UDC 004.421.4

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INFORMATION TECHNOLOGIES IN PROMOTING COMPETENCE 'S APPROACH TO TEACHING ELECTRICAL ENGINEERS

It is regarded the possibility of using information technology to identify specific parameters of studies in the formation of competence model of the future engineer. It was proposed and justify the feasibility and effectiveness of the information approach to the formation of information and substantive content of structural units (logical units) with the restriction of the total training time, with the influence of the parameters of studies on the formation of competencies.

Keywords: *competence of the engineer, the set of competencies, quantitative parameters of classes, expert iterative approach*

The current paces of technological changes in manufacturing requires correction approach to training future engineers. Education, which focused on a "ready knowledges" ceases to be effective more tangible. In paper [1] states that "Improving the quality of education is one of the most pressing problems not only for Russia, but for the entire world community. The solution to this problem is connected with the modernization of educational content, optimizing processes and technologies for the organization of the educational process and, of course, reinterpretation of the objectives and results of education". M.Ivanova [2] points out that "Currently characteristic type of thinking is not an engineer ready assimilation of scientific and practical knowledge, and creative self-educational activities for the design of new knowledge, planning, forecasting, modeling, and ensure efficient operation of the production". In the work of A.Dymarska [3] states that "The labor market has requirements not only to the level of theoretical knowledge of a potential employee, as to the level of his skills, responsibility, communication skills, learning and adaptability." We agree with the above-indicated views that modern education, including training of future engineers should focus on labor market demand, consistent with global trends.

One approach to solving the problem of training highly qualified engineers is competence-oriented approach, as evidenced by the paper [1] "... there is an abrupt reorientation of the education evaluation with the concepts of "preparedness", "education", "common culture", "education", on the concept of "competence", "competence" of students". O. Hutorsky [4] says "Introduction to the legal competence and the practical component of education can solve the problem that is typical for the Russian school ..." N. Shymonina [5], in which the author states that "Competence approach in technological organization of pedagogical process, based on a modular knowledge representation, ensure the quality of training of engineers through linkages between educational requirements and market sectors" and others.

Thus, the labor market makes it tougher requirements for potential workers: today requires professionals with a high level of practical skills, responsible, sociable, creative, capable of adapting and learning, and construction of traditional educational process was suitable for the preparation of such specialists. The relevance of this problem is confirmed by the fact that this approach to training future professionals laid today in the National Strategy for Education in Ukraine for 2012-2021 [6], where indicated that the main task of higher education is "the development of higher education, oriented competence approach in education ... "

Analysis of recent research.

Analyzing the problems of training of competitive specialists should be implemented new efficient approach in education. Jacques Delors in his paper [7] emphasizes "Universities need to develop new approaches to development that would allow their countries to begin a genuine building of a better future. Universities of these countries have to provide vocational and technical training of prospective elite and graduates of high and medium level that are needed by the country...". To solve this problem you can use it competency approach.

In A.Lebedev's paper [8] considered competence approach, which according to the author's position is a set of general principles defining the goals of education, curriculum selection, organization of educational process and evaluation of educational outcomes. This definition we consider the most complete. Competence approach focuses on the ability to use the knowledges in the professional activities. From the standpoint of basic competency approach direct result of education is the formation of competences. There are many interpretations of the terms "competence" and "competency", for example, in the works of Doctor of Psychology, Professor I.Zymnia [4], Doctor of Pedagogical Sciences, Professor

J.Tatour [10]. In our opinion, the most complete interpretation is that provided by O.Hutorsky [11]. Competence - a "possession of a person competent jurisdiction, which includes his personal attitudes and the subject". Competencies – "a set of interconnected 'associated personality traits (knowledge, skills, and ways of life), defined in relation to a range of objects and processes, and quality required for productive activities in relation to them".

There are different approaches to the classification of competencies [9]. We use the classification for universities proposed in the draft TUNING [10] and in the preparation of draft standards for specialty bachelors and masters degree.

