RESEARCH IN COMPUTERIZED INFORMATION TECHNOLOGIES AS BASES OF TRAINING AND EDUCATIONAL SYSTEMS

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Abstract. The objective of the article is to improve the methodological apparatus in computerized information technology of training to optimize education systems in the context of globalization based on the identification and formalization in new links for technological components of learning information processes with elements of information theory and information systems control theory. Research methods. The basis of the research is the theory of information, information systems, and processes, control, optimization. Main research results. The specificity of the education systems globalization on the basis of the training computerized information technology and the adaptation of information theory to the interaction and control in training information systems is revealed. In this context, we obtained: the norm over the event space as a functional dependence on information for evaluating causal relationships, the producing differential equation, the analytical expression for information evaluating; the concept of normalized metric information space; the information processes types in learning systems; the entropy determination functions based on the mathematical expectations of norms and metrics for information transfer processes evaluating; the information processing operator; the sets of information objects; the scheme of the learning information system operation as a control with optimization feedback for information perception errors minimizing; the procedures for decisions making in the conformity of perception models to information flows, analysis of the information objects structures; the concept in the informational essence of learning processes with adaptation to the requirements and limitations; the formalized descriptions of information perception in learning; an algorithms on the perception and advancement of infor-

mation flows; an elaboration in the optimization task of the training information systems control; the concept of modern information learning environments improving with information theory and information systems theory using. Scientific novelty. The new concepts, algorithms, and models have been developed, which allowed formalizing the identified interrelations for the components of learning information processes with elements of theories in information and information systems optimization control, achieving improvements in computerized information training technologies, taking into account the globalization of education systems.

Practical`s significance. The introduction of the obtained theoretical developments on the improvement of control in training information systems based on computerized information technologies in the practice of education systems in the context of globalization can significantly improve the effectiveness of learning information processes.

Keywords: *information technology, computer, network, system, process, training, education.*

Problem's statement. Information processes of information perception, accumulation, and storage form the basis of learning in the animate and inanimate nature, human society. Features of the learning information processes implementation are displayed in educational practice in teaching methods. The methodological foundations of training are based on the theoretical basis of information processes, technologies, and systems. Control of learning information processes requires the formation of goals and the identification of learning actions sequences that ensure the successful achievement of the goals. The tasks of training control, viewed from the point of view of information aspects, are solved by education systems. The defining theoretical basis for learning is the theory of information`s systems, and for educational systems is the theory of control. In the long evolution process, learning paradigms were formed, containing in its composition the processes of information perception, accumulation, and storage. However, the constant strengthening of globalization trends requires the adjustment in existing theories of learning information technology in order to ensure the optimal development of education systems.

Analysis of recent research and publications. The value of progressive education systems, as well as effective processes and quality learning outcomes in the modern world, is constantly increasing. Education is the primary resource that precedes the use of economic resources, is able to awaken the economy and make it more dynamic, can provide a breakthrough in the development of production and agriculture; thus, education acts as a generator, the main productive force of society, the basis of the triad "education–science–production", the cornerstone for solving the foundations of the state life [1-10]. A significant part (40-70%) of the increase in national income activates the growth of the population knowledge and level of education, there is an intellectualization of all society productive forces. Education plays the role of the main factor for the emergence of changes in economic development. Each country has its own specific requirements, recommendations and wishes for education, the prerequisites of which can be attributed to the following two large groups: climatic conditions, characteristics of the countries territories, communication routes, borders, etc.; the globalization aspects of the society and the economy. Improvement of education systems activates the development of technologies, which, in turn, stimulates the emergence of new industries (Table 1).

