International Journal of Education and Information Technology
Vol. 1, No. 1, 2015, pp. 1-10
http://www.publicscienceframework.org/journal/ijeit

Information Systems in Management of the Student Self-Education Process

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Abstract

The paper presents the model of the information system designed to organize and manage the student self-education process. There is shown that with the current methods of teaching in universities the principle of individualization of teaching can be implemented only during individual student's work. The method of individual plans forming and the method of redistribution according to typological groups are proposed. The first method is based on the choice of individual methods according to different levels of complexity for individual student's work. The second one is carried out according to the modified method of k-means of McKean. Individual methods are adjusted to distribute a student of a typological group on the basis of incorrect answers to questions given by the time of module control and student's choice of the set of competences which the students want to acquire during their studies. Proposed methods of information technology can help solve problems the individualization of the education at higher educational institutions and therefore improve students' performance.

Keywords

Information System, Independent Work of Students, Behaviour of Students, Individual Plans, Typological Groups, Product Model, Frame Model, Semantic Network

Received: February 27, 2015 / Accepted: March 20, 2015 / Published online: March 26, 2015

1. Introduction

In modern society, education has become one of the most extensive human activities. Education, especially higher education, is seen as a major leading factor for the social and economic progress. At the present stage of development of education, special attention is paid to the creation of a single information and the design of a information system for management of education. This article deals with new possibilities of modern information system according to the management of teaching process on the basis of decision-making theory, heuristic methods of knowledge representation, artificial intelligence theory, fuzzy set theory and others. During the research of higher education, for example the course called "Computer Science", it has been revealed that students enroll in college having different levels of training [1].

Taking into account the personal characteristics of each student, in particular the student's ability to learn, it has been concluded that for successful training of a group of students there's a necessity to introduce a personalized technology into the teaching process [2].

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Since the principle of individualization requires transforming a lot of data, an information system is needed to organize the whole process of learning, which is, according to Encyclopedia Britannica, is "an integrated set of components for collecting, storing, and processing data and for delivering information, knowledge, and digital products" [1]. Leonard Jessup and Joseph Valacich stated that "computer-based information systems are complementary networks of hardware/software that people and organizations use to collect, filter, process, create, & distribute data (computing)" [3].

There are different kinds of information systems, for instance: expert systems, decision support systems, transaction processing systems, office system, knowledge management systems and so on.

The paper presents the example of knowledge management systems which, according to Irma Beccera-Fernandez and Rajiv Sabherwal, are "applications resulting from such synergy between the latest technologies and social/structural mechanisms"[4]. The education needs more and more information systems to organize process of teaching and verifying students' achievements but if the university authorities decide to individualize this process, the information system is essential to organize this process in order to help each student learn and develop their skills according to an individual plan and program. Currently, however, for the task of individualization of teaching there is no clear evidence-based guidance.

University professors often work with a large group of students, so that the teacher is not physically in a position to make up an individual work plan for each student. Consequently, for implementation of the principle of individualization of the teaching process, the teacher needs a tool to create individual education plans for students. On the other hand, when methods of teaching a group are considered, each student is not able to work at the same pace, so they need individual plans. In the paper there is shown that with the current methods of teaching in universities the principle of individualization of teaching can be implemented only during individual student's work (ISW).

Recently, the technology of modular training has become popular in the practice of higher education. As part of the credit-module concept, a half of hours assumed for studying different courses is allocated for ISW. In this case, teachers have no tools to organize and direct the work of students after teaching hours. The usage of information system in the educational process allows teachers to organize effective training for each student and promote pedagogical work on a higher quality level corresponding to the present level of development of science and technology.

For ISW organization, that is for individual plans formation, the following assumptions for the system have been made:

1. Individual plans are formed on the basis of individual methods, which are recommended to students for independent work and depend on their level of competence during the course.

2. The level of student's competencies on the taught subject is measured by means of the test in Moodle environment according to a 100-point scale.

3. Individual techniques are developed by teachers who teach a particular course and constitute a bank of individual practices.

4. Selection of individual techniques is carried out in accordance with the distribution of students into typological groups in pursuance of the predicted performance.

5. Prediction of student's performance is held at the beginning of each course, the study of which is based on cluster analysis. Having regard to this, the modification of the k-means method of McKean was proposed [5].

6. According to the results of performance prediction, the students are divided into typological groups and after that they are offered techniques for self-preparation appropriate to their individual typological groups.

7. After the control of each module there is performed a redistribution of students into typological groups by means of cluster analysis application.

8. Individual methods are adjusted to distribute a student of a typological group on the basis of incorrect answers to questions given by the at the time of module control and student's choice of the set of competences which the students want to acquire during their studies.

The functional diagram of the information technology for ISW plan's formation is shown in Fig. 1.

2. Description of the Information System of ISW Plan's Formation

2.1. Testing in the Moodle System

It is used to assess the level of student's competences before the beginning of the course. There can be used a set of tests for assessing the level of knowledge, skills and abilities of students of the course before the beginning of studying in the Moodle or any other test system [6, 7].

