various processors; indeed, some parallel computing techniques require specialized programming to permit the processors to work together in parallel. It can be seen that on Monte Carlo simulations, algorithms proceed by averaging large numbers of computed values. It is sometimes straightforward to have different processors compute different values, and then use an appropriate average of these values to produce a final answer.

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THE MATHEMATICAL MODELING OF CHANGES DYNAMICS IN NUMERICAL INDICATORS TO DESCRIBE THE LEARNINGPROCESS

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The mathematical modeling, as one of their methods of the scientific knowledge and cognition is provided the opportunity to be explored the surrounding reality phenomena and the processes, by means of the symbolic expressions transformations, having displayed the significant interconnections and associations. So, the analogies establishment between the explored and the already studied objects, as one of the mathematical modeling methods, is allowed us to be studied the general system – wide laws and the regularities, having governed the quite inherent complex structural formations of the different nature [8]. The methodology development of the systems general theory under the modern information society conditions has already been led to the mathematical modeling using in the research – diversity of the didactic systems in the pedagogy.

The special model to be described the didactic systems functioning can be acted the differential equations. The example of the logistic parabolic equation use for the quality of the education modeling in the Institute of the Higher Education, the College, the University has been presented in the paper [9]. E.A. SolodovaandYu.P. Antonov, on the basis of the study results analysis of the mathematical model, have already revealed the main tendencies of the further improvement of the educational activity. So, the mastering quality development of the academic subject and the discipline [4] is one of the component of the quality of the education, so it is seemed appropriate to be studied its changes dynamics also the logistic parabolic equation to be applied.

Thus, the differential equation (DE), having called the logistic one, has been suggested in 1848 by the Belgian mathematician P.F. Verhulst (1804–1849) [7]. So, it has been allowed, for the first time, in modeling the special systemic factor, having limited the population growth. The population has been considered, as the opened developing system of the coverage in this presented model. Its number size change had been rushed to the certain limit, which was intended to be characterized the resources capacity of the habitable ecological niche. In this study, the fixed number mastering ofthe training elements (TE) [2] can be spoken the analogue of the growth restriction of the population quantity, within the framework of the program of some academic subject and the discipline. The set of the TE – this is the system of the theoretical knowledge and the practical skills, having formed in the learning process. So, the mathematical model, in this case, is as it is followed:

$$\frac{dn(t)}{dt} = kn(t)\left(1 - \frac{n(t)}{N}\right), \qquad (1)$$

where:$dn(t)/dt$ – the rate of the mastering of the TE; k – the coefficient of the proportionality; $n(t)$ – the amount of the TE, which have been mastered by the students at the time moment t; $(1 - n(t)/N)$ – the relative magnitude of the mastering completion of the TE; N – the TE number, which are necessary to be mastered, in the framework of the program.

The Equation (1) is presented itself the DE with the multiple variables, so its general solution is by the integral calculus methods [3]. So, the particular solution for the initial condition,$n(0) = n_0$ will be taken the following expression:

$$n(t) = \frac{Nn_0e^{kt}}{N - n_0 + n_0e^{kt}}, \qquad (2)$$

where n_0 – the number of the TE, which are necessary to be mastered at the previous stage of the learning, to be understood the theme material, the chapters, or the academic subjects, or the disciplines.

The functional dependence study (2) has been become quite possible, when the parameters values defining of the mathematical model (k, n_0, N). The coefficient k may be assigned, for example, the value of one, if the student performs the control and training activities for the standard time. If the execution time is quite more, than the normative one, then, in this case,k can be considered less, than one. If the execution time is quite less, than the normative one, then k should be taken more, than one. All these values of k are allowed to be distinguished three groups of the students. Thus, the First group

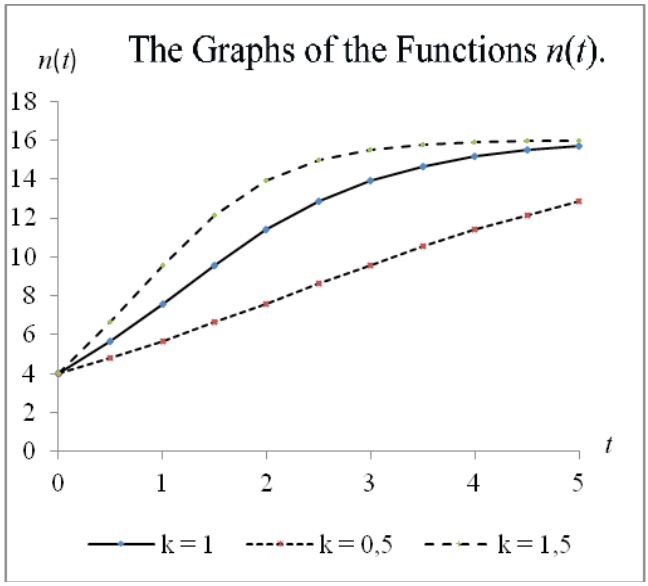
(A) – are the students, who are managed to be solved all the learning tasks and their activities for the time, scheduled by the teacher (k = 1). The Second group (A_-) – are the students, who are planned over the time to be coped only with only the part of the prescribed academic work (k< 1). The Third group (A_+) – are the students, who are spent less time to be successfully completed the planned learning activities (k> 1). Thus, the parameters values $n_0$and$N$are set on the basis of the results summarizing of the educational material analysis.