Table 1

The technology impact on the emergence of new industries

The developed technology (the university where the development was carried out)	The industry that emerged on the basis of a new technology
Electronic calculator (University of Pennsylvania)	Computer manufacturing
Optical fibers (Massachusetts Technology Institute)	Telecommunications
Vegetative reproduction (DNA cloning) (Stanford University)	Biotechnology
Supercomputer (University of Illinois)	Internet

Along with the acquisition of knowledge, the essential point is the preservation of knowledge. A reliable way to obtain and preserve knowledge is the learning process. To reveal the essence of learning, consider a number of definitions [2-4, 6, 11-16, 33-46]. First of all, learning acts as a type of learning activity in which the quantity and quality of the trainee knowledge and skills elements are brought to the proper level by the trainer [13, 41, 33-46]. The training activity is considered completed if the quantity and quality of educational material in the trainee's replicated product correspond to the training objectives and represent the proper level. The learning process is a set of consecutive interrelated actions of the trainer and the trainees, aimed at obtaining the following achievements: a solid assimilation of the scientific knowledge and skills system and the formation of the ability to use them in life; the development of such cognitive trainees abilities as independent thinking, observation, etc.; mastering the elements of the mental labor culture; the formation of the foundations of the world view. Analyzing the sources [2, 3, 6, 11-13], it is possible to trace the global trends in changes of the time intervals values for training specialists in the direction of the training duration increasing. The analysis of materials [1-16, 33-46] leads to the following conclusions: the higher the indicator of the years number allotted for education, the faster the economy develops, and countries with accelerated rates of improvement in higher education have increased economic growth rates; the importance of education as a factor of development is associated with its effect on human capital (as the main resource) and production technologies; education has a positive effect on investment in human capital, contributing to economic growth.

Considering the education importance in the modern world from the point of view of analyzing the development and modern achievements evolution in the computerized information technology training field, it is necessary to note an even greater increase in its capabilities and advantages. The training implementation with the use of high-tech, progressive, continuously improving information and communication technologies allows increasing the education effectiveness at a rapid pace. In the period of globalization, education, viewed from the perspective of modern information processes, systems, and technologies for the accumulation and preservation of knowledge, has an even stronger impact on the society`s economic development.

Within the framework of the information approach, teaching methods play an important role. In Ukraine, the system of division into education levels is defined as a set of educational institutions, complexes, methodological recommendations and relevant educational programs [2, 3, 6, 11-13]. There is a tendency to increase the share of full higher education and reduce the number of people with primary education. In the works [3, 7, 12-13] the scheme of training is presented within the framework of the Ukraine educational system structure and the assessment of degrees. The essential point in the education system is the teaching model adopted by the pedagogical community. The basic model of education is the unity of the three teaching methods: passive; active; interactive [2, 4, 6, 14-16, 33-40, 42-26]. On the way of teaching methods improving, it is necessary to note the following current trends: the desire to develop structurally complete models of knowledge formation processes []; the increase in the value of the evaluating knowledge problem as a result of learning [2, 4, 6, 14-16, 33-40, 42-26]. Based on the analysis of the source [2, 4, 6, 14-16, 33-40, 42-26], a more detailed classification system can be distinguished. Active methods are used, which are divided into the following types: various modeling (game, social, imitational); business games; concretized situations analysis (case studies); method of active sociological tested analysis and control, close to real life situations. Modern teaching methods use information and computer technology [28-37] based on the use of advanced high-tech tools for information processing and transmitting. The difference in modern computer technology of education is interactivity, which is achieved on the basis of situations modeling and ensuring the possibility of rapid feedback for the student with the system of information support from the trainer. The principle of feedback in pedagogy and the presentation of teaching scientific methods is presented in [2, 4, 6, 14-16, 33-40, 42-26], where: training is viewed as a process of knowledge and skills transferring from the teacher to the learner; allocated negative feedback in the learning system.

