УДК 519.95

MODERNIZATION OF THE UNIVERSITY MANAGEMENT SYSTEM BY MEANS OF INFORMATION TECHNOLOGIES. PART 2. THE PROCEDURE OF SIMULATION AND OPTIMAL PLANNING OF EDUCATIONAL PROCESS[1]

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Арзамасцев А.А., Зенкова Н.А., Зусман Ю.А. Модернизация системы управления университетом с использованием информационных технологий. Часть 2. Процедура оптимального проектирования учебного процесса. Приведен общий алгоритм проектирования учебного плана для системы высшего профессионального образования, учитывающий особенности группового обучения.

Introduction.[1] The major problem of the planning of educational process at present time is its insufficient formalization. This problem is becoming especially acute now due to the increased complexity of the tasks and need of new curriculum design. Today the effectiveness of project development in education is based on subjective estimates by education experts. This weakens the process of making decisions.

The computer-based procedure of educational project design is being worked out at the Computer and Mathematical Simulation Department of Tambov State University. The procedure is based on computer simulation, computer-assisted testing of students (by means of artificial neural networks) and on the statistical processing of their outcomes.

The general algorithm of the offered procedure contains the following stages.

Step 1. The definition of the initial level of the first year students for their further educational and cognitive activity in a certain specialty. In our opinion, the initial level is a complex parameter including different elements: I.Q. level, certain knowledge and skills, motivation for training, creative and other abilities, which can be used by a student within the framework of the chosen specialty. This step is the most essential because its results influence the control of the whole educational process.

Step 2. The development of the thematic plan (a full list of the themes to be studied) for the given specialty. The specialty standard contains this database.

Step 3. The determination of the possible directed graphs of educational process on the basis of the thematic plan. The selection of graphs corresponding to the certain criteria of optimality.

Step 4. The selection of independent structures from the graph and their integration into an academic course or a discipline. This is carried out on the basis of the algorithms of the complex systems decomposition.

Step 5. The determination of individual time of studying of all the themes by students. These data can be received from the questionnaires given to senior students. The outcome of this step is distribution of the time of study for each academic course.

Step 6. The determination of the distribution of the total time of study in the university (the full time to receive a degree in a certain specialty). This step is carried out by means of computer stochastic simulation.

Step 7. The solution of two alternative problems of the educational process optimization: minimization of the total time of study (task 1) and maximization of the educational level (task 2).

The object of the study, optimal design and raising efficiency is a teaching process which is schematically presented in Fig.1 in the form of a directed graph, the elements of which are educational courses and topics studied by the students.

The initial learner's level corresponds to state 1, which characterizes the intellectual, creative and other abilities of school-leavers (applicants). The aim of educational activity is to transfer a learner from state 1 to state 2 which characterizes the level of educational and professional qualification standards.

The object elements (Fig. 1) which need optimization or raising efficiency are: time of education; quality of learning educational topics and courses; distribution of total time among separate courses and its dependence on the given contingent of students; decomposition of a group of interconnected topics into an independent educational course.

Difficulties of teaching process planning are:

1. It is accepted to consider that having passed entrance university exams an applicant demonstrates a certain level which is taken as a point of orientation while scheduling a curriculum. In fact instead of having a fixed level we have some casual value the distribution of which (according to a nine-grade scale) for one of the specialties of Tambov State University is shown in Fig. 2.

2. As a result the graph of the teaching process built on the basis of intuition and expert evaluations has a number of defects:

– the necessary preceding of educational topics and courses is not taken into account to a full extent; the fact is

[1] This work is being carried out within the framework of TEMPUS TACIS project "System Modernization of University Management" (SMOOTH, UM_JEP-24217).

that some of the courses must be necessarily based on the previous ones, while other courses are based only on the applicant's level of knowledge;

– the time of studying a particular topic is usually expected to be fixed and its value is usually presented in the curriculum; however it is quite obvious that the time of studying a particular course is an individual feature of a learner and consequently it is a random quantity characterized by some distribution (Fig. 3); the latter is true for non-individual teaching;

– educational topics are integrated into separate courses to a considerable extent subjectively which may lead to either the revision of some topics in different courses or to the fact that some topics will not be passed in any of the courses.