[1] http://www.britannica.com/EBchecked/topic/287895/information-system, [01.02.2015].

2.2. Method of Predicting Performance

It is necessary for initial pre-assessment of students' readiness and abilities. It was developed on the basis of clustering procedure and is proposed in [5].

Initial data for prediction consists of: the initial level of knowledge of the discipline (measured at the first lesson in the testing environment, Moodle), the level of student's competence formed on the first topic of a given discipline, absenteeism of classroom at the time of the forecast.

2.3. The Method of Typological Groups' Distribution

After the predicting procedure, each student is allocated to one of four typological groups. If a student is expected to score less than 60 points, he/she is distributed to the class of "Poor", when the score from 60 to 74 points is projected – the student is allocated to the class of "satisfactory", if 75 to 89 points – to the class of "Good", and 90 to 100 points – to the class of "Excellent". The distribution of students into typological groups is not definitive, because during the semester, students have the opportunity to change their grades and be redistributed to another typological group.

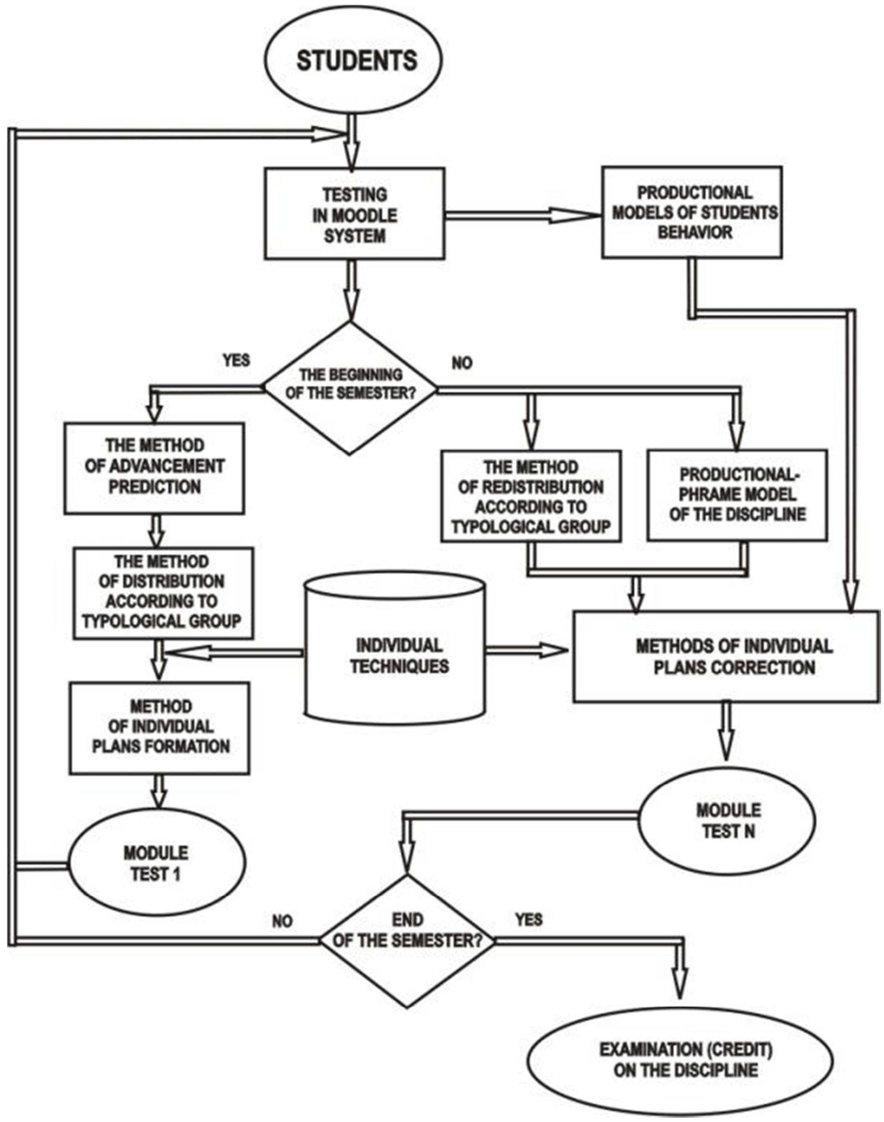

Fig. 1. Block diagram of the information system designed for formation of individual students' work plans

2.4. Method of Individual Plans Forming

It is based on the choice of individual methods according to different levels of complexity for ISW. The complexity level of the selected tasks depends on a student's membership in a certain typological group. The effectiveness of the given method is verified by methods of nonparametric statistics which were proved during experiments conducted at KhNAHU [2] in years 2010-2011. The experiments were carried out on the sample of the course" Informatics". In the

[2] KhNAHU – Kharkov National Automobile and Highway University

experiment in the year 2010 there were involved 136 first-year students. For these students there were drawn up forecasts of their performance, which were then compared with the record-achievers. These students were taught using traditional methods. The results of the experiment are shown in Fig. 2.

