Quality Assessment of Teaching the Disciplines in the E-learning Environment of Sumy State University

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Abstract. In the article the expediency of quality assessment of teaching the disciplines in higher education institutions was justified. A method of quality assessment level of teaching the disciplines and respective algorithm were proposed for making informed decisions in the quality management of education. This method is based on using the expert method of paired comparison and identifies two common forms of control: control at the level of teacher to learn the experience of colleagues (reciprocal visits) and a survey of students after studying disciplines. The paper concentrates on the correlation between indexes of teaching quality renders possible to quantify the overall index, which is called "level of teaching quality". Furthermore, the method takes into account the requirement of quality management systems to identify critical points and eliminate inconsistencies.

Keywords: quality, teaching, assessment, expert method, quality index.

Key terms: MathematicalModeling, EducationalProcess, InformationCommunicationTechnology, KnowledgeManagementProcess, QualityAssuranceProcess.

1   Introduction

Rapid changes in the political, socio-economic and cultural realities in Ukraine and abroad, the current trends of globalization and integration of the world community have an impact on education. The modernization in education requires the use of innovative technologies, creative search of new strategic directions for content improving, methods, techniques and means of education and their application in the educational process of higher education institutions.

Higher education institutions begin to develop the quality management system at this current stage of development of higher education in Ukraine, that meet the requirements of ДСТУ ISO 9001:2015 (harmonized with ISO 9001:2015) [1] and include not only the organization of the educational process, but also technical, financial and other material and methodological resources. In this connection, acutely raised the question about the teaching quality of discipline that affects the activation of students' knowledge and their positive motivation.

In addition, significantly increases the role of modern information technology, namely the use of a single computer learning environment. This renders possible a systematic approach to raising the level of educational services within higher education institutions.

Therefore, raising the quality of educational services by application the assessment system of teaching subjects in a single information space is an important issue for higher education institutions.

2 The Application Relevance of Quality Assessment System of Teaching the Disciplines

Today higher education in Ukraine is in the process of transformation from the Soviet to the European model, established in accordance with the signed by Ukraine in 2002 Bologna agreement. By joining the Bologna process, Ukraine has pledged to work on bringing the quality of national education in line with European standards.

The main focus in reforming of higher education made on the need to create the internal quality systems. One of the main tasks of quality management systems according to the standards requirements of ISO 9001:2015, which are implemented in modern universities, is the presence of the feedback and determines the satisfaction degree of internal customers – students. The education quality or obtaining specialists, which are required by employers, primarily dependent on the quality of teacher's work [2]. So, the issue of control and assessment of the teacher's work quality is one of the difficult and important tasks in management of the education quality. Such assessment is necessary to correct actions in the educational processes and for changes to the organization management, educational programs and technology education, as well as joining the Bologna process, which requires accreditation of individual disciplines of the curriculum.

The main principles of creation of feedback systems involved in a number of scientists: C. Evans [3]; A. Lizzio and K. Wilson [4]; E.C. Ball [5]; P. Black and D. William [6]; J. Hattie and H. Timperley [7] etc. Their research focused on the study of the influence of these systems on the motivation of students (and thus the education quality at all).

The study of feedback is not new in Ukraine. For example, in Kherson State University under the guidance of Professor Spivakovsky O.V. the information system of satisfaction assessment of students, based on the use of KSU Feedback service, was organized [8,9].

Analyzing the results and making decisions, based on them, is no less important stage of assessment quality of teaching the disciplines.

To ensure the quality of higher education have approved a number of normative documents in Ukraine such as [10,11]. They identified the main ways to improve the education quality and responsible departments.

