STATISTICAL APPROACHES TO EDUCATIONAL PROGRAM QUALITY ASSESSMENT

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This article is devoted to the development of quality assessment techniques for educational programs involving the individual results of graduate learning outcomes. This statistical approach characterizing the quality of educational programs and denoting learning results as a system introduces not only an entropic indicator as quality indicator of educational program as a whole, but also as a level indicator of discrepancy in the system itself. The statistical approach was examined. The sources of the internal and external validity are shown.

Key words: *competency model, evaluation of the competency level, educational program quality, statistical approach.*

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The implementation of Bologna process in Russia, representing some major changes in educational paradigm and shift towards outcomes-based or competency-based approaches has significantly influenced the basic methods of educational program (EP) development. Being urged by the adoption of the 3rd generation of Russian State Educational Standards, the application of professional competency model developed alongside with the educational program identifies the need to elaborate appropriate methods for competency level evaluation. The proposed control system enabling the faculty to identify the intended and actual outcomes of a learning experience is an essential condition for effective educational program management and fulfillment of Federal Education Standards requirements in terms of annual renovation of educational programs. The results of such evaluation experience could be applied not only for the analysis aimed at identifying the shortcomings of an educational program but also in the adoption of various managerial decisions.

One of the basic training objectives of engineering education is to prepare highly-qualified, knowledgeable, competitive and socially conscious engineers, who are able to perform qualified jobs within creative and science absorbing industries. Quality assessment of any educational program must be based on the evaluation of learning outcomes of each graduate. In fact, the quality and competitiveness of any educational program are defined by the quality and competitiveness of a graduate training.

In accordance with the last amendment of Federal Sate Educational Standards, learning outcomes are formulated at the stage of educational program development in terms of competencies (Fig.1). Therefore, the evaluation of the results or competencies being attained should be carried out at the same way [1-2]. From this point of view, the development of appropriate competency level evaluation methods

Fig.1. Competencies and Bachelor's Curriculum (221400 "Quality Management") Correlation Sample

Discipline Codes	General Cultural Competencies (GCC)																
	GCC-1	GCC-2	GCC-3	GCC-4	GCC-5	GCC-6	GCC-7	GCC-8	GCC-9	GCC-10	GCC-11	GCC-12	GCC-13	GCC-14	GCC-15	GCC-16	GCC-17
B.1.1	■	■				■		■		■	■			■			■
B.1.2	■	■				■									■		
B.1.3		■				■											
B.1.4	■	■		■		■		■	■							■	
B.1.5	■	■		■		■		■	■							■	
B.1.6	■	■	■			■										■	
B.1.7	■	■	■	■	■	■			■	■	■			■			
B.1.8	■	■	■	■	■	■			■	■							
B.1.9	■	■	■	■	■	■				■							
B.1.10	■	■				■						■	■	■			
B.1.11	■	■	■	■	■	■	■			■		■	■		■		■
B.1.12	■	■	■	■	■	■	■	■	■	■		■		■			
B.1.13	■	■	■	■	■	■	■			■		■	■		■		■
B.1.14	■	■	■	■	■	■	■	■	■	■		■		■			

is an essential condition for successful implementation of 3rd generation educational programs. It is impossible to apply competency-based approach efficiently without the development of a thorough competency assessment framework.

Basic requirements for learning outcomes evaluation are as follows: reliability and objectivity; correspondence and validity; unambiguity and efficiency; comparability and timeliness. Besides, the accuracy of individual learning outcomes evaluation is a necessary condition for accurate assessment of the educational program as a whole. The proposed control system should not contradict the learning process itself, while the expenditures for its development and implementation should not exceed the value of the obtained results. One of the important characteristics of the system concerned is the possibility of visual presentation, which makes it more convenient to analyze, compare and correlate the results.

The analysis of the content and inherent characteristics of the competencies shows that, in general terms, a competency consists of three main components:

- cognitive - connected with knowledge and knowledge acquisition;
- integral-pragmatic – defines the process of skill formation based on the obtained knowledge and ability to transfer skills and knowledge to a variety of sign system allowing a graduate to adapt to new situations and professional settings;
- personalized – connected with personal value system which can influence significantly competency development.

The cognitive component defines the knowledge and intelligence level of a graduate including his/her creativ-

ity grade. It is closely connected with theoretical and methodological bases of the subject concerned and identifies whether a graduate is ready for professional activity from the point of scientific and vocational skills.

The integral-pragmatic component underlines the ability of a graduate to apply the obtained knowledge not only in the fields closely connected with his/her profession, but also in so-called "inter-subject zones" or even absolutely new ambiguous settings. The component defines the capability of a student to apply the lessons learned in his/her job performance.