In the experiment of the year 2011 there were involved 61 first-year students who were asked to get involved in the studying process according to their own individual plans. For them there were also drawn up forecasts of their performance. The experiment's results are shown in Fig. 3.

These diagrams show that the actual performance of students in 2011 on the average is higher than the predicted one, and that of students in 2010 – on the contrary, the prediction performance is higher than the real one. This result suggests that students who were engaged in individual plans were able to realize their potential more effectively and the level of their results of learning the material of the course ”Informatics” was higher.

The comparative data of forecasted performance of students on various technologies is presented in Table. 1.

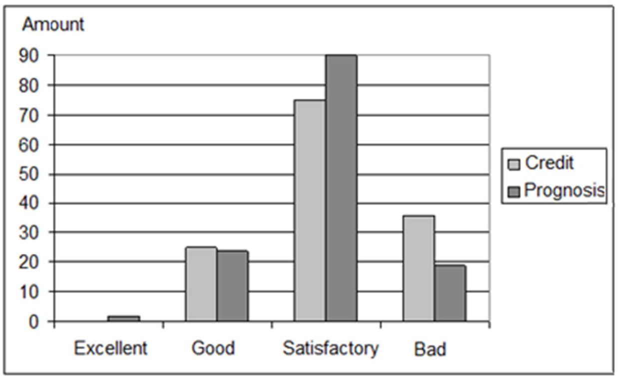

Fig. 2. The comparison chart of the course and forecast data of the experiment conducted in 2010

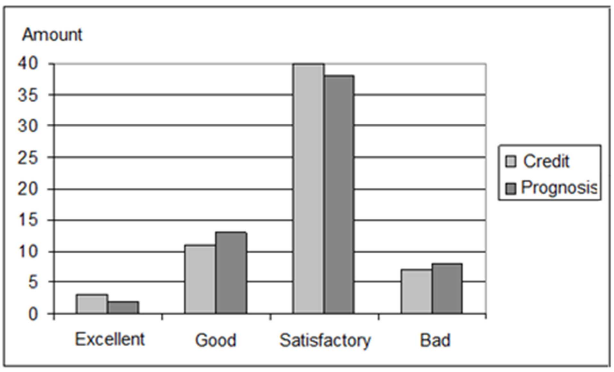

Fig. 3. The comparison chart of credit and forecast data of the experiment conducted in 2011

Qualitative performance is the percentage of students with academic performance as "good" and (or) "excellent" to the total amount of students. Absolute performance is the percentage of students without estimates "unsatisfactorily" to the total amount of students.

Tab. 1. The comparative data of prediction and students record performance

	Education according to traditional technology		Education according to individual plans	
	Qualitative performance	Absolute performance	Qualitative performance	Absolute performance
Prediction	19,12%	85,29%	24,59%	86,89%
Credit	18,38%	73,53%	22,95%	88,52%

According to the data shown in Table 1, it can be noticed that the application of the developed method for forecasting of the performance of ”Informatics” students exceeds the absolute progress of students taught by traditional methods by 15%. The increase in the absolute performance is achieved by reducing the number of low performers from the groups of better prepared students. Thus, it can be seen that organization of independent student's work is more effective.

The homogeneity of the source data in the experiments was tested by two methods of nonparametric statistics: the median test and the Wilcoxon-Mann-Whitney test. Both methods confirmed that the original data in the experiments was homogeneous with uniform probability equal to 0.95.

The effectiveness of the method of formation of individual plans for ISW was also tested using nonparametric statistics and confirmed by the Kolmogorov-Smirnov test with a probability of 0.95.

2.5. Production Models of Students' Behaviour

Students have different goals and motivation during training, which is defined as the preferences of students to evaluate their competence in the final test (exam). There are models of students' behaviour:

1) just to pass the exam;

2) it is desirable to pass the exam with a "good" or "excellent" mark;

3) get only a "good" or "excellent" mark;

4) it is desirable to pass the exam with at least an "excellent" mark

5) pass the exam with only an "excellent" mark.

Let is write models of students' behaviour s in the language of the predicate:

MB1. $\forall\chi\left[P,V\uparrow(\lambda(\chi))\to K_y=60\le\lambda(\chi)<75\right]$,

MB2. $\forall\chi\left[P,V\uparrow(\lambda(\chi))\to K_x\subseteq K_y=60\le\lambda(\chi)<90\right]$,

MB3. $\forall\chi\left[P,V\uparrow(\lambda(\chi))\to K_x=75\le\lambda(\chi)<90\right]$,

MB4. $\forall\chi\left[P,V\uparrow(\lambda(\chi))\to K_o\subseteq K_x=75\le\lambda(\chi)<100\right]$, MB5. $\forall\chi\left[\mathrm{P}, \mathrm{V}\uparrow(\lambda(\chi)) \to \mathrm{K_o} = 90 \le \lambda(\chi) < 100\right]$,

where MB1, MB2, …, MB5 – models of students' behaviour; $\forall\chi$ – all students were studying the discipline "Informatics"; P – predicate that reflects desire of the student; $\mathrm{V}\uparrow$ – operator of the possibility; $\lambda(\chi)$ – student's mark. On the subject "Informatics"; $\mathrm{K_y}$ – class "Satisfactory"; $\mathrm{K_x}$ – class "Good"; $\mathrm{K_o}$ – class "Excellent".

