Increasing the efficiency of the educational process through research of the knowledge dynamic

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***Abstract**: Different kinds of systems describing knowledge dynamic and their corresponding Petri net models are previewed in this paper. The most essential moments of the three basic stages of the learning process are described – knowledge assimilation, control and forgetting. Various possibilities for enhancing and increasing the effectiveness of the educational process are being looked into. The purpose of this paper is to demonstrate the description of the knowledge dynamic by using the instruments of the Petri nets.*

***Key words:** Education, Petri nets, Knowledge dynamic*

INTRODUCTION

Education as a process of acquiring knowledge is an interesting subject, studied by many experts from different fields. The actual organization of the educational process with the aim to increase its efficiency is a topic on which it is being worked all the time.

In [2,4] it was mentioned that the level of the student training is changing continuously. It influences the quality of the activities each person does after the specific knowledge assimilation. Therefore it is useful to evaluate the knowledge dynamic of the separate terms, topics and school subjects.

This is done using different characteristics, for example intensity of knowledge assimilation, flow of the school material, knowledge restoring, probable vector of term assimilation of the school subjects and so on.

MODELLING DYNAMIC OF THE KNOWLEDGE

Under the knowledge dynamic description can be understood a set of a final number of assimilation, control and knowledge diagnostic levels stages. The different terms from the school subjects or the different kinds of activities pass through these stages in a different sequence.

In the theory three different kinds of nets are differentiated: opened, closed and mixed. In the opened nets the input stream of the school material doesn't depend on the net state or the number of the terms entered in it yet. In the closed nets the number of the terms in each of them is a constant, and the intensity of the school material stream on the entrance of each stage depends on the system status. The differentiation on these stages can be done easily with the introduction of different initial markings in Petri nets. Essentially, Petri net machine has powerful means for describing the dynamic of a system with parallel asynchrony process. So, it can be used for modeling the dynamic of knowledge assimilation in the school process. In the other hand excepting the parallel assimilation of different knowledge, there is a parallel regarding to the two most important processes: assimilation and forgetting of the knowledge (it's normal because in the nature each action has a corresponding reaction).

The introduction of Petri nets can be graphical or analytical. The graphical introduction is easy for a visual acquire, and the analytical, by the vectors and matrixes, has convenient means, by software processing, for analyze and syntheses. When describing a system structure by Petri nets two structure elements are used: transactions, giving the actions in the system, and positions, giving the conditions for their action's execution and the result of them. So, for each of the transition can be defined input and output positions. In the context of human perceptions, this is a presentation of the causality-consequently relations. The action of the cause marks with markers in the corresponding input places. The system static is modeling by a graph.

When the action, modeled by this transaction, is activated and executed the markers from his input places pass to his output places. That's why in the theory is said, that the net's dynamic is modeling by the accessibility tree. It shows all accessibility markings of all positions executing all transitions. Consequently, the net dynamic is defined by the rules for the transaction execution and the initial system status.

Building a state's graph allows quick and easy determination of the transition sequence, which will guide the educational system from one state into another. For building the graph a variety of software products can be used DPN tool, INA, Matlab_toolbox PNet, etc. Searching for the fastest route between two states in the network can be optimized using those products, as well as simulation of the whole network using PIPE. Analyzing the already built graph can lead to conclusions, about what actions must not be taken in order for the system to remain in a desired state.

TWO BASIC KINDS OF NETS – CLOSED AND OPENED

In the most simple version of the closed net the student pass two stages of a term assimilation: assimilation stage S2 and forgotten stage S1 /fig.1./. With b_1 is noted the mean time for forgetting the term and with b_2 the mean time for assimilation or recovering the term knowledge. D1 and D2 are respectively the actions for forgetting/recovering the terms.

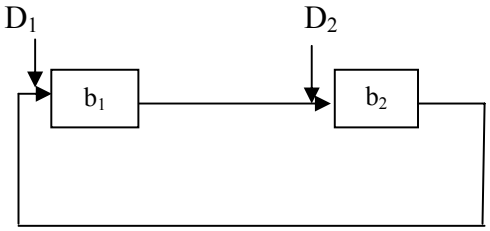

Fig.1.

The introduction of this scheme with Petri net with these two basic processes: of assimilation and forgetting, with their corresponding transitions t_1 and t_2 is given on Table 1.

We use a simple way to present a Petri net with a table: the rows associate to the transitions, the columns associate to the position. For each position we show input and output number of arcs and the initial state as a number.

Table 1

	P1		P2		P3		P4	
	1		1		1		0	
	in	out	in	out	in	out	in	out
T1	1	1	1	1	1	0	0	1
T2	0	0	0	0	0	1	1	0

The necessary preliminary conditions for the assimilation process to be accomplished are: the presence of a student – p_1, knowledge for the current terms in the stream of school material– p_2 and the absence of this knowledge in the student knowledge – p_3. After this stage as an output condition presence of knowledge for this term in the student knowledge is obtained - p_4.

One more complicated version is when the student has to assimilate N numbers of terms. The net, which describes the dynamic of this knowledge with a curtain number of compulsory terms, can be with different complexity. Again the most simple case includes two stages: stage of assimilation S2 and stage of forgetting S1. Here with b_{1i} is noted the mean time for forgetting of the i-term, and with b_2 the mean time for assimilation or recovering of the same. D_1 and D_2 are respectively the actions on forgetting/recovering of the terms. O_2 presents the sequence of the terms on the entrance of the assimilation stage S_2 /fig.2/.