The personalized component is reported to be the most essential and systemically important as it reveals the attitude of a graduate toward his/her professional activity. It significantly influences the dynamics of competency development. Therefore, considering the fact that the basic characteristic of a competency is that it must be always personally recognized as an own experience embodied into personal attributes and system of values, skills and knowledge, it is possible to assume that this component should be the subject of extensive research to solve the problems of competency level evaluation.

Russian and most foreign scholars believe that competencies are dynamic as they are not absolutely static units in human personality and can be characterized in terms of dynamic capacity, i.e. the capability of improving or disappearing due to the absence of motivation. Therefore, it is obvious that such terms as competency level and evaluation can be reasonably applied.

To develop a competency means to obtain the vision of what constitutes the specific knowledge, skills and appropriate value system required for a definite performance, searching for new solutions and ways out in absolutely unfamiliar settings. As a competency level is a rather latent and hidden parameter which cannot be immediately measured, probability approaches should be applied. The examples of application of probability approaches for competency level evaluation and description of personal characteristics influencing the competencies are provided in the works by A.A. Maslak [2] and I.N. Eliseev [3].

Whatever grading scale is applied for individual outcomes evaluation (five-point scale or 100-point scale), probability or statistical approaches allow us to obtain integral estimation of the learning outcomes of all graduates (according to each competency concerned) not only in terms of average score but also as dispersion value. Being a system of the elements including knowledge, skills and experience, a competency that should have been acquired and developed by the end of the education program is assumed to be reflected throughout the whole education period in terms of statistical value. i.e. entropy. Entropy is calculated based on the data of dispersion value of individual grades:

$S = \ln\sigma^2$,

where S – entropy, σ^2 – total dispersion.

This index identifies the influence of various factors on the learning outcomes. Besides, being a measure of the "disorder" of system elements, entropy is definitely connected with the level of possible discrepancies in a system (Fig.2). Herewith, minimal entropy corresponds to a minimum level of disorder and discrepancies (N) in a system. It makes possible to compare different educational programs, evaluate the dynamics of training quality.

Based on the fact that personalized and cognitive components are reflected in current and interim grades or attestation as well as the integral-pragmatic component of a competency is developed up to the end of education and reflected in final grades it is possible to propose the statistical approach as the basic method for educational program quality assessment considering, as well, competency level evaluation. It includes:

1. Consideration of the learning outcomes attained by a student at all stages of attestation within all

disciplines being taught in a definite time sequence in accordance with the corresponding weighting coefficients required for competency level evaluation (Fig.1).

2. Consideration of all individual learning outcomes of a graduate in diagnostic testing.

3. Holding the assessment results in database or university data system.

4. Consideration of the final grades including the evaluation provided by a scientific advisor, reviewer and members of the State Attestation Commission.

5. Calculation of integral competency level index based on the above-mentioned procedures, graphing of individual learning outcomes and comparative analysis of learning outcomes of different students (Fig.3).

6. Dispersion analysis of competency level evaluation, calculation of entropy index S.

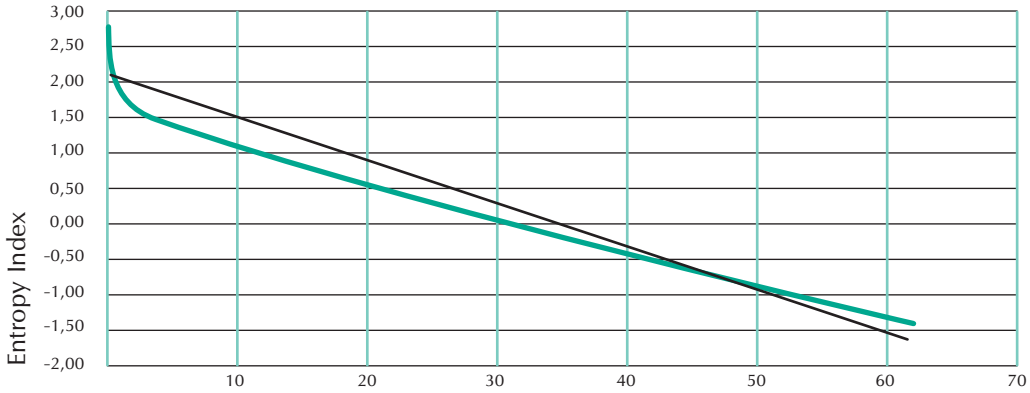
The current control systems which are widely applied in higher educational institutions for the assessment of students' academic performance include the above-mentioned 1-4 stages and in most cases to hold the assessment results, university database is commonly used. Based on the data accumulated in the university database, it is possible to plot a diagram of individual student results automatically as well as to calculate integral indexes, define dispersion value and calculate entropy index characterizing the quality of an educational program.

