometric mean of all expert estimates in each of the rows of the table are determined, then the found values are summed up, and the values of the geometric mean for the rows are divided by the found total value. Thus, the values are normalized, they are transferred to the range from zero to one. The resulting values determine the values of the weighting coefficients that provide the contribution of the value to the achievement of the global goal. Table 5 presents a matrix of pairwise comparisons of attendance with the definition of weighting factors.

Table 5
Matrix of pairwise comparisons by attendance:

Attendance	Lectures	Seminars	LR	TFR	Average geom.	Weight
Lectures	1	1/5	1/5	3	0,59	0,10
Seminars	5	1	1/3	5	1,70	0,30
LR	5	3	1	7	3,20	0,55
TFR	1/3	1/5	1/7	1	0,31	0,05
Weight					5,80	1,00

A similar procedure must be carried out for the values of the performance criterion, by calculating the average share of the performance of a given teacher's classes for each type of activity.

The obtained values are added up and give an assessment of the quality of the teacher's work.

3. Conclusion

Thus, to determine the quality of a teacher's work, it is necessary to calculate the percentage of the average performance of students of a given teacher in all groups (subgroups) for this type of activity and multiply the found value by the appropriate weight coefficient. Next, you need to find the sum of such products for all types of attendance and multiply the resulting value by the weight coefficient of the attendance criterion.

If the teacher does not teach any type of class (for example, his courses do not include laboratory practice), then the pairwise comparison matrices will be incomplete. It is necessary to calculate the weights for the minors of the matrix, deleting from the matrices the rows and columns corresponding to the laboratory work.

Such matrices do not need to be calculated every time, they are typical and are calculated once for the corresponding combination of teacher activities.

The proposed approach provides an objective assessment of the quality of the daily work of the teacher, related to the current academic performance and attendance of students, and not only with the results of intermediate final assessments

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