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Compilation of the Education Program in Computer Science for the Students of Economic Specialties of Higher Educational Institutions

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Abstract: This article is to determine the necessity and urgency of content compilation of computer science course for the students according to their specialties in higher educational institutions. In particular, it was determined by the analysis of educational program for the students of economic specialties that the content of the computer science course should have both fundamental and variable parts. A fundamental part should provide the extension of existing knowledge and skills acquired in school until the level required for study of a material of a variable part and the variable part should ensure the study of the specific subject appropriate to the economic specialty. Therefore, the general factors affecting the acquisition of knowledge and skills required for prospective economist and related with implementation of information technology were underlined. To achieve these objectives, the general technique of expert compilation of the best possible content of educational program based on the analytic hierarchy process technique of T. Saaty has been considered.

Key words: Computer science · Training course · Specialty · Economic specialty · Analytic hierarchy process technique

INTRODUCTION

The main peculiarity of the practical activity of a modern economist is his ability to efficient and professional processing a bulk of information on the economic condition as both macro and micro levels.

In present, it is evident that an enterprise or institution carrying out the financial and economic activities based on the modern information technologies, receives significant competitive advantages, which significantly increases the need in professionals, able to realize these advantages. The current social demands and advantages of this profession clear for a man determine the social order for teaching of these specialists for both solution of pragmatic professional tasks and the tasks related with the acquisition of fundamental education [1-3].

The numerous researchers assume that the basic concepts, laws and methods related to fundamental theoretical knowledge practically implemented in the educational content and activities reflecting the main method of cognition in the subject area are the fundamental nature of education. Computer science as fundamental discipline contains several established and recognized issues and some others, which are fast developing fields of knowledge. At the same time, computer science in the training program of specialists in economics, is hardly considered among the main subjects of educational program and is being studied as a secondary discipline [3-5].

In present, the study of computer science begins in a high school and continue in the higher educational institution and these teachings often have the different goals, therefore the learning content is duplicated that results in unnecessary expenditures and losses of instructional time. Thus, there is the challenge to organize the continuous training in computer science as a part of fundamental education program in general and appropriate demands of economic specialties.

There is an extended and constantly developing list of economic specialties in the great number of higher educational institutions. The specificity of the subject appears in the difference between the requirements to the results of computer science trainings, which can significantly depend on the specialty. Consequently, the implementation of training simultaneously in several economic specialties requires the division of educational groups [5].

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Thus, we can conclude that the content of the training course in computer science for the students of economic specialties should include the fundamental and variable parts. A fundamental part should provide the extension of existing knowledge and skills acquired in school until the sufficient level for studying of a study material of variable part and the variable part should provide the study of the specific subjects relevant to the economic specialty. The solution to this task will determine the best approach to the teaching of computer science of the students of the economic specialties.

General: Analysis of the composition and qualitative characteristics of study courses in different educational–methodical complexes of computer science for students of different economic specialties and assessment of the results of some training programs in this discipline allows the determination of several basic conditions (factors) influencing the acquisition of knowledge and skills by prospective economist, related with application of information technologies:

- A great number of different basic study manuals for development of a training course on computer science. The author of a training course on computer science has to take into account that the study manuals and study programs can become outdated in 2-3 years losing their relevance in conditions of fast development of information technologies (IT) [4, 5];
- A large volume of actual material in particular discipline (dozens of different sections and topics) that are difficult separate to the fundamental and variable parts according to the specialty of students. Some study courses reach the volume from 200 to 800 pages and more [5-7];
- Significant difficulties in identification of the fundamental part of the educational course and organization of continuous training in computer science, related with the content of the school study program in this discipline to avoid the duplication of the content, which results in unnecessary expenditures and the losses of training time [5-7];
- Significant uncertainty in study topics, types of lectures and volume of study material required for revealing a content related with the compilation of a variable part according to the specialization of students [5-7].

Obviously, these factors complicate and sometimes make impossible the determination of the most efficient approach to the teaching of computer science for students of the economic specialties. Meanwhile, there is a lack of the existing methods of pedagogical science proposed for stipulation of the content of professional training in computer science.

In present, there is variety of approaches to the compilation of the content of educational courses on computer science, including the object-oriented, contextual, module-hierarchical, decomposition, etc. However, all these methods are very subjective and do not ensure the valuable courses in training of computer science [8, 9].