According to the classification proposed in TUNING, competencies are divided into two groups:

I. General (universal, key) – required for every educated person in the development of any profession:

• tool - cognitive, technological, linguistic, communicative (eg the ability to retrieve and analyze information from various sources, the ability to solve problems, the ability to make decisions);

• interpersonal (eg, the ability to collaborate with experts in other subject areas, the ability to accept diversity and cross-cultural differences);

• system (eg, the ability to initiative and entrepreneurship, responsibility for the quality, the desire to succeed).

II. Subject-specialized (professional).

• in-process technology such as the development of methods and techniques of designing, debugging, production and operation;

• organizational and managerial (eg, the ability to organize work team, the ability to properly organize the workplace);

• research (eg, research and development of theoretical and experimental models of objects of professional activity - analysis of the dynamics and quality of objects using appropriate methods and tools for research, the creation of theoretical models that can predict the properties and behavior of the states of study object);

• design (eg systems analysis facility design domain and the relationships between its elements, the development and analysis of generalized solutions to the problem, predicting possible outcomes of the compromise in the face of uncertainty, the planning of the project);

• economic (eg, engineering design, followed by an analysis of the economic consequences).

The goals of article.

For each training program most appropriate, in our view, the introduction of competence approach is a modular system of training. However, the rapid obsolescence of technical knowledge, due to technological progress requires constant updating course content maintenance college courses, and in this sense, modernization of training engineers to be the case always. Existing methods of training have drawbacks, the most significant of which is the subjectivity in the selection of educational material without adaptation curriculum, technology in the formation of general and professional competencies. The aim is to propose and substantiate the effectiveness of an information content approach to the logic modules based on the total training time constraints and the influence of parameters on the formation of classes competencies.

The main material.

Electrical engineer - a specialist who deals with the design, manufacture and operation of electricity hardware. Focusing on education and qualification characteristics specialist areas of training 7.050701 "Electrical and Electric" specialty 7.05070103 "Electrical power systems" we give a list of basic competencies engineer, formed during the training:

• ability to choose optimal methods and technical means of creating power systems;

• searching and analyzing the causes of the problems in the electricity and the development of measures for their prevention;

• a search for ways to improve the quality and reliability of electricity.

To generate a set of competencies required for electrical engineering, we propose the development of sound logically completed modules that mission is to develop general and professional competencies (depending on the discipline, in preparation), their respective content and link from already learned, objective differentiation of educational material as well as learning and teaching materials to contemporary models of student development and implementation of new information technologies to enable selection of a more flexible trajectory acquisition of competencies.

A set of competencies that must be formed in a student as a result of studying of logical module consists of a set that should be the maximum possible value as of each competence separately or in a set in general:

$$K = \begin{bmatrix} 1 & 1 & \dots & 1 \end{bmatrix} \times \begin{bmatrix} K_1 \\ K_2 \\ \dots \\ K_n \end{bmatrix} \to \max \qquad (1)$$

where K - the set of competences;

$\begin{bmatrix} 1 & 1 & \dots & 1 \end{bmatrix} = [1]$ - connection matrix for the total value of competency as a finite number;

$K_1, K_2, \dots, K_n$ – competence, each of which can take on a certain value on a 100-point scale: 0 - lack of competence, and 100 - maximum ownership of competence;

n – umber of competencies that must be formed as a result of the logic module.

Competencies $K_1, K_2, \dots, K_n$ except numeric value with some lexical definitions that depend on a set of so-called indicators. For example, the competence "calculate electrical parameters in different operating conditions" is composed of the indicators "ability to formulate a problem", "ability to "translate" the problem of the home language in mathematical record", "select the most appropriate method of calculation", "directly to calculate the parameters electrical equipment","ability to analyze the result".

We offer as a constituent competencies using multiple indicators, each of which can take on a certain value for a 10-point scale: 0 - lack of ability, to 10 - maximum skill:

$$I = \begin{bmatrix} I_1 \\ I_2 \\ \dots \\ I_m \end{bmatrix} \qquad (2)$$

where, I - set of indicators, such as:

I_1 - the ability to identify the main idea of listening comprehension;

I_2 - the ability to use methods of scientific knowledge;

I_3- critical perception of information;

I_4 - ability to work with the literature on the subject;

I_5 - ability to work in electronic retrieval system;

m - number of indicators.