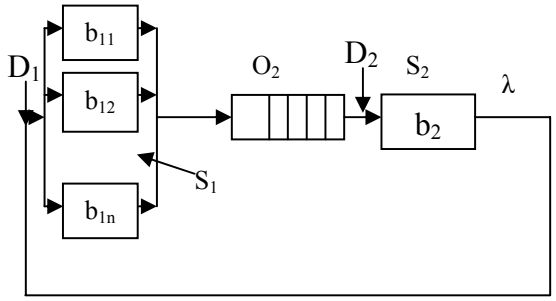

Fig.2.

For simplification is accepted $b_{1i}= b_1$=const. $\mu_1=1/ b_1$ is the intensity of forgetting of the separate terms. In this model can be accounted the terms which must be finally assimilated with probability p_{22}. With this probability the term is arranged in the end of the queue O_2. And with a probability p_{21} the assimilated term passes in the stage S_1.

In the model of figure.2. is not enough detailed the process of control (diagnostic) of the knowledge and the following assimilation. This process is reflected only with the summary stage S_2. As an example for more adequate net model securing guaranteed quality of specialist training can be defined as following: The stage S_1 corresponds to N basic states, allowing constant intensity of their forgetting, equal to $\mu_{1i}= \mu= 1/b_i$ (i=1,N). The stage S_2 with queue O_2 reflects the process of knowledge control with mean time for control od a state, equal to b_2. The accepted by the control as unassimilated positions, from the exit of stage S_2 go with possibility p_{23} in the assimilating stage S_3. The positions which are accepted as assimilated on the stage S_2 go to S_1 with possibility p_{21}. Unassimilated positions from the exit of a stage S_3 return with a possibility p_{33} in the queue O_3 to continue assimilating (each assimilation can be divided on phases). The positions from stage S_3 , with possibility p_{34} , pass to the next – S_4, stage with queue for control or diagnostics of the knowledge – O_4 and mean time for control b_4. From the exit of stage S_4 the positions accepted as unassimilated return to stage S_3 with possibility p_{43}. Accepted as assimilated positions, with possibility p_{41} return to stage S_1.

In the general case, for the multistaged net for assimilating knowledge the intensity of assimilating, control, diagnostics and other kinds of knowledge processing on stage S_i , can depend on the number of the positions n_i (i = 1, N), which are located on a certain stage.

On this base there can be design two-priorited and two-staged closed models. Details about the reasons and the schemes of the models are given in [3].

In the most simple version of the opened net the student goes through two stages: stage of assimilation S_1 and stage of control S_2 /fig.3/. D_1 and D_2 are respectively the actions on assimilation and control of the terms.

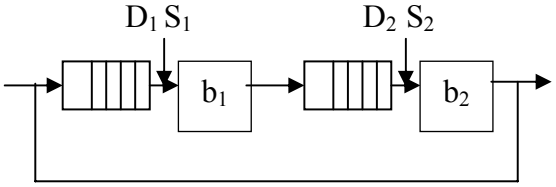

Fig.3.

Modelling with the Petri nets there can be separated two stages with three transitions: t_1 – process of assimilating, t_2 – process of controlling and letting the student work with the system and t_3 – process of control and returning the student for additional training /Table.2/: The necessary preliminary conditions for assimilating process to be done are: presence of a student – p_1, knowledge for the current term in

the stream of the school material – p_2 and not full knowledge of the term in the student's knowledge– p_3. After this stage as an exit condition there is obtained presence of some kind of knowledge about this term in the student's knowledge - p_4. The necessary preliminary conditions for control and letting the student work are: presence of a teacher – p_5, presence of some kind of knowledge about this term in the student's knowledge - p_4 and judgement for satisfying student's knowledge – p_6. After this stage as an exit condition turns out the end of the training – p_8. The necessary preliminary conditions for control and returning the student for extra training are: presence of a teacher – p_5, presence of some kind of knowledge about this term in the student's knowledge - p_4 and judgement for non-satisfying student's knowledge– p_7. After this stage the exit result indicates not full knowledge of the term in the student's knowledge – p_3.

Table 2

	P1		P2		P3		P4		P5		P6		P7		P8	
	1		1		1		0		1		1		0		0	
	in	out	in	out	in	out	in	out	in	out	in	out	in	out	in	out
T1	1	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0
T2	0	0	0	0	0	0	1	0	1	1	1	1	0	0	0	1
T3	0	0	0	0	0	1	1	0	1	1	0	0	1	1	0	0

CONCLUSIONS

The advantage of using the Petri network engine is the possibility to analyze and research the system's behavior.

From the designed Petri net models of the different systems, presenting the dynamic of knowledge assimilating there is confirmed that this machine has powerful means of modelling like Turing machines, but in contrast to them it contains bigger deciding power typical for the finite automats. There are not so much languages that allow all terms, constructing a topic, and all topics constructing a school subject, to be described in most details. Besides, all the time from the training process different priorities of the obligated and additional knowledge are given and controlling if the necessary assimilation power is reached. In addition, through all the assimilation process time the natural possibility of the student to forget is accounted.

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