Some theme, topic, academic subject or discipline content can be presented, as the set of the TE. For example, «The Probability Theory» (PT) theme, having taught in the framework of the «Mathematics» academic subject and the discipline for the students of the technical specialties and the areas of the training, may be quite included twelve TE [1]. Thus, the TE content is the following: 1) the probability of the elementary event; 2) the actions with the events; 3) the sum probability of the incompatible and the joint events; 4) the product probability of the independent and dependent events; 5) the rules ofthe combinatorics, combination, arrangement, and permutations; 6) the independent replicated trials; 7) the total probability formula and the Bayes' formula; 8) the Poisson theorem, the locally and integral theorem of de Moivre and Laplace; 9) the distribution law of the discrete random variable and its characteristics; 10) the binomial law distribution and the Poisson law; 11) the probability density function of the continuous random variable and its characteristics; 12) the normal, uniform and exponential distribution laws of the non – continuous random variable.

The success of the PT students' studying is based on the system of the previously mastered TE at the previous stages of the learning: 1) the graphs of the main elementary functions; 2) the derivative of the function finding; 3) the calculation of the definite integral; 4) the improper integral finding. So, the presented TE are determined the parameters values $n_0 = 4$, $N = 12 + 4 = 16$, and their substitution in the Equation (2) is allowed to be obtained the of the dynamics mathematic model of the TE quantitative indicators mastering of the probability theory ($k = 1$, $n_0 = 4$, $N = 16$).

$$n(t) = \frac{16 \cdot 4e^t}{16 - 4 + 4e^t} = \frac{16e^t}{3 + e^t}. \qquad (3)$$

So, the graphical model of the functional dependence (3) has been presented in Fig. 1.



The Graphs of the Functions $n(t)$.

Fig. 1. The Particular Solution so fhe Logistic Equation.

The analysis of the functional dependence (3) is shown, that if $t \to \infty$, then$n(\infty) = 16$. This tendency is held and performed for all three graphs (Fig. 1), and it, moreover, is illustrated the fact, that the whole learning and the cognitive process are not completed by the PT studying. For the computational experiment carrying out, the values of 0.5, 1.0, 1.5 have been assigned to the coefficient k. The already selected gradation is created possibility to be visually seen the divergence curves degree in the graphs for the quite different speed of the TE mastering. Thus, the number counting of the TE mastered at the PT studying in each of five distinguished time intervals (Fig.1) has been shown in the Table No.1.

The Table No.1.

The Number Distribution of the TE by the Intervals *t*.

The Interval*t*	*k*		
	0.5	1.0	1.5
[0; 1]	2	4	6
[1; 2]	2	3	4
[2; 3]	2	3	1
[3; 4]	1	1	1
[4; 5]	2	1	0
Σ	9	12	12
$\Sigma/(N - n_0)$	0.75	1.0	1.0

Having depended on teacher's design of the PT students studying, in accordance with the main requirements of the educational program, the presented time intervals formula (e.g. Table No.1) are equated to the specified number of the credit units *q*(c.u.), where *q* is shown their multiplicity. For example, if seventy two academic hours or two c.u. are given for the PT studying, then, in this case, 14,4 hours or 0.4 c.u. will be corresponded one interval *t*.

The PT mastering by the students of the technical specialties and the areas of the training can be distributed by two, three, or four stages of the learning activity (LA). So, the *First Stage* of LA – is the knowledge system formation on the laws of the probability. *The Second Stage* of LA – is the skills formation to be used the laws of the probability for the standard mathematical problems solution. *The Third Stage* of LA – is the research skills development to be applied the probability laws at the laboratory and the practical tasks and fulfillment. *The Fourth Stage* of LA – is the culture thinking and the creative skills and abilities development in solving the unusual mathematical problems [5] tobe established the laws of the probability.

The LA stage duration is determined by the expert assessment method, having taken into account the level of the students' mathematical preparation and the amount of the instructional and the training time, having expressed in the *q*(c.u.). So, the possible option of the LA stages passing at the PT studying by the students of three selected groups has already been presented in the Table No.2.

The Table No.2.

The LA Stages Duration.

The Group of the Students	The LA Stage			
	I	II	III	IV
	q(c.u.)	*q*(c.u.)	*q*(c.u.)	*q*(c.u.)
A_- (k< 1)	0.6	0.4	–	–
$A(k = 1)$	0.4	0.4	0.2	–
$A_+(k$> 1)	0.4	0.2	0.2	0.2

The mathematical modeling application of the TE mastering dynamics is allowed the teacher to be formed the special information field of the numerical data for the students' educational activities planning.The determination of the effectiveness of the statistical significance of the educational process organization, on the basis of the presented mathematical modeling here, is required the mathematical statistics methods involvement [6]. Thus, the mathematical modeling inclusion into the instructional and educational design is quite enabled to be created the favorable special conditions for the further improvement of the educational process.

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