The value of each of the proposed set of indicators may easily determine the results of audits, tests and etc. Therefore, having a specific numerical value for each of a set of indicators, taking into account the fact that competence consists of indicators, we can write:

$$K = [1] \times K(I) = [1] \times ki \times I = \begin{bmatrix} 1 & 1 & \dots & 1 \end{bmatrix} \times \begin{bmatrix} ki_{11} & ki_{12} & \dots & ki_{1m} \\ ki_{21} & ki_{22} & \dots & ki_{2m} \\ \dots & \dots & \dots & \dots \\ ki_{n1} & ki_{n2} & \dots & ki_{nm} \end{bmatrix} \times \begin{bmatrix} I_1 \\ I_2 \\ \dots \\ I_m \end{bmatrix} \to \max \qquad (3)$$

where ki - factors influence the competence indicators that show the effect each of the indicators I on the formation of specific competencies K.

For example, the indicator "choose the most appropriate method of calculation" has a significant impact on competence "calculate the parameters of electrical equipment in various modes of operation", so the corresponding coupling coefficient between this indicator and this competence may be, for example $ki = 3$. Indicators I, in its turn, are formed as a result of a particular set of classroom and self-study for a logical unit. Each auditorium classes taught certain issues solved some problems, using some visual aids and teaching and learning aids. Each lesson has specific quantitative parameters educational classes, each of which can also be easily identified:

$$P = \begin{bmatrix} P_1 \\ P_2 \\ \dots \\ P_S \end{bmatrix} \qquad (4)$$

where, P - set of quantitative parameters activities, such as:

P_1 – number of tasks and issues to be considered in the classroom or self-employment;

P_2 – number of techniques you need to learn (theorems, formulas, laws, postulates);

P_3 – number of illustrative examples;

P_4 – examples from practice with regard to qualification or specific student audience;

P_5 – the number of questions for discussion;

P_6 – number of questions for self-study;

s - number of parameters.

Thus, the formation of the indicators I vary depending on the classes and parameters of students independent work P:

$$I = I(P) = kp \times P = \begin{bmatrix} kp_{11} & kp_{12} & \dots & kp_{1S} \\ kp_{21} & kp_{22} & \dots & kp_{2S} \\ \dots & \dots & \dots & \dots \\ kp_{m1} & kp_{m2} & \dots & kp_{ms} \end{bmatrix} \times \begin{bmatrix} P_1 \\ P_2 \\ \dots \\ P_s \end{bmatrix} \quad (5)$$

where kp - influence factors for each parameter P to form a specific indicator I_i.

For example, setting classroom lessons "problems and issues to be considered in the classroom or self-employment" affects the indicator "choose the most appropriate method of calculation" because the corresponding coupling coefficient between this parameter and this indicator can be, for example $kp = 7$.

Thus, given the formula (3) and (5), the set of competencies K is defined as:

$$K = [1] \times ki \times I = [1] \times ki \times kp \times P = \quad (6)$$

$$= [1 \quad 1 \quad \dots \quad 1] \times \begin{bmatrix} ki_{11} & ki_{12} & \dots & ki_{1m} \\ ki_{21} & ki_{22} & \dots & ki_{2m} \\ \dots & \dots & \dots & \dots \\ ki_{n1} & ki_{n2} & \dots & ki_{nm} \end{bmatrix} \times \begin{bmatrix} kp_{11} & kp_{12} & \dots & kp_{1S} \\ kp_{21} & kp_{22} & \dots & kp_{2S} \\ \dots & \dots & \dots & \dots \\ kp_{m1} & kp_{m2} & \dots & kp_{ms} \end{bmatrix} \times \begin{bmatrix} P_1 \\ P_2 \\ \dots \\ P_s \end{bmatrix} \rightarrow \max$$