Let us further characterize the features of globalization for information processes in education. The use of computer technics in the educational process made it possible to talk about computer education, the effectiveness of which has been dramatically increased due to the wide and easy access to a large number of diverse educational materials. According

to [2, 3, 6, 11-13], computer-based education is global, and globalization is seen as a process of international economic, political, and cultural integration. The process of globalization is a global trend covering all levels of education. In foreign pedagogy [2, 4, 6, 14-16, 33-40, 42-26], the following opposing paradigms for the implementation of the global education concept can be distinguished: global interdependence and international understanding; global economic competition. The development of information technology has led to the introduction of the information society concept, where the majority of workers are engaged in informational production, storage, processing, and sale. Prospects for the education development associated with the use of training information technology in the global information space of the network Internet, World Wide Web. Globalization necessitates an increase in the value of the education fundamental nature [2, 3, 6, 11-13], by which we understand the consolidated use of the following types of knowledge: the versatile humanitarian and natural-science knowledge of the relevant areas of science; specialized vocational-oriented knowledge; general education disciplines that form intelligence in a person. The fundamental nature of higher education is a combination of scientific knowledge and the educational process. Globalization contributes to increasing risks, namely, increasing their number and expanding their diversity. In order to compensate for the phenomena generated by globalization, education should be organized taking into account many factors, namely: to strive for compensation and to counter risks; be fundamental; provide the ability to work in the information environment of the Worldwide network; function in the global information space; expand international understanding and use of international languages (above all, English); strive to reach all education levels.

The objective of the study. The main purpose of the work is to identify the interrelationships of methods and techniques for the learning information processes implementation with the theoretical foundations of information technologies that provide the possibility of education systems further development based on the information systems theory application. Speaking about the theoretical foundations of information processes, first of all, the theory of information is meant as a mathematical discipline, allowing formalizing descriptions of information processes, in particular, in the education field.

Research findings. We begin our consideration by analyzing the features of the fundamental theoretical foundations in education and training problems solving. The education task is posed as a typical optimal control problem, in which [47-54] for the system *W*, given its description, the goal is formed as a function or functional *J*(**u**, **x**, **β**), depending on the control vectors **u**, the learning trajectory **x,** and the parameters **β**:

$$\begin{aligned} &\mathbf{u}^*, \mathbf{x}^* \rightarrow optJ(\mathbf{u}, \mathbf{x}, \boldsymbol{\beta}); \\ &W = W((\mathbf{u}, \mathbf{x}, \boldsymbol{\beta}, t). \end{aligned} \quad (1)$$

The education task, formulated in the above statement, is often seen as rather vague and it defines restrictions, such as funding, various conditions, etc. As a rule, the goal in the stated problem formulation is not unique, which leads to the formulation of a vector (multi-criteria) optimization problem:

$$\begin{aligned} &\mathbf{u}^*, \mathbf{x}^* \rightarrow opt\mathbf{J}(\mathbf{u}, \mathbf{x}, \boldsymbol{\beta}); \\ &\mathbf{W} = \mathbf{W}((\mathbf{u}, \mathbf{x}, \boldsymbol{\beta}, t). \end{aligned} \quad (2)$$

A problem modified in this way is posed easier, but it is more difficult to solve [47-54]. At the same time, attempts are being made to construct models of objects and use methods of control theory.

Since information objects, processes and technologies are the most relevant in learning tasks, it is necessary to talk about the tasks of information systems control [17-28, 41, 47-54]. Accordingly, we will continue the question presentation from the point of view of the information and information system concepts. Each branch of science uses an established mathematical apparatus and methods for constructing models of objects and processes. The basis of information systems is natural to see information theory [17-28, 41]. However, perfectly describing the tasks of communication, the theory of information as such, without additional study, is of little use for the tasks of information systems control and training. In this paper, steps have been taken towards the expedient use of information theory elements in learning tasks, which consider information as a fundamental concept and are explored from the point of

view of information objects, processes, technologies, and systems conceptual categories.