Formalize the preferences of students to assess their competencies in pass (examination) and identify students' behaviours. Description of the models is presented in [8].

2.6. The Method of Redistribution According to Typological Groups

It is carried out according to the modified method of k-means of McKean [5] to evaluate the current students' progress on the factors, $f_i \in F, i = \overline{1,6}$, where F is a set of factors affecting the student performance; i is an index (the number of factors); f_1 denote the level of basic knowledge in the discipline; f_2 – the average score for subjects of the studied discipline; f_3 – the number of missed classes; f_4 – the average score with taking into account the material forgetting of the previous topics; f_5 – the average score given the ISW; f_6 – the results of the modular control (evaluated by means of the Moodle testing system). It is the basis for adjustment of individual plans for ISW.

The average score for the studied subjects of a given course (factor f_2) is calculated using the following formula:

$$f_2 = \frac{\sum_{1}^{NS} Z_n}{MS}, \qquad (1)$$

where NS denotes the number of subjects of a given course; Z_n – the level of students' competencies for the n-th topic of the course, which is measured during the process of testing in scores on a 100-point system of estimate.

The average score given by forgetting the previous material (factor f_4) is calculated using the formula (2), which was obtained experimentally [9]:

$$f_4 = \sum_{1}^{NS} Z_n - Z_n \cdot 0,2(MS - n), \qquad (2)$$

where Z_n denotes the information about the student's academic achievement on the n-th subject of the course in points on a 100-point scale; n – the number of the course topic.

The average score after the ISW (factor f_5) is calculated using the formula (3), determined experimentally [9, 10]:

$$f_5 = f_4 + 0,35 f_4. \qquad (3)$$

The process of students' redistribution into typological groups based on a dedicated in work [8] set of clear non-dominant alternatives is formalized by productional rules.

For the model of students' behaviour MB1 ("just to pass the exam"), there is one clear non-dominant element – the transition from the group "Bad" into any other group. For students from the group "Bad" there is the $\mathrm{M_b}$ method, the usage of which helps the students obtain a positive evaluation of the discipline. A graphical representation of the transition function from the group "Bad" at the behaviour model 1 is shown in Fig. 4.

Agreed notations in Fig. 4 – Fig. 8:

 – a graphical representation of a fuzzy area students belonging to the class of "bad";

 – a graphical representation of a fuzzy area of progress, to which students choose to belong;

 – a graphical representation of a fuzzy area of progress, in which students have the opportunity, but do not choose to move;

 – a graphical representation of a fuzzy area of progress, in which students have the opportunity to move with the own preference.

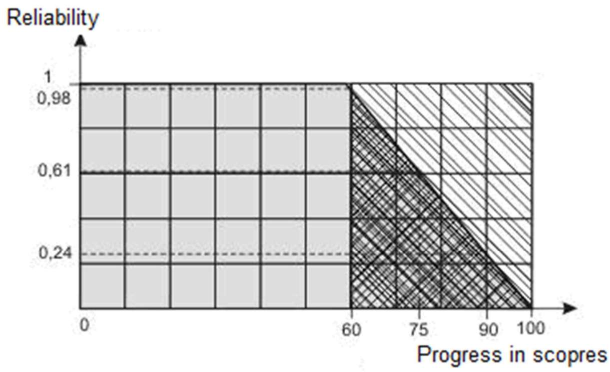

Fig. 4. Graphical representation of the possibility of students' transition with MB1 from the class of "Bad"

Let us describe the conditions for transition of students from the group "Bad" by means of productional rules:

$$PS1(C_b) = \langle C_b; MB1; M_b; \mu : C_s \to (0,61; 0,98] \rangle, \qquad (4)$$

$$PG1(C_b) = \langle C_b; MB1; M_b; \mu : C_g \to (0,24; 0,61] \rangle, \qquad (5)$$

$$PE1(K_b) = \langle C_b; MB1; M_b; \mu : C_e \to [0;0,24] \rangle, \quad (6)$$

$$PS1(C_b) \sim PG1(C_b) \sim PE1(C_b). \quad (7)$$

Production rules (4) – (6) determine that for a student from the C_b group with the model of behaviour MB1, studying according to the M_b method, transition into the class C_s with confidence μ within $(0,61;0,98]$ is possible; into the class of C_g – with certainty μ within $(0,24;0,61]$, and into the class C_e – with certainty μ within $[0;0,24]$. Expression (7) takes into account the equivalency of the student's preference.