In present, there are training systems in a number of economic specialties reflecting the realities and demands of practical activities in the numerous countries. This system was formed during the last 50-60 years and involved a significant number of scientists and teachers, whose work reveals in the study materials and manuals and was formalized in various educational standards. These materials possess a great value and should be directly used in the computer science training courses.

Obviously, the variety of educational, methodical and informational materials on conditions and development of IT sphere creates the problem of search for the “best” content (alternatives) of training courses in computer science, therefore the determination of the best alternative of the training program requires the essential factors (described above), as well as inferences or conclusions of the authors of the study program (teachers) to determine the importance of any section (a chapter) or topic of the discipline [5-8].

One of the methods for problem solving is the method of analysis of hierarchies proposed by T. Saaty [10].

The method of analytic hierarchy process (AHP) is a simple and convenient tool to structure the problem, reveal alternatives, identify the key factors and assign their significance, evaluate alternatives for each factor, find mistakes and contradictions in the judgments of an author or expert engaged to development of the training courses, rank alternatives, analyze the solution and substantiate the results.

It is known that the AHP technique reflects the natural way of human thinking. Three principles (steps), which implementation is analytic hierarchy process were formulated and based on these properties of human thought:

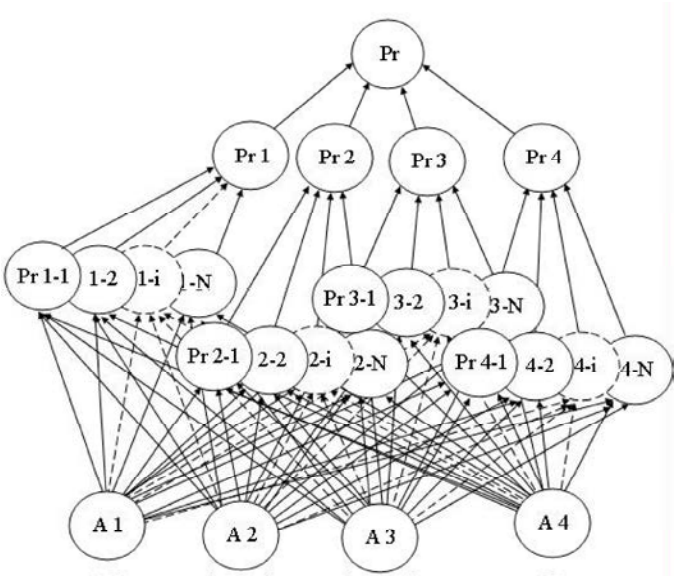

Fig. 1: Hierarchy for selection of the best possible content of an educational program for the specialists of economic specialties

- Step – the implementation of the principle of identity and decomposition;
- Step – implementation of the principle of discrimination and comparative judgments;
- Step – implementation of the principle of synthesis of judgments.

At the *first step*, the author of training courses using the AHP and facing a number of controlled or uncontrolled elements reflecting the difficult situation combines them into the groups according to distribution of certain properties between the elements.

This process repeats until the groups, or their common characteristics will be considered as elements of the next level of the system. These elements can be combined according to other properties, creating the higher-level elements and this process continues until the top of hierarchy reflecting the solution of a problem. This step is not formalized.

The described process is commonly referred to formation of hierarchies, – the multilevel system, each level of which consists of many elements or criteria (factors). Hierarchy for the selection of the best variant of the program content of computer science teaching as a system consisting of levels is shown on Fig. 1.

The top level in the hierarchy is the decision of the problem, in our case – this is the best content of the educational program for the specialists of economic specialties (Pr) (Fig. 1).

The second level of the hierarchy is composed of the possible thematic sections of the fundamental and variable parts, for example:

- Pr 1 – principles of economic computer science;
- Pr 2 – technical and software of information systems;
- Pr 3 – applied software;
- Pr 4 – information security.

The third level of the hierarchy includes the names of the chapter (topics of lectures) proposed for the appropriate sections of the program. For example, a section “the principles of economic computer science” included into a fundamental part of the course is divided into the following topics of lectures:

- Pr 1–1 – Contemporary society and the problems of its informatization;
- Pr 1–2 – Information as a strategic resource of the society;
- Pr 1–3 – Computer science as a science and a branch of applied activities;
- Pr 1–4 – Information nature of management of economic objects;
- Pr 1–5 – Economic information;
- Pr 1–6 – Information processes and technologies;
- Pr 1–7 – Organization of storage and search of information: models and methods of data storage;
- Pr 1–8 – Banks and databases;

- Pr 1-9 – Information search and legal-reference systems.