As a basis, an assumption is made about the analytical dependence of information on the norm, which is defined over the event space. Information is considered as an assessment for the degree of a causal relationship in the event space. In this case, the function is the norm over the event space, and the function argument is information *I*. For a probability space with probability *P*, as the norm over the event space, we obtain $P = P(I)$. The main thing is the possibility of representing the function $P(I)$ by a power series and obtaining, in a linear approximation, the generating differential equation $DP / DI = f(P, I, a)$. The solution of the generating equation allows, taking into account the initial conditions, to obtain an estimate of the information in the form $I = P^{-1}(I)$. For different processes, we will have different methods for information evaluating [17-28, 41, 47-54]. This conclusion is confirmed by the existence of a methods variety for information evaluating. Using elements of information theory, one can choose the generating equation. For example, the organic growth equation corresponds to the Hartley measure; at the same time, for the case of collecting information from a variety of incompetent and unrelated sources, by virtue of the central limit theorem, the confidence value estimate will be an estimate of the information content. Thus, it is possible to measure information as the degree of causation. Having determined the method for estimating the informational proximity of events (metric), we obtain the normalized metric information space induced over the event space. The information space corresponds to simple mathematical construction. For processes of different nature, norms and metrics will vary. Since events, evaluations of informational links between events and the distance between events must be considered in the information space, it is impossible to build an information model outside the information space. As a rule, when modeling information systems, first of all, the following are required: physical models (like aerodynamic and hydrodynamic systems); operators (like control systems).

Using block *A* (for processing information I_A) and block *B* (for processing information I_B), which are interconnected by information flow lines, you can define an elementary information flow as a sequence of events associated with the information transfer. Since the elementary information flow is unidirectional, the information processes in the elementary information system are reduced to the information transfer (Figure 1) and comparison (Figure 2). Based on the evaluation of the flow $I\varepsilon$, can be non-trivial solutions and build complex algorithms. However, elementary systems, consider only those options of information flows formation, which were shown in figures 1, 2. The fact that the process in the blocks of information processing can be varied, does not affect the structure of links.

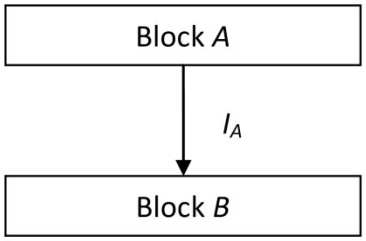

Figure1 – Possible information stream in the elementary information system: information transfer

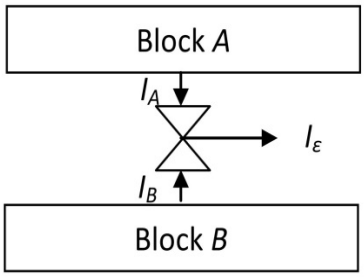

Figure 2 – Possible information streams in the elementary information system: information comparison and producing differential information flow Iε

The information transfer process is evaluated by the information space norm, and the information flows comparison related to the metric notion. During the transition to expected assessments, practically there is a transition to the mathematical expectation of the norm and metric (entropy estimates):

$$H_A = M\{\|I_A\|\};$$
$$H_\varepsilon = M\{a(I_A, I_B)\}. \quad (3)$$

The question of information processing in blocks of the system is more complicated since it affects processes in the event space, calculations of transformations, and so on. However, ideas about the elementary information system and the elementary information flow are quite sufficient for building complex models of information systems.

Consider as a visual example the task of translating from one natural language to another, where the elementary information system from the source (source text *A*) and the receiver (translation text *B*) is subject to consideration. With proper translation, the accuracy (or error) criterion is that the return receiver flow must compensate for the source forward flow. The problem is solved in its own coordinates. An algorithm is generated that represents the information system model, but you also need to deal with the operations in the blocks.

Information processing, which is carried out as a change in the magnitude of cause-effect relationships, occurs due to processes in the event space.

The simplest flow is formed by an ordered set elements sequence, and the simplest operation that is performed at the receiver is the mapping of the vector **x** by operator *A*:

$$\mathbf{y} = A\mathbf{x}. \tag{4}$$

An ordered set is transformed into a set that is represented by definition, by virtue of operator *A*.