For the model of students' behaviour MB2 ("it is desirable to pass the exam with a "good" or "excellent" mark") there is also one clearly non-dominant element – transition from the group "Bad" into any other group. For students with preferences MB2 it is also recommended to apply the M_b technique. A graphical representation of transition function from the group "Bad" at MB2 behaviour model is shown in Fig. 5.

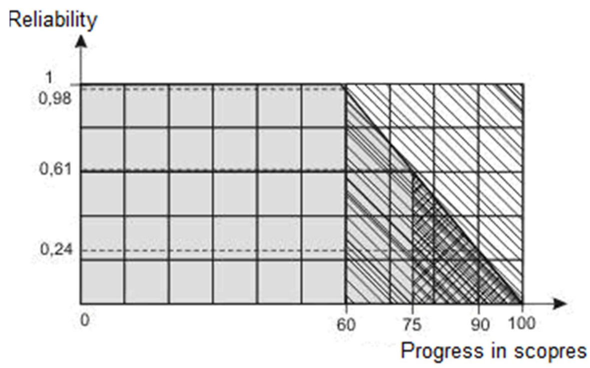

Fig. 5. Graphical representation of the possibility of students' transition with MB2 from the group "Bad"

Productional rules of transition from group "Bad" for MP2 students' behaviour model are represented by (8) – (11):

$$PS2(K_b) = \langle C_b; MB2; M_b; \mu : C_s \to (0,61;0,98] \rangle, \quad (8)$$

$$PG2(K_b) = \langle C_b; MB2; M_b; \mu : C_g \to (0,24;0,61] \rangle, \quad (9)$$

$$PE2(K_b) = \langle C_b; MB2; M_b; \mu : C_e \to [0;0,24] \rangle, \quad (10)$$

$$PG2(C_b) \sim PE2(C_b) \succ PS2(C_b). \quad (11)$$

For the model of students behaviour MB3 (get only a "good" or "excellent" mark), there are two clearly non-dominant elements – transition from the group "Bad" and transition from the group "Satisfactory" into the group "Good" or the group "Excellent". For students from the group "Bad" it is recommended to apply the M_b methodology, and for students from the group "Satisfactory" – the technique of M_s. Graphical representations of transition functions of the group "Bad" and the group "Satisfactory" at MB3 is shown in Fig. 6.

Productional rules of the transition from group "Bad" for MB3 are expressed by (12) – (14):

$$PG3(C_b) = \langle C_b; MB3; M_b; \mu : C_g \to (0,24;0,61] \rangle, \quad (12)$$

$$PE3(C_b) = \langle C_b; MB3; M_b; \mu : C_e \to [0;0,24] \rangle, \quad (13)$$

$$PG3(C_b) \sim PG3(C_b). \quad (14)$$

Production rules of transition from the group "Satisfactory" for MB3 are represented by formulas (15) – (17):

$$PG3(C_s) = \langle C_s; MB3; M_s; \mu : C_g \to (0,39;\ 0,96] \rangle, \quad (15)$$

$$PE3(C_g) = \langle C_g; MB3; M_g; \mu : C_e \to [0;0,39] \rangle, \quad (16)$$

$$PG3(C_s) \sim PE3(C_s). \quad (17)$$

For the model of students behaviour MB4 (it is desirable to pass the exam with at least an "excellent" mark), there are also two distinct non-dominant elements – transition from the group "Bad" and transition from the group "Satisfactory" into the group "Good" or the group "Excellent". Graphical representations of transition functions of the group "Bad" and the group "Satisfactory" in MB4 are shown in Fig. 7.

Productional rules of transition from the group "Bad" to MB4 are represented by correlations (18) – (20):

$$PG4(C_b) = \langle C_b; MB4; Mb_n; \mu : C_g \to (0,24;0,61] \rangle, \quad (18)$$

$$PE4(C_b) = \langle C_b; MB4; M_b; \mu : C_e \to [0;0,24] \rangle, \quad (19)$$

$$PE4(C_b) \succ PG4(K_b). \quad (20)$$

Productional rules of transition from the group "Satisfactory" for MB4 are represented by correlations (21) – (23):

$$PG4(C_s) = \langle C_s; MB4; M_s; \mu : C_g \to (0,39;0,96] \rangle, \quad (21)$$

$$PE4(C_s) = \langle C_s; MB4; M_s; \mu : C_e \to [0;0,39] \rangle, \quad (22)$$

$$PE4(C_s) \succ PG4(C_s). \quad (23)$$

For modeling the students behaviour MP5 (pass the exam with only an "excellent" mark), there are three distinct non-dominant elements – transition from the group "Bad", transition from the group "Satisfactory" and transition from the group "Good" into the group "Excellent". For students from the group "Bad" it is recommended to apply the M_b

method, for students from the group "Satisfactory" – the technique of M_s, and for students from the group "Good" – the technique M_g.