In Sumy State University (SSU) the number of normative documents such as: Regulation "About the quality control system of the educational process in SSU", Regulation "About bureau of quality assurance of education and quality of higher education" and others were introduced [12,13,14,15]. These documents regulate the organizational forms and components of the quality control system of the educational process, monitoring the quality of educational activity and quality of higher education at all in its

various components throughout the university. Also, the Council on ensuring the quality of educational activity and the quality of higher education was established at the university, which implements the university policy in the field of quality assurance and monitoring. Moreover, since 2015 the EU project Erasmus+ "Quality Assurance system in Ukraine: Development on the Base of ENQA Standards and Guidelines" (QUARE-562013-EPP-1-2015-1-PL-EPPKA2-CBHE-SP) has been implementing in the SSU in cooperation with leading universities in Ukraine with the support of the Ministry of Education and Science of Ukraine.

But the analysis of requirements of normative documents of Ukraine and SSU has demonstrated that the criterias and methods of evaluating the quality of teaching are not identified, therefore the authors propose the development of a system and method of assessment of indexes of teaching quality.

It should be noted that nowadays the educational process is characterized by the introduction of modern information systems, which is to create single information space [16]. This greatly simplifies the exchange of information and data collection. In addition, IT renders possible create large amounts of the original data and analyze it as soon as possible.

SSU implemented a system of e-learning [17], which operates in a single information space of the university and consists of subsystems: storage and access to teaching materials; management of educational process; providing the development and filling of educational content; interaction of participants of the educational process and student's electronic office. All subsystems are closely integrated with each other and work together in a single system.

So, the development of an assessment system of the quality of teaching the disciplines should be carried out with capabilities and requirements of information systems, which are implemented at the university.

3 Development of Assessment Method of Teaching Quality Indexes

Analysis of national experience in the quality assessing of teaching the disciplines renders possible to identify two common forms of control: control at the level of teacher conducted to learn the experience of colleagues (reciprocal visits) and a survey of students at certain intervals of time or after studying particular disciplines.

As already noted, the assessment criterias of the quality of the teacher of university are not defined normative. Therefore, in educational institutions there are different lists of requirements for teachers. Typically, they are used in the procedure of competitive selection for vacancies and assessment of these indexes is subjective and linguistic, for example "good" or "satisfactory".

To make decisions about the quality of teaching the disciplines it was proposed an overall index, which is called "level of quality". We should have an opportunity to evaluate it quantitatively for the proving our decisions. Therefore, the system of indexes of teaching quality was proposed (Fig. 1).
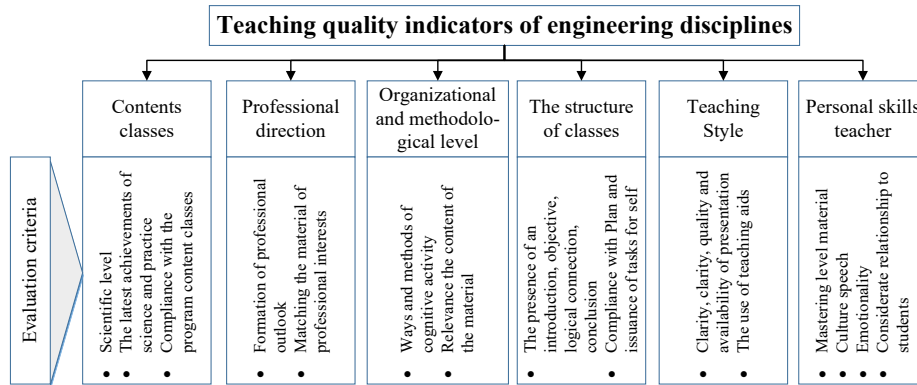
Teaching quality indicators of engineering disciplines

Evaluation criteria

Contents classes	Professional direction	Organizational and methodological level	The structure of classes	Teaching Style	Personal skills teacher
• Scientific level • The latest achievements of science and practice • Compliance with the program content classes	• Formation of professional outlook • Matching the material of professional interests	• Ways and methods of cognitive activity • Relevance the content of the material	• The presence of an introduction, objective, logical connection, conclusion • Compliance with Plan and issuance of tasks for self	• Clarity, clarity, quality and availability of presentation • The use of teaching aids	• Mastering level material • Culture speech • Emotionality • Considerate relationship to students