In the formula (6) are known coefficients ki and kp, and the values prevailing competences K, which should be maximized. Variables in equation (6) is a quantitative parameters P. Obviously, the simplest solution of this equation - increasing values of quantitative parameters of classes P is unacceptable as it is contrary to the logic of the educational process within the discipline as a whole - even for generating top quality skills can not "grasp the immensity". Thus, the solution of equation (6) should be considered limitations. On the other hand, the formation of K competencies within each module completed logically allocated a limited amount of training time (T_0), which is shared between the auditorium classes (T_A) and the self students studying (T_{SSS}) for the following distribution:

$$T_o = T_A + T_{SSS} = const \quad (7)$$

where T_A - time classes in hours:

$$T_A = t_L + t_{PC} + t_{SL} + t_{LW} + t_{CW} \quad (8)$$

where t_L, t_{PC}, t_{SL}, t_{LW}, t_{CW} - by the number of hours of lectures, practical classes and seminars, laboratory work and computer workshops;

T_{SSS} - total time bidding in a logical modules in hours.

Each of the quantitative parameters of training sessions P directly affects the amount of time required to process the learning material. For example, increasing the number of methods for solving the problem considered in the framework of the logical module - increases the required number of lecture time to familiarize students with these methods and increases the amount of time practical training to work out these methods. Increasing the number of visual aids, however, reduces the required amount of time. Thus, each of the parameters of the distribution of hours depends on T_A and T_{SSS} quantification of classes:

$$T_0 = T_0(P) = [1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1] \times \begin{bmatrix} t_L(P) \\ t_{PC}(P) \\ t_{SL}(P) \\ t_{LW}(P) \\ t_{CW}(P) \\ T_{SSS}(P) \end{bmatrix} = const \quad (9)$$

$$T_0 = [1] \times kt \times P = [1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1] \times \begin{bmatrix} kt_{11} & kt_{12} & \dots & kt_{1S} \\ kt_{21} & kt_{22} & \dots & kt_{2S} \\ \dots & \dots & \dots & \dots \\ kt_{z1} & kt_{z2} & \dots & kt_{zs} \end{bmatrix} \times \begin{bmatrix} P_1 \\ P_2 \\ \dots \\ P_s \end{bmatrix} = const \qquad (10)$$

where *kt* - factors that determine the impact of quantitative parameters *P* for the number of hours allocated to each of the classes *t*. That is, these factors determine how much time for each training session parameters required for the formation of each of the indicators that make up the necessary competence.
z - number of types of classes; *[1]* - matrix of connection that is required to determine the total amount of training time as a numerical value.

The result of the study of logic module technical discipline (which includes all types of training sessions and SSS) should be formation of a set of general and professional competencies *K*. Thus the content of the training module, its quantitative parameters of *P* must be such that the rate of formation of competence was maximized. Before the teachers involved in the development of educational logic module with relevant technical discipline is to choose a content module, including its quantitative parameters *P*, to the end of his study results were as close as possible to those of engineering competencies identified in educational standards. To eliminate subjective factors, taking into account individual abilities and opportunities of student groups and facilitate the development volume of work we propose to use an expert an iterative approach to construct logical training modules in technical disciplines in preparing future engineers. Its logical structure may be simply represented as in the diagram in Figure 1.

Under the proposed structural scheme to generate a list of competencies *K* used indicators *I*, the value of which depends on the parameters of classes *P*. According to the logic of the module the students formed a real competence K'. If the result does not match the expected, changing the parameters of the expert classes *P*, thus changing the indicator *I*. The process is repeated until the generated competence K' will not match the expected competencies *K*.

The complexity of the application of the proposed structural scheme is that after correction of parameters of classes *P,* expert as the result should provide certain value given to the study of logic module of study time T_0. In addition, the influence of parameters of classes *P* on competencies required for the formation of a classroom t_L, t_{PC}, t_{SL}, t_{LW}, t_{CW} and a SSS depends not only on the student's abilities, but also on the quality of teaching materials and other factors, the impact of which is difficult and uncertain by dependencies (6) . For example, if the expert will significantly increase the parameter "number of jobs submitted to a laboratory classes," he must adjust all other parameters of classes so that the total time T_0 that is allotted to the study of logic module remains the same and formed competencies K' have become more value than in the previous iteration.