Graphical representations of transition functions at MP5 are shown in Fig. 8.

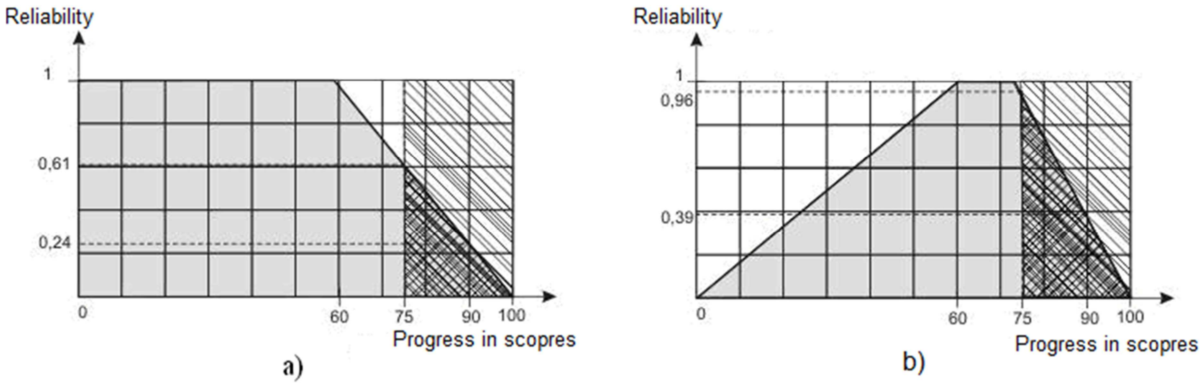

Fig. 6. Graphical representation of the possibility of students' transition with MB3: a) from the group "Bad", and b) from the group "Satisfactory"

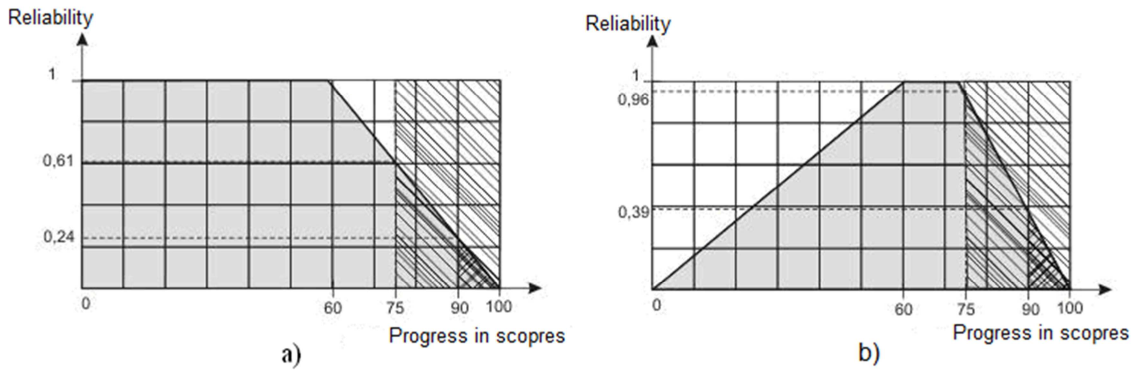

Fig. 7. Graphical representation of the possibility of student's transition with MB4: a) from the group "Bad", and b) from the group "Satisfactory"