Fig. 1. Indexes of teaching quality (fragment)

For the assessing of the "level of teaching quality" of disciplines at the universities a comprehensive index of teaching quality is proposed, which is calculated according to the formula [18,19,20]:

$$R = \frac{\sum_{i=1}^{n} Q_i \cdot \gamma_i}{9} \cdot 100 \ , \% \ , \qquad (1)$$

where Q_i – value of unit quality index in classification group (in scores);
n – number of indexes of teaching quality.
For clary presentation of the complex index, its value is normalized to a standard that has a value of 100%. Also has used a conversion factor of dimension – 100/9, as the maximum value of a single index of teaching quality that is equal to 9 scores.
The assessment process is recommended to use according to the algorithm that is shown in Fig. 2.
In Fig. 2 the value of individual index of teaching quality is obtained through students in a questionnaire in the electronic office (block 3) or interviews with experts, teachers during reciprocal visits (block 4). To quantitative (scoring) characteristics of individual index of quality teaching Qi usually used scale, which is given in Table 1.
Authors propose to substantiate values of the weighting coefficients of the index of teaching quality by carring out of using expert method of paired comparison – a set of logical, mathematical and statistical methods and procedures which related to the expert's activities on processing information that is necessary for analysis and decision making.
The procedure for determining the weighting coefficients consists of two stages: the first stage is the selection of the optimal set of X features, the second is the set of numerical values of each feature X.
The coding factors and determination of expert's opinion are carried out after work on the formation of the expert group. Results of analysis the opinions sheet of the member of expert group is given in the Table 2.
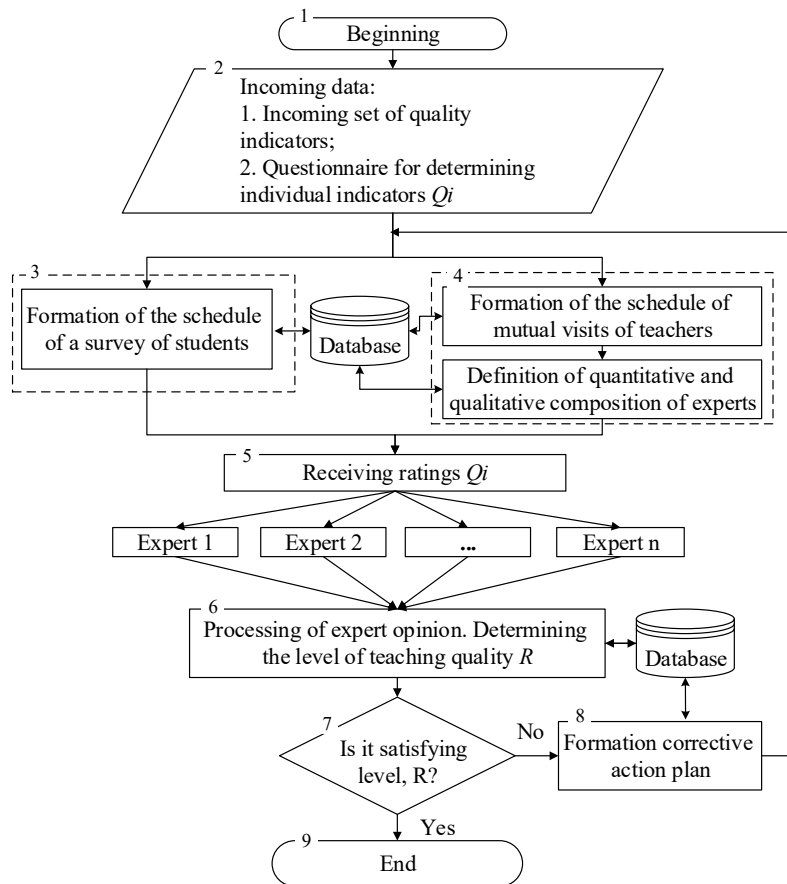
Fig. 2. The algorithm of the assessment of teaching quality