3. Planning the total time of the teaching process taking into consideration an «average student» results in the following paradoxical situations:

– «strong» students quickly master a given course and are frankly bored at the rest of the lectures;

– «weak» students do not manage to master a course in due time and fail at the exams (which results in a high percentage of dismissal and is uneconomical for both educational institutions and a state as a whole); the alternative is a bad practice when an exam or a credit test is passed without any grounds (which in the long run leads to the fact that undergraduate students do not meet educational and professional standards);

– there is no reasonable explanation to the fact why the total time of teaching is taken for this or that term (usually it equals to 5 years at Russian universities); for example, it is quite possible that mastering one specialty needs only 4 years and 7 months while mastering another specialty – 5 years and 9 months; it is also possible that the total time of teaching may be varied for various initial levels of applicants.

The problem of applicants' initial level identification is being solved with using the apparatus of artificial neural networks [1–5]. Structure of first-year students' readiness for cognitive activity is shown in Fig. 4 (for students of exact sciences) and the parameters of an artificial neural network is shown in Fig. 5.

We have developed the simulation of time characteristics and decomposition of the educational process graph in our special researches [1–4].

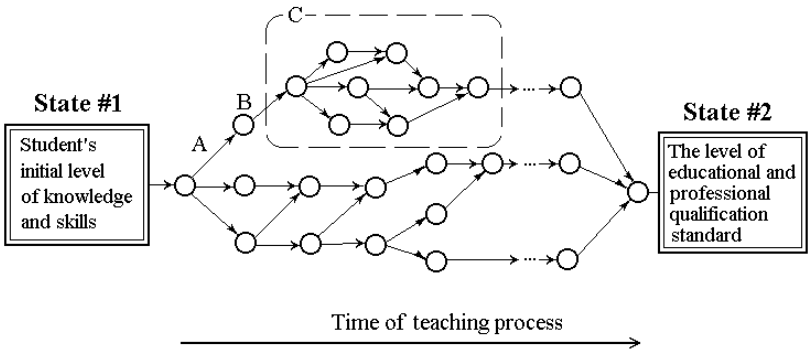


Fig. 1. The scheme of learner's steps on a «tree-like» way of teaching process. The letters stand for the following: A (line with an arrow) – a process of studying a separate educational topic or a short course; B (circle) – a state corresponding to the completion of topic assimilation;
C (closed area) – several interconnected topics isolated from other parts of the graph making up an educational discipline

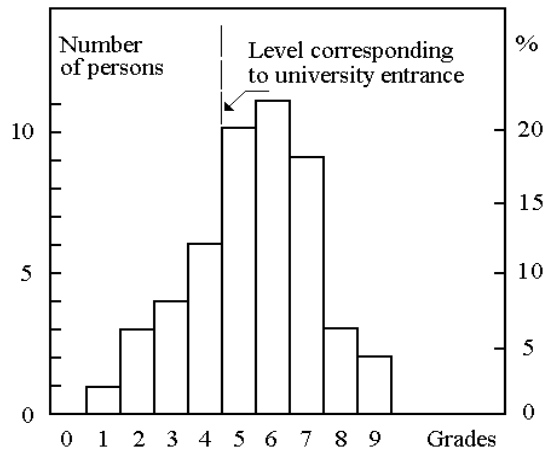


Fig. 2. Distribution of the initial level of applicants' knowledge at one of the universities of Russia. Level evaluation is determined according to the nine-grade scale. The dotted line shows the level corresponding to university entrance

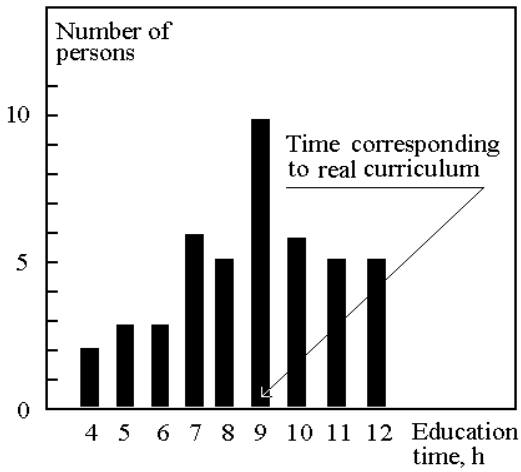


Fig. 3. Distribution of the time needed to master a certain topic by various students at one of the universities of Russia

