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OPTIMIZING DISTRIBUTION OPERATIONAL TIME DURING THE PREPARATION OF ENGINEERING AVIATION TRAINING

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Abstract

Considers the problems of information connectivity portions of educational information related to the content of discipline modules. The questions of assessment of connectivity modules disciplines curriculum and operational optimization of the time distribution in the preparation of engineering aviation personnel.

MAIN ASPECTS OF THE PROBLEM

Educational information is presented in the form of the discipline that foreseen a curriculum and is a sequence of more or less connected in meaningful relationships topics and sections. Improving the content and temporal structure of the learning process (LP) associated with the analysis of logical relationships, both within the academic disciplines and between disciplines. The main structural elements in terms of LP content are didactic invariants that form the basis of its hierarchy. Number of educational information will define the concept of teaching through invariant.

Structuring of subjects as in content and in terms of time, it seems like the problem of studying the information connectivity between elements [1]. For this were proposed some mathematical models for two types of educational information links. In this paper we consider simple diagrams of connectivity didactic units of which can later be built more complex schemes:

We consider two types of possible schemes:

– considered a minimal system of two didactic units (themes) between which there are rigid and non-rigid connection;

In case non-rigid connection may appear more than two levels of assimilation. And will play a big role scale selection and device efficiency. Consider the Shannon approach to information connectivity of two random variables or two groups of random variables [3]. His approach is based on the following links: firstly, on the fundamental role of quantitative measures of uncertainty – entropy, and secondly, on the randomness of probabilistic description of media. Under information refers to change in uncertainty and in the amount of information – the difference between quantitative measures of uncertainty before and after receiving information [4]:

$$I_{xy} = H_x - H_{x|y} \tag{1}$$

is the mutual information values *x*, *y*. It can be interpreted in the full sense, as the number of information *x* contained in the *y*.

The amount of information (1) was introduced Shannon, who also showed the value of this quantity in information theory. Using the known relation:

$$H_{x|y} = H_{xy} - H_y \tag{2}$$

we can write formula (1) as follows:

$$I_{xy} = H_x + H_y - H_{xy} \tag{3}$$

Define the usual entropy H_x, H_y, H_{xy} by formula:

$$H_\xi = MH(\xi) = -\sum_{\xi} P(\xi)\ln P(\xi) \tag{4}$$

Where *M* - mathematical expectation.
Quantity of information connectivity of two random variables has the form:

$$I_{xy} = M\left[H(x) + H(y) - H(x,y)\right] = M\ln\frac{P(x,y)}{P(x)\cdot P(y)} \tag{5}$$

There are also equivalent forms of writing:

$$I_{xy} = M\ln\frac{P(x|y)}{P(x)} = M\ln\frac{P(y|x)}{P(y)} \tag{6}$$

Besides average entropy H_ξ there is random entropy $H(\xi) = -\ln P(\xi)$ and random information connectivity can be entered [3]:

$$I(x,y) = H(x) + H(y) - H(x,y) = \ln\frac{P(x,y)}{P(x)\cdot P(y)} = \ln\frac{P(x|y)}{P(x)} \tag{7}$$

Consider the case when studying two servings of educational information (two „blocks” or theme) with two types of bonds (Fig. 2 a, b).

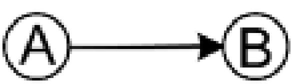

Fig. 1. a) rigid connection

Fig. 1. b) non-rigid connection

At a rigid connection (Fig. 1.a) assimilation of information pieces *B* is impossible without mastering pieces of information *A*. With non-rigid connection portion of information *B* can assimilate without mastering pieces of information $\overline{A}$. In this case we consider not rigid link (Fig.1.b.).