In the future, you can make a decision regarding the set of perceived objects Ω by going to the set specified by the enumeration:

$$\mathbf{y} \in \omega_i \quad if \quad = \left\langle (a_{i1}, a_{i2}, \ldots a_{in}), \mathbf{x} \right\rangle = y_i \to extr. \tag{5}$$

Thus, we obtain the perception model of the first level in the form of an algorithm for the information system functioning, presented in Figure 3.

The trainer forms the information flow I_A, perceived by the trainee as an image of y_i. Since the learning process requires the student to achieve the correct response, based on operator *A*, an inversion of model A^{-1} is formed, which allows the information flow of the student I_B to be generated. Comparison of the flows of the trainer and the learner generates a differential information flow I_ε, which creates the basis for building an optimization procedure of finding the optimal operator (Block 4 of Figure 3). The stream of ordered sets generates an optimal operator that allows for minimizing errors. We have the process of elementary skills and concepts learner obtaining.

The compensation degree of input and return flows determines the training quality. The growth of the accumulated information causes an increase in the dimension of the operator matrix. The error occurs in the following cases: before training; in the event of additional information flows due to disturbances that were not taken into account during training.

The direct (immediate) transformation of an ordered set into a set specified by enumeration makes errors. If fuzzy sets are used in the input sets stream represented by definition, then conversion to sets specified by enumeration requires the definition of a proximity measure and the construction of a membership rule, that is, a model, which in this case is defined on a set of images and membership rules. Memorization is associated with the optimization procedure for changing the fixed part of the image and the corresponding membership rule. In this case, the error is obtained after finding the optimal solution.

The transformation of a set, which is set by description, to a set, which is set by enumeration, is an algorithm for describing an image, which is set by the description in its name.

Training involves the formation of an algorithm that is optimal with respect to the minimum error, which allows us to speak about the optimal solution of the training problem.

That is, with perception, a sequential transformation of the set, which represents the signal (M_D), into sets that are represented by definition (M_F) and by enumeration (M_L) occurs. At each stage, its own model is formed: at the stage of transition from the signal to the image, the model is implemented with the help of an operator; at the stage of transition from the image that is specified by description to the name, to the set that is specified by enumeration, the procedure for deciding whether the model corresponds to the input stream is applied; when working with a set of object names, the procedure for analyzing the structure of an object is applied. Thus: an ordered set is transformed into a set by definition using an operator; the set is by definition converted into a set by specifying using an optimization procedure for

finding the best description; the set by enumeration allows you to build algorithms that describe the organization (structure, building) of the input stream. In this case: the first stage requires significant amounts of data memory; the second stage assumes the presence of images bases and proximity measures, which requires a smaller memory amount, but more time; the last stage involves the storage of algorithms where a small memory amount is required, but it takes a long time to optimize.