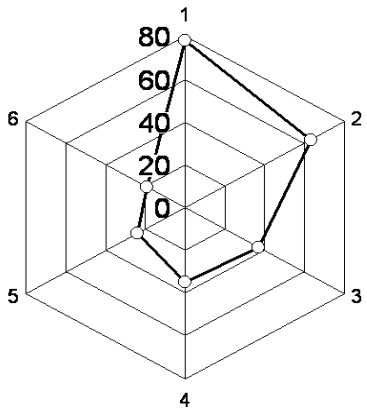
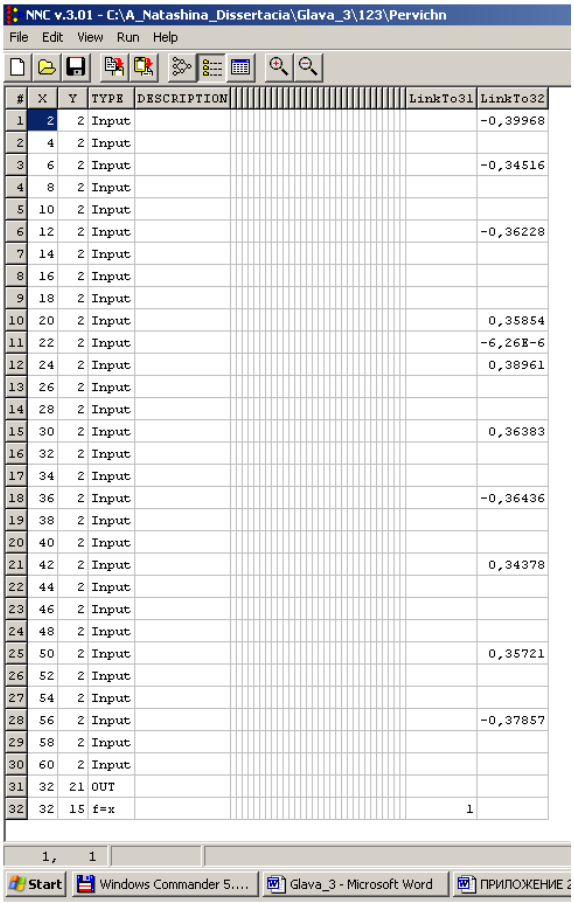


Fig. 4. 1 – motivation level; 2 – ability for intellectual activities; 3 – capability for modeling and decision-making in a given field; 4 – starting education level; 5 – capability for memorizing; 6 – logical thinking



#	X	Y	TYPE	DESCRIPTION	LinkTo31	LinkTo32
1	2	2	Input			-0,39968
2	4	2	Input			
3	6	2	Input			-0,34516
4	8	2	Input			
5	10	2	Input			
6	12	2	Input			-0,36228
7	14	2	Input			
8	16	2	Input			
9	18	2	Input			
10	20	2	Input			0,35854
11	22	2	Input			-6,26E-6
12	24	2	Input			0,38961
13	26	2	Input			
14	28	2	Input			
15	30	2	Input			0,36383
16	32	2	Input			
17	34	2	Input			
18	36	2	Input			-0,36436
19	38	2	Input			
20	40	2	Input			
21	42	2	Input			0,34378
22	44	2	Input			
23	46	2	Input			
24	48	2	Input			
25	50	2	Input			0,35721
26	52	2	Input			
27	54	2	Input			
28	56	2	Input			-0,37857
29	58	2	Input			
30	60	2	Input			
31	32	21	OUT			
32	32	15	f=x		1	

Fig. 5. The coefficients of computer model (artificial neural network)

On the basis of all this, we have developed an automation complex described in the article [6].

We are going to use the above mentioned methodology for the optimal design of educational process and its optimization in the Institute of Mathematics, Physics and Informatics at Tambov State University within the framework of TEMPUS TACIS project “System Modernization of University Management” (SMOOTH, UM_JEP-24217).

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Поступила в редакцию 14 сентября 2005 г.