Table 1. Scores characteristics of assessment of individual index of quality teaching Q_i according to the criteria

The number of points for the single index	Description of compliance criteria
9–8	quality is shown by all criteria
7–6	quality appears frequently, but not at all criteria
5–4	quality appears in 50% criteria
3–2	quality appears rarely and only on certain criteria
1–0	no quality criteria for all

The clarification of weighting coefficients in this work is proposed to realize by the method of successive approximation. In a Table 2 the values of weighting coefficients obtained by double paired comparison method of successive approximation, in which the result of measurement in the (w) approach is defined as the weighted mean. Initial results are considered in this case as a first approximation.

Table 2. Example of the opinions sheet of the member of expert group

Indexes j \ Indexes i		1	2	3	4	5	6	$G_j(1)$	$\gamma_j(1)$	$G_j(2)$	$\gamma_j(2)$	$G_j(3)$	$\gamma_j(3)$
1	The content of the class	1	2	1	2	1	1	8	0,222	46	0,229	257	0,231
2	Professional direction	0	1	1	1	0	2	5	0,139	28	0,139	152	0,137
3	Methodo-logical level	1	1	1	1	2	2	8	0,222	46	0,229	254	0,228
4	The struc-ture of clas-ses	0	1	1	1	1	1	5	0,139	28	0,139	155	0,139
5	Teaching style	1	2	0	1	1	0	5	0,139	28	0,139	158	0,142
6	Personal teacher skills	0	1	0	1	2	1	5	0,139	25	0,124	137	0,123
Sum								36	1	201	1	1113	1
Note. The advantage of j-th object before i-th is numbered by 2, the equivalence by 1, and the advantage of j-th object before i-th is numbered by 0.													

The second approach used as weighting coefficients $\gamma_j(2)$ of experts opinions. Obtaining the new results with these weighting coefficients, in the third approach are considered again as the weighting coefficients $\gamma_j(3)$ of the same expert opinion, etc. According to Theorem Peron-Frobenius [21], in particular conditions, this process converges, i.e weighting coefficients tend to some constant values that reflect the relationship between objects under examination established expert input.

The result of measurement of the j-th index in the first approximation $G_j(1)$ (original result) determined by the formula:

$$ G_j(1) = \sum_{l=1}^{m} K_{jl} \text{,} \tag{2} $$

where K_{jl} - number of benefits of index j by one expert ($l=1\dots m$);
Measurements of j-th index in (w) approaching equal [22]:

$$ G_j(w) = \sqrt{[(G_1(w-1)]^2 \cdot K_{j1} + \dots + [(G_m(w-1)]^2 \cdot K_{jm}} \text{,} \tag{3} $$

where $G_j(w\text{-}1)$ – outcome measurement of j index in a $(w\text{-}1)$ approximation.
The value of the weighting coefficients (w) approach defined as:

$$ \gamma_j(w) = \frac{G_j(w)}{\sum_{j=1}^{m} G_j(w)} \text{,} \tag{4} $$

Values clarification process as long as the accuracy will not match the specified one, in other words, until reaching the condition:

$$\gamma_j(w) - \gamma_j(w-1) \le \varepsilon, \qquad (5)$$

where ε – given the accuracy of calculations, which is accepted [20]:

$$\varepsilon = 0,001 \; npu \; 1 < a \le 1; \\ \varepsilon = 0,01 \; npu \; a > 5 \qquad (6)$$

where a – coefficient that shows: how many times the weighting of the best index exceeds the weighting of the worst index.

For the coefficient assessment of consistency of expert opinion, usually use the Kendal coefficient of concordance [22]. Consistency of expert opinions is considered as acceptable if the value of the coefficient of concordance $W \ge 0,6$.

Summary table of weighting coefficients of indexes of teaching quality is the result of expert assessments (Table 3).