It is difficult to overestimate the significance of the final assessment which is usually manifested in the fulfillment of a design project, i.e. the simulation of actual job performance, expert review, opinion of the scientific advisor and the members of the State Attestation Commission. Besides, the development of a definite final attestation procedure will require eloborating a well-grounded list of competencies to be evaluated at the end of the education [4].

The approbation of the discussed approach carried out in National Research University of Electronic Technology within the framework of the 2nd generation educational programs ("Quality Management" educational program) as well as the comparative analysis of statistical evaluation of graduates' academic performance and students' test results for educational program quality assessment have obviously proved the high objectivity of the proposed quality assessment system of educational programs.

The validity of system discussed is provided, on the one hand, by the thorough investigation of the object concerned (student's learning outcomes evaluation is carried out at different

Fig.2.Dependence of Entropy and Dispersion Indexes



stages of current and interim attestation with all results being held in university database) and, on the other hand, by the internal relations (while evaluating competency level, it is essential to consider the learning results within those disciplines that directly contribute to the development the competency being analyzed (Fig.1).

The advantages of the proposed approach are the following:

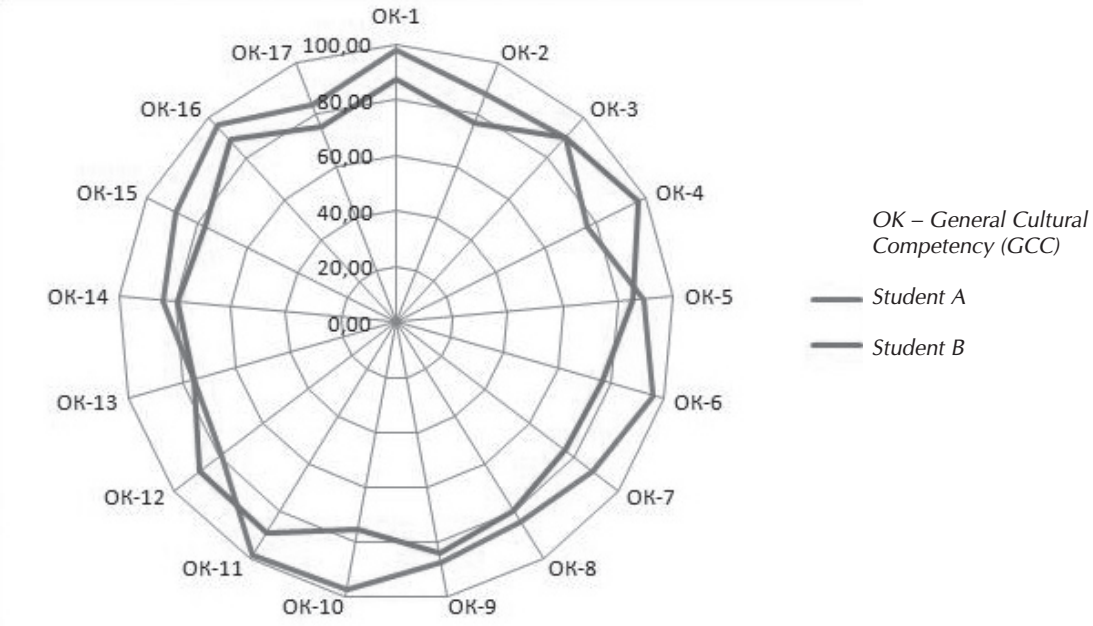
- Comparability of competency level evaluation results obtained in terms of interim attestation and diagnostic test data. Such comparison makes it possible to estimate the weight of a given discipline in the development of a competency;
- Comparability of academic performance results of different students (Fig. 3);
- Comparability interim and final attestation results;
- Possibility of integral assessment of educational program quality based on the evaluation results of graduates' training quality (entropy index(Fig.2)).

All this clearly demonstrates the essential convergent validity of the proposed approach.

At the same time, the possibility to compare entropy index of various student groups, different educational programs proves also external validity of the approach.

Complete evaluation of individual learning outcomes and educational program efficiency including, on one hand, assessment of academic performance results, and, on the other hand, monitoring of employer's satisfaction allows us to insure constant improvement of educational programs, provide the competitiveness not only of the graduates in labor market but also of a university in educational industry.

Fig.3. Comparison of Individual Learning Outcomes Based on the Development of General Cultural Competencies (2 students)



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