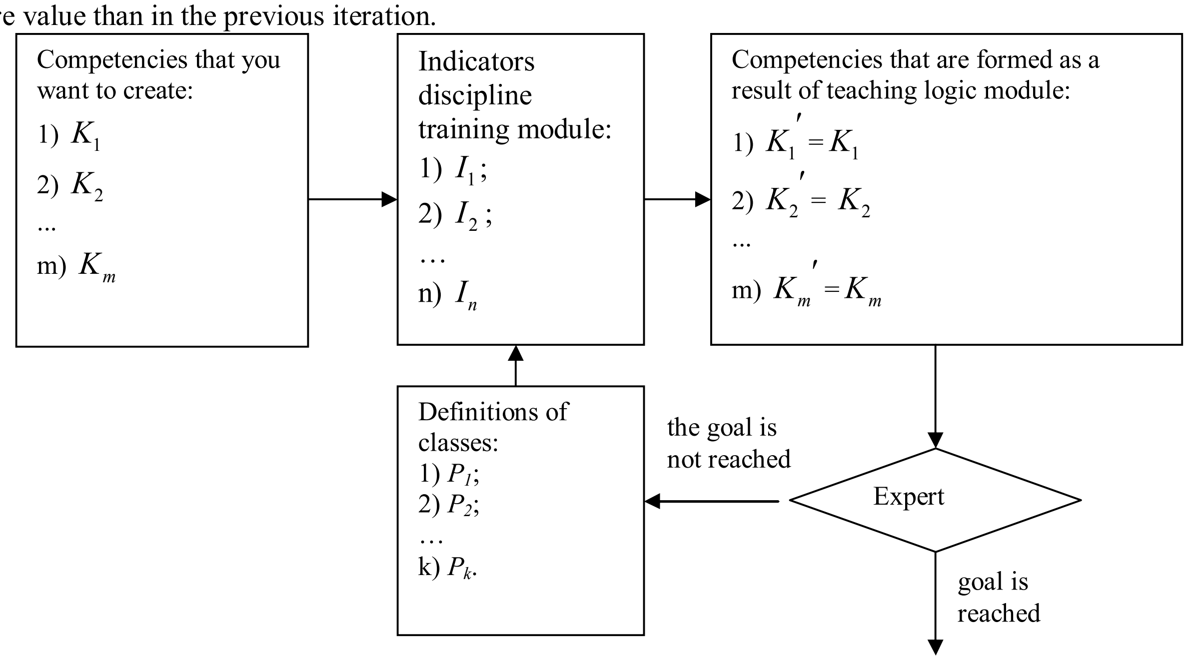

Figure. 1. Block diagram of the iterative approach of building expert teaching logic module.

Thus, the expert has to decide a difficult mathematical problem - which is logical content module, which is quantitative parameters (number of problems and issues, techniques, examples, etc.) to choose for each training session in order to achieve the maximum level indicator and "meet" in allowed for the study of logic module time. The solution to this problem, in our opinion, possibly using information technology.In terms of the mathematical solution of equation (6) subject to restrictions (9) to solve the system of matrix equations:

$$\begin{cases} [1] \times kt \times P = T_0 = const \\ [1] \times ki \times kp \times P = K(P) \to \max \end{cases} \quad (11)$$

In the system (11) is unknown quantitative parameters *P*, all other - factors *kt*, *ki*, *kp*; volume training time T_0 – is known. Thus, the solution of (11) is looking for the maximum value of the function of several variables *K(P)* in the presence of constraints.For the solution of complex systems of the form (11) to use the methods of mathematical modeling. In the simplest cases, especially when you reach a preset level of competence, rather than seek its maximum possible level, the solution of this system can be obtained manually.

Conclusions.

Implementation of training technical subjects using a modular system based on logic, the completed modules can move from assessment "ready knowledge" students to form their competence, the presence of a specialist is a basic requirement of modern labor market. The main problem with this scheme is learning is a learning module content to the level of competence formation as a result of the module was maximized. The solution to this problem is possible with the use of information technology for determining the specific parameters of each training session. The work proposed and proved the effectiveness of the information content approach to the logic modules based on the total training time constraints and the influence of parameters on the formation of classes competencies.Remains a problem of logic design interconnection modules together, the quality of their semantic content, the ideal of controls allowing for the field of study and individual academic groups.

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