Table 3. Weighting coefficients of indexes of teaching quality (results of expert assessment)

Number rate	Teaching quality indicator	Weighting coefficient γ_i
1	The contents of classes	0,223
2	Professional direction	0,137
3	Methodological level	0,201
4	The structure of classes	0,138
5	Teaching style	0,143
6	Personal teacher skills	0,158

The scale of desirability Harington is used for the formalization of complex quality index [23]. It refers to scales that are in the interval from zero to one. Therefore, for decision-making, based on comprehensive assessment "level of teaching quality", are offered the following recommendations (Table 4).

4   Practical Implementation of the Method of Assessment Teaching Quality

The proposed in chapter 2 algorithm considers two forms of control: control at the level of teacher (reciprocal visits) and a survey of students at certain intervals of time or after studying particular disciplines.

Requirements for the first form of control are presented in SSU normative documents [12,13,14,15]. According to the requirements of these Regulations SSU introduced reciprocal visits. Annually forming composition of expert groups and schedule of visits to classes.

Table 4. Recommendations for decision-making of "level of teaching quality"

Result of "level of tea-ching quality", %	Recommendations for decision-making
Above 80 to 100	Very good quality. The process of teaching complies with all re-quirements; quality ensured.
Above 63 to 80	Good quality. A minor mismatch. The process of teaching may be acceptable subject to the implementation of corrective action; there are insignificant inconsistencies (or one big inconsistency)
Above 37 to 63	Satisfactory quality. Much discrepancy. The process of teaching is satisfactory and can be conditionally enlisted; there are signif-icant inconsistencies that shoul be eliminated. The process re-quires the development of analysis and eliminating of inconsist-encies (or development of plan for corrective actions).
Above 20 to 37	Bad quality. Critical discrepancy of teaching process. The pro-cess requires a time limit to eliminate inconsistencies.
Above 0 to 20	Very poor quality. Complete mismatch. The process requires the development of a plan of corrective action, and time limit to re-moving inconsistencies and re-inspection.

However, the quality of teaching is not sufficiently appreciated without taking into account feedback from the students. The survey can be conducted through questionnaires or in the electronic office. SSU currently being tested "electronic personal office" – a single window access to various information services that will enable easy and timely receive customized information on training.

Practical implementation of the the proposed model of teaching quality assessment was conducted by the example of teachers of the department of Manufacturing Engineering, Machines and Tools. There were 32 students in specialty "Manufacturing Engineering" (level of Master of Science degree) on the five core disciplines teachers. The results data are summarized in Table 5.

Table 5. Assessment results "level of the teaching quality"

Result of "level of teach-ing quality", %	Recommendations for decision-making	Number of teachers
Above 80 to 100	Very good quality	1
Above 63 to 80	Good quality	3
Above 37 to 63	Satisfactory quality	1
Above 20 to 37	Bad quality	0
Above 0 to 20	Very poor quality	0

The teacher presence in the "satisfactory quality" explains his lack of experience teach-ing (first year after graduate school) and teaching a new course for the new curriculum. During the evaluation revealed the following critical points: the interconnection of material with professional interests and insufficient use of technical training aids.

5   Conclusions

The work presents the research that aimed at improving the process of assessment of teaching quality at the universities, namely the current situation and ways of improvement of the teaching process were analyzed. The analysis of normative documents in field of education has shown the lack of a broad research of the question of assessing of teaching quality and the lack of uniform system of indexes of teaching quality.

Therefore, as the result of research the overall index of teaching quality, the system of component indexes of quality and the method for its assessment in teaching the disciplines were proposed. In addition, the recommendations for decision-making based on the level of teaching quality were developed.

The application of the proposed method of assessment the teaching quality in universities in practice renders possible to:

- on the basis of quantitative evaluation to carry out an objective assessment of the level of teaching quality at the universities;
- make informed decisions in the quality management of educational process;
- identify discrepancies (critical points) and criterias for developing a plan of corrective actions.

In the nearest future it is planned to improve normative base of higher education institutions through the development of a normative document, in which the requirements for teaching quality will be regulated and the method and nomenclature of indexes of assessment the teaching quality at higher education institutions will be presented.

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