A central problem in building of the hierarchy is in determination of the strength of the influence of particular factors on the inclusion or exclusion of a certain chapter or topic of a training course at the lowest level on the hierarchy to the top, – the general objective of the "best" program.

To answer this question, the author of the program has to involve the experts to form and assess the alternative variants of the content of the educational program for the specialists of economic specialties (A1, A2, A3, A4).

Uneven influence of the factors on all topics of lectures requires the determination of the strength of the influence, or priority of the topics included into the study program. Identification of priorities for the topics of the lowest level relatively to the objective can be reduced to a sequence of the tasks to determine the priorities for each level and each task to the sequence of paired comparisons [10].

Thus, at the *second step*, each expert (a teacher or scientist) developing the program determines the best solution by gradual and paired comparison of alternatives based on the comparative judgments. This can be performed on the branches of hierarchy or by paired comparison of alternatives on the matrix of paired comparisons. In all cases, the ordering relationship on the multitude of alternatives is determined as a result of gradual paired comparison of alternatives or by the imposition of order based on comparison of the values of the multicriterion utility functions. In general, the formulation of the problem of multicriterion choice is performed in [10].

A multitude of alternatives to solve a problem $A=\{A_i\}_{i=1}^{n}$ and a multitude of criteria $Q=\{q_j\}_{j=1}^{m}$ for evaluation of the usefulness of the alternatives were assigned. Each alternative A_i receive a grade x_{ij} from the experts involved into decision making for whole multitude of criteria, where Q is a grade of the *i*-th alternative by *j*-th criterion. The grades are either points (for example, using common scale of examination grades) or the parts of unit (weight), or within the framework of fuzzy logic.

The assessment results are represented as a matrix of decisions (Fig. 2).

Then, utility function U_i is calculated for each vector of estimates $\bar{x}_i = (x_{1i}, x_{2i},...x_{mi})$ (according to an adequate situation of the decision-making and a multicriterion choice model). The best alternative is an alternative for which the utility function has a maximum value. Criterion weight w_j had been also considered in calculations of utility function.

	A_1	A_2	...	A_n
q_1	x_{11}	x_{12}	...	x_{1n}
q_2	x_{21}	x_{22}	...	x_{2n}
...	...	...	...	...
q_m	x_{m1}	x_{m2}	...	x_{mn}

Fig. 2: Matrix of decisions at paired comparison of alternatives

The determination of the best structure of the content of the educational program for the specialists of economic specialties occurs at the *third step*. It is based on thematic levels of the hierarchy of the highest priority variant (A1, A2, A3, A4) calculated using the grades received from experts with appropriate weight coefficients.

The technique described above was used by the authors for compilation of the content of educational programs for students of economic specialties in higher educational institutions of the Voronezh region. The experience of implementation of this method has shown that educational programs developed on its basis are effectively applied in the structure of academic process and the overwhelming majority of the experts adequately perceive this methodology. This technique is universal and can be used for compilation of the content of educational programs for different specialties.

The considered procedures allow the choice of the best possible structure of the content of the educational program for the specialists of economic specialty. However, the implementation of all steps is a rather difficult task and its solution requires time- and resource-consuming, what is not acceptable for the present development of educational program in computer science. In this regard, the use of the computer support and decision-making based on the AHP are tools that more appropriate in present.

CONCLUSIONS

- Analysis of the current situation related with the computer science education of the students of economic specialties has revealed a wide and constantly developing nomenclature of economic

specialties in variety of higher educational institutions. The specificity of the subject area for these students is manifested in the difference in the requirements to the content of the educational program and essentially depends on specialty.

- Comparative analysis of the known educational programs in computer science for students of economic specialties showed that, in spite of the differences, they can be conditionally divided into fundamental and variable parts, which content should be considered in development of the educational program.
- Division of educational program into fundamental and variable part is stipulated by several different factors, which considerably complicate the process. However, the current approaches to the compilation of the content of computer science educational courses are hardly promoting the sufficient development of educational programs in computer science.
- The best variant of the educational program in computer science for students of economic specialty completed using the method of expert analysis of the subject based on the analytic hierarchy process technique of T. Saaty. Experience of implementation of this technique in different higher educational institutions of Voronezh city (Russia) revealed that educational programs developed on its basis are effectively applied in the academic program and the overwhelming majority of the experts adequately perceive this methodology. This technique is universal and can be used to complete the content of educational programs for various specialties of different educational institutions.

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