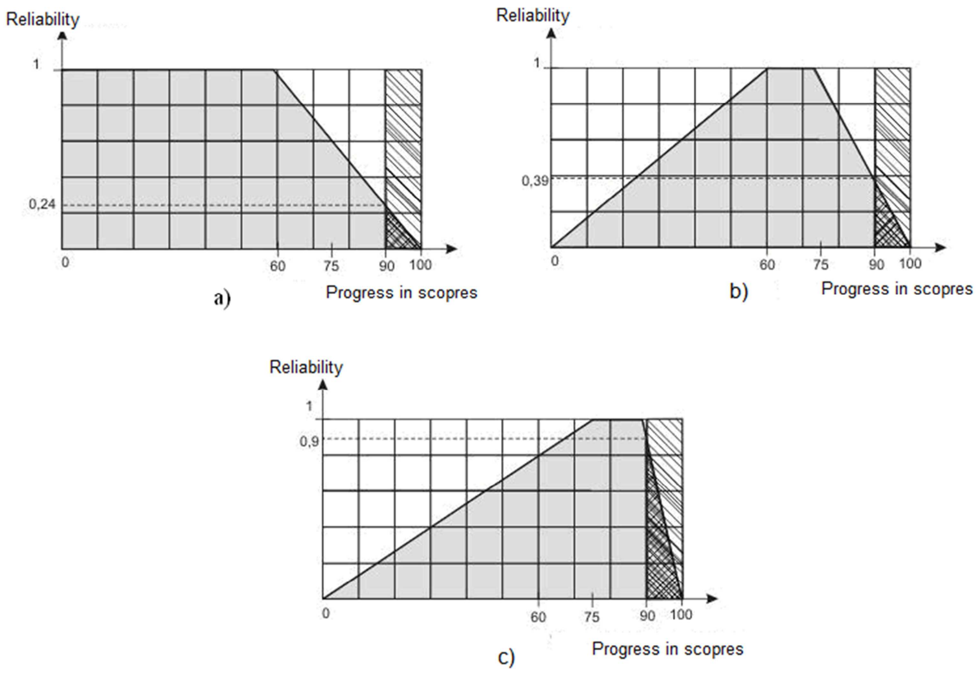

Fig. 8. Graphical representation of the possibility of student's transition with MB5: a) from the group "Bad", b) from the group "Satisfactory", and c) from the group "Good"

Productional rules of transition from the group "Bad", from the group "Satisfactory" and the group "Good" for MB5 are represented by (24) – (26), respectively:

$$PE5(C_b) = \langle C_b; MB5; M_b; \mu : C_e \to [0;0,24] \rangle, \quad (24)$$

$$PE5(C_s) = \langle C_s; MB5; M_s; \mu : C_e \to [0;0,39] \rangle, \quad (25)$$

$$PE5(C_g) = \langle C_d; MB5; M_g; \mu : C_e \to [0;0,9] \rangle. \quad (26)$$

2.7. Productional-Frame Model of the Course

Productional-frame model of the course has been designed to formalize the structure of the course. It allows to select the necessary material for the ISW depending on the questions that were answered wrongly during the test.

The formalization of the discipline structure will be considered on example of the course "Informatics". Let us represent the course "Informatics" in the form of a semantic network [11, 12]. According to the curriculum, the course "Informatics" consists of seven topics:

1. Basic information about computer engineering (T1).
2. Software Grading (T2).
3. Basic concepts and principles of work in Windows (T3).
4. File Managers (T4).
5. Programs – archivers (compression tools). Virus control (T5).
6. Text editor Microsoft Word (T6).
7. Spreadsheet Microsoft Excel (T7).

The semantic web course "Informatics" is shown in Fig. 9.

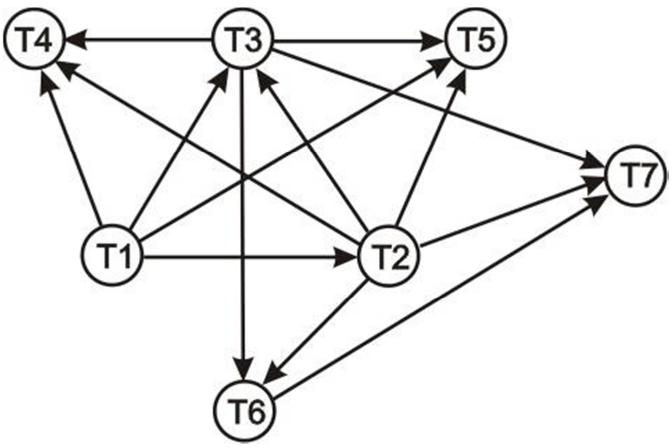

Fig. 9. Illustration of links of "Computer Science" course

Analytically, the semantic web is a set of sets of pairs of course topics: {(T1, T2), (T1, T3), (T1, T4), (T1, T5), (T2, T3), (T2, T4), (T2, T5), (T2, T6), (T2, T7), (T3, T4), (T3, T5), (T3, T6), (T3, T7), (T6, T7)} and a set of relations between them. To identify the structural organization of each subject of the course, let us represent the studying material in the form of a frame [11].

The generalized knowledge structure represented by the frame is given by:

$$\{IF, \langle Is1 : Zs1 \rangle, \langle Is2 : Zs1 \rangle, ..., \langle Is\,n : Zs\,n \rangle\}, \quad (27)$$

where IF denotes the name of frame; Is i – the name of the i-st slot; Zs i – the value of the i-st slot.

The names of the frames will be defined in strict accordance with lesson topics on the course "Informatics", i.e., each subject of the course will be presented by a separate frame.

We shall distinguish the following slots:

1) slots – lectures (sl), consisting of slots – lecture questions (sv);

2) slots – labs (slr), consisting of slots – laboratory tasks (slz);

3) time slots (st), which store information about the time of subjects study.

Sv and slz values shall be interpreted by means of vague statements, the degree of truth which takes values within the interval of [0,1].

To simulate the learning process of students at additional lessons according to the individual program there will be introduced the concept of empty slots $\langle \varnothing : \varnothing \rangle$ in which the names and values are missing.