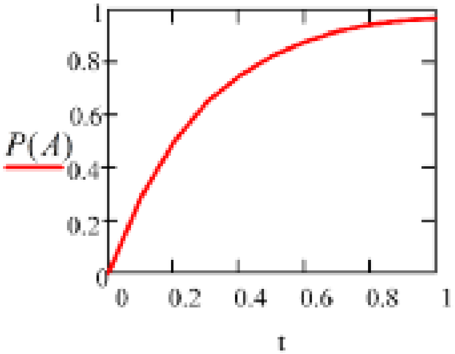

Fig. 2. Graph of the curve by the expression (8)

Consider two models of depending $P(A)$ on time t.

$$P(A) = 1 - e^{-a t_1} \tag{8}$$

We use the model (8), probability of assimilation pieces of information B on condition that A already mastered, is:

$$P(B / A) = 1 - e^{-b t_2} \tag{9}$$

Probability of not mastering $\overline{A}$:

$$P(B / A) = 1 - e^{-b \cdot t_2} \tag{10}$$

Then the probability B of learning by not mastering pieces of information $\overline{A}$:

$$P(B / A) = (1 - e^{-b_2(T - t_1)}) \tag{11}$$

Complete probability absorption of B is:

$$P(B) = P(A) \cdot P(B / A) + P(\overline{A}) \cdot P(B / \overline{A}) \tag{12}$$

Substituting the values of expressions (3-4) we get:

$$P(B) = (1 - e^{-a t_1})(1 - e^{-b_1(T - t_1)}) + e^{-a t_1}(1 - e^{-b_2(T - t_1)}) \tag{13}$$

Then probability of simultaneous absorption A and B will be [2]:

$$r_{AB} = \ln \frac{P(B / A)}{P(A) \cdot P(B / A) + P(\overline{A}) \cdot P(B / \overline{A})} = \frac{1 - e^{-b_1(T - t_1)}}{(1 - e^{-a t_1})(1 - e^{-b_1(T - t_1)}) + e^{-a t_1}(1 - e^{-b_2(T - t_1)})} \tag{14}$$

Parameters a, b_1, b_2 depend on the complexity of themes A and B, level of analytical skills of the student.

b_1 – used in the assimilation of information pieces A;

b_2 – used in the not mastering pieces of information $\overline{A}$.

In the second stage we performed the identification parameters a, b_1, b_2. For this we taken statistical data of module control students of the first and second courses of Mechanical and Energy Department. This was taken statistics from the data module control students' first and second courses of Mechanics and Energy Department. Based on data were obtained depending mastering portions of information from the time, from which it is clear how to divide the time between two portions of educational information to its assimilation was quality. According to expression (8) have been identified parameters a, b_1, b_2 and obtained the following data (table 1).

Table 1. Probabilities of information learning

Group 101						
$P(A) = 0.33$	$P(\overline{A}) = 0.66$	$P(B/\overline{A}) = 0.125$	$P(B/A) = 1$	$a = 0.756$	$b_1 = 9.798$	$b_2 = 0.284$
Group 102						
$P(A) = 0.87$	$P(\overline{A}) = 0.13$	$P(B/\overline{A}) = 0$	$P(B/A) = 1$	$a = 3.849$	$b_1 = 9.798$	$b_2 = 0$
Group 103						
$P(A) = 0.3$	$P(\overline{A}) = 0.7$	$P(B/\overline{A}) = 0.093$	$P(B/A) = 0.89$	$a = 0.673$	$b_1 = 4.696$	$b_2 = 0.212$
Group 104						
$P(A) = 0.43$	$P(\overline{A}) = 0.57$	$P(B/\overline{A}) = 0$	$P(B/A) = 0.83$	$a = 1.061$	$b_1 = 3.77$	$b_2 = 0$
Group 105						
$P(A) = 0.57$	$P(\overline{A}) = 0.43$	$P(B/\overline{A}) = 0.17$	$P(B/A) = 0.875$	$a = 1.592$	$b_1 = 4.424$	$b_2 = 0.396$

In the (Table 2), presents the results of probabilistic optimization time structure of the discipline of theoretical physics.

Table 2. Comparative analysis of the optimal time allocation of discipline (theoretical physics) on the module with non-rigid connection

Group	$t_{\text{ср}}$	$t_{\text{опт}}$	Probability learning pieces of information $\Delta P(B)$ %	Weeks	Weeks
101	0.53	0.76	7.5	9	12
102		0.65	3		11
103		0.59	3		10
104		0.61	3		10
105		0.61	5		10

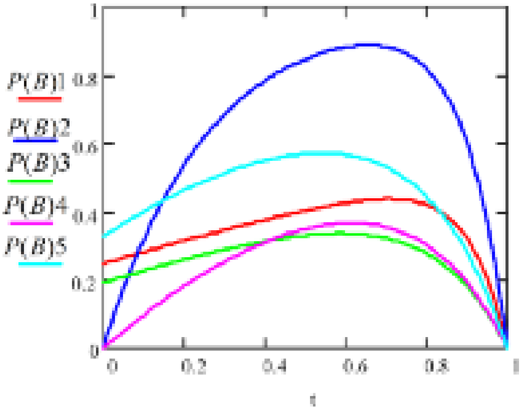

Fig. 3. Probability of absorption portion of educational information *B*
from the time for non-rigid connection

Consider how to change the time for rigid connection.

Table 3. Comparative analysis of the optimal time allocation discipline
(theoretical physics) on the module by a rigid connection

Group	t_{cp}	t_{ym}	Probability learning pieces of information $\Delta P(B)$ %	Weeks	Weeks
101	0.53	0.71	7	9	12
102		0.65	3		11
103		0.66	7		11
104		0.61	3		10
105		0.61	2		10

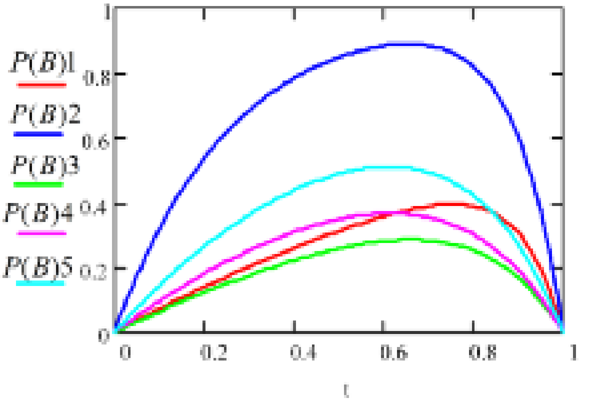

Fig. 4. Probability learning portion of educational information *B*
from the time for a rigid connection

These tasks are simplified but they contain the basic meaning of the problem. They show that cumulative statistics as a result of the Bologna system can be used. When the problems solved, we can say that you need to do to optimize a training course. It is proposed to issue data development in the form of recommendations to the research methods of the learning process in terms of subjective analysis, with the goal of optimizing its content and temporal structure.

CONCLUSION

The developed approach of forming modules disciplines allows complementing and partially removing the shortcomings of existing methods based on a modular approach. It also will improve the efficiency of LP as a result of this approach.

LITERATURE

[1] Сетевые методы планирования и организации учебного процесса[Текст]/ А.А.Овчинников, В.С. Пучинский, Г.Ф. Петров.– М.: «Высшая школа», 1972.– 157с.

[2] Стратанович Р.Л. Теория информации [Текст] / Р.Л. Стратанович. – М.: Сов. радио, 1975. – 424 с.

[3] Шеннон К.Е. Работы по теории информации и кибернетике [Текст] / К.Е. Шеннон. Пер с анг. Под ред. Р.Л. Добрушена, О.Б. Лупанова М., ИЛ. 1963. – 832 с.

[4] Яглом А.М., Яглом И.М. Вероятность и информация [Текст] / А.М. Яглом, И.М. Яглом. – М.: Наука, 1973.– 512 с.