Given the above, we will express the frame of the course "Informatics" in the form of formula:

$$\tilde{F}=\Bigg\{T_i\Big\langle L_{1,T_i}:\Big\langle \overbrace{V_{1,L_1}:(\mu:D\to[0,1])}^{sv_1}\Big\rangle,\ldots,\Big\langle \overbrace{V_{q_1,L_1}:(\mu:D\to[0,1])}^{sv_{q_1}}\Big\rangle\Big\rangle\to[0,1],\ldots,$$
$$\ldots,\Big\langle \overbrace{L_{m,T_i}:\langle V_{1,L_m}:(\mu:D\to[0,1])\rangle,\ldots,\langle V_{q_m,L_m}:(\mu:D\to[0,1])\rangle}^{sl_m}\Big\rangle\to[0,1]\times$$
$$\times\Big\langle LR_{1,T_i}:\Big\langle \overbrace{Z_{1,LR_1}:(\mu:D\to[0,1])}^{slz_1}\Big\rangle,\ldots,\Big\langle \overbrace{Z_{k_1,LR_1}:(\mu:D\to[0,1])}^{slz_{k_1}}\Big\rangle\Big\rangle\to[0,1],\ldots, \tag{28}$$
$$\ldots,\Big\langle \overbrace{LR_{j,T_i}:\langle Z_{1,LR_j}:(\mu:D\to[0,1])\rangle,\ldots,\langle Z_{k_j,LR_j}:(\mu:D\to[0,1])\rangle}^{slr_j}\Big\rangle\to[0,1]\Big\rangle\to$$
$$\to[0,1]\Big\langle \overbrace{T^t:\langle t_{r_1}:zt_{r_1}\rangle,\ldots,\langle t_{r_9}:zt_{r_9}\rangle\langle t_{lr_1}:zt_{lr_1}\rangle,\ldots,\langle t_{lr_9}:zt_{lr_9}\rangle}^{st}\Big\rangle\times$$
$$\times\Big\langle \overbrace{\varnothing\langle\langle\varnothing\rangle,\ldots,\langle\varnothing\rangle\rangle}^{\varnothing}\Big\rangle\Bigg\},$$

where $\tilde{F}$ denotes the frame of the discipline; T_i – the name of the i-st subject of the course, $i=\overline{1,7}$; L_{1,T_i}, L_{m,T_i} – the first and last name of the i-st lecture topic of the course, m – the number of lectures in the i-st topic; V_{1,L_1}, V_{q_1,L_1} – the name of the first and last issue of the first lecture, q_1 – the number of questions in the first lecture; V_{1,L_m}, V_{q_m,L_m} – the name of the first and last question of the last lecture, q_m – the number of questions in the last lecture; LR_{1,T_i}, LR_{j,T_i} – the first and last name of the laboratory work on the i-st subject; j – the number of laboratory works on the i-st topic; Z_{1,LR_1}, Z_{k_1,LR_1} – the name of the first and last assignment in the first laboratory work, k_1 – the number of assignments in the first lab; Z_{1,LR_j}, Z_{k_j,LR_j} – the first and last name of the assignment in the last lab, k_j – the number of assignments in the last lab; μ – the membership function; D – the study materials of the appropriate slot; T^t – the amount of time allocated for the study of the lectures of the study material according to the timetable; t_{lr} – time intervals allocated for the study material according to the schedule of lectures; t_{lr} – time intervals allocated to carry out laboratory work according to the schedule of classes.

2.8. Method of Individual Plans Adjustment

Method of individual plans adjustment consists in forming the set of theoretical knowledge and practical tasks directed to achieve the desired estimate by a student on the basis of a more detailed study of specific topics of a given course, which causing difficulties to the student [13, 14]. It is formalized by productional rules of individual plans adjustment:

$$\begin{aligned}PB&=\langle C_b;T_i;MBS;M_b\to M_i\rangle,\ i=\overline{1,7};\\ PS&=\langle C_s;T_i;MBS;M_b\to M_i\rangle,\ i=\overline{1,7};\\ PG&=\langle C_g;T_i;MBS;M_g\to M_i\rangle,\ i=\overline{1,7},\end{aligned} \tag{29}$$

where PB, PS, PG denote production rules of individual plans adjustment for students' self-study of the typological group "Bad", "Satisfactory" and "Good" respectively; C_b, C_s, C_g – conditions of a student membership to the appropriate class; T_i – subject of the course in which the student has a failing grade; MBS – model of students behaviour to achieve the desired evaluation of their competence at the final test (examination) M_b, M_s, M_g – individual methods for students self-study of the appropriate class, M_i – adjusted methodology with in-depth training on the i-st subject of the course.

3. Conclusions

Development of information systems will automate the process of individual plans formation for self-study and take into account motivations and personal abilities of students, which is especially important when education takes place in large groups.

Application of the information system for forming of individual plans of ISW releases teachers from the laborious process of each student's progress's analysis. Moreover the system can make recommendations, so it can improve the academic achievement of each student.

Introduction of the information system of individual plans formation of the independent self-study work of students into the teaching process allows organizing, controlling and managing of the ISW, which leads to increased efficiency of the ISW and has a positive effect on students performance.

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