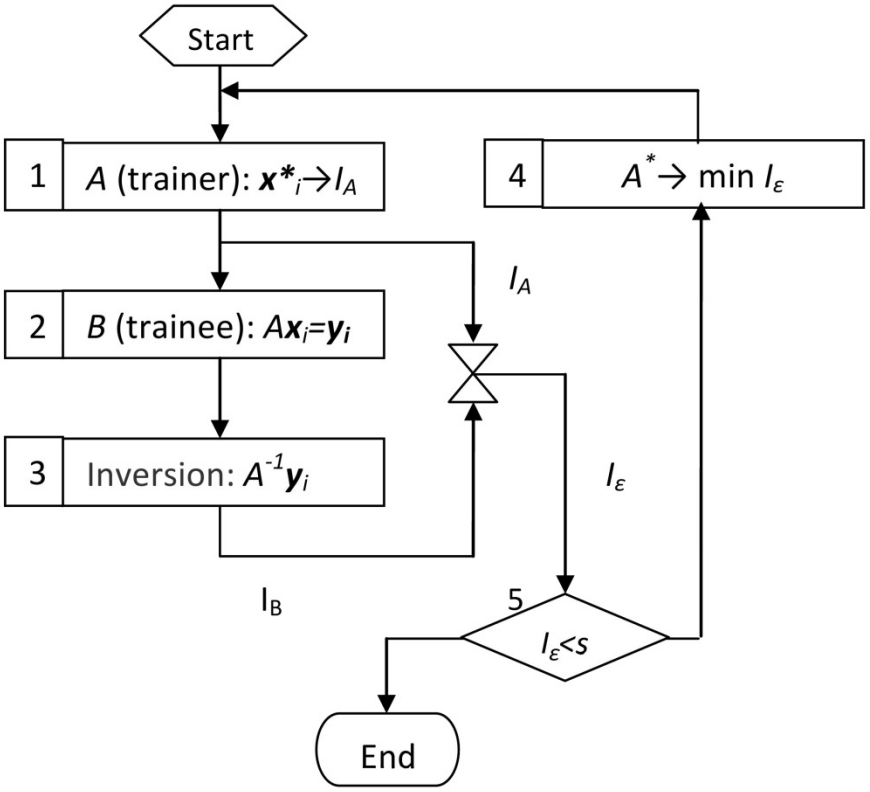

Figure 3 – Information model of the first level perception

It should be noted that statements about the existence of two possible elementary information interactions (transmission and comparison of information flows) and three possible elementary structures for information perception and accumulation are in the nature of limitations. Of the above fundamental elements, you can build a system. Thus, learning is an informational process where adjustment to the requirements and constraints is necessary. We characterize the specifics of learning as an information process. The first thing to consider is the importance of repetition in order to eliminate errors and form reflex operators. Further, it is important to form images, which also requires repetition. In turn, the construction of algorithms and logic circuits is perceived almost immediately. With perception, the following happens: the operator and the base of the images are compressed, leaving only what is expected; algorithms and logic circuits are compressed, eliminating repetition. Therefore, you need to submit the material without overloading it with unnecessary information.

We will analyze the concept and informational essence of the learning paradigm (following [2, 4, 6, 14-46], we will assume that the paradigm is an accepted model, standard, or sample). Within the framework of the above concepts, we will have the following: a teacher is a source of information; a learner is an object; the model of the student is determined only with respect to the formal accumulation of knowledge.

Consider perception as an objective process. The information process of perception consists of the processes of

receiving, processing and storing the information that is created by the source of information. Due to the one-sided orientation of the information flow, there are only two possible forms of information interaction, transmission, and comparison of information. Naturally, the above determines the formation of algorithms for information perception. Moreover, the existence of three methods for defining sets, sufficient to form models of the external world, determines the existence of three perception levels.

Here it is necessary to dwell on the principle of optimality. Given the limitations of the sets specifying, we can distinguish three tasks of informational perception. The first task of information perception is analogous to the Wiener problem, where for ordered sets it is required to find an operator that minimizes the difference *Iε* between the trainer message I_A and the student response I_B:

$$\begin{aligned} &I_\varepsilon = a(I_A, I_B); \\ &A^* \to \min \varepsilon. \end{aligned} \quad (6)$$

Actually, we have the task of forming reactions and habits, and the reaction will be the more correct, the more correct the operator will be. Training is reduced to finding the optimal operator. Errors are corrected only after their completion. At this stage, the operator determines the need for static memory. The model is formed long, stored completely.

The second task of information perception is determined by the formation of the external world model *W*, which allows to model it using the inversion model. This task is similar to the Bellman problem, where the optimal sequence *X** and the optimal control of the *U** model, which delivers the minimum expected error, are sought:

$$\begin{aligned} M\{I_\varepsilon\} = H_\varepsilon = M\{a(I_A, I_B)\}; \\ W = W(X, U); \\ U^*, X^* \to \min H_\varepsilon. \end{aligned} \quad (7)$$

In this case, the model describes elements that are represented by definition, that is, elements that have nonrandom components and rules for determining membership (in fact, they are fuzzy sets or images). To store these models, a dynamic memory organization similar to the database is required. The elements of the image are saved here. This task requires figurative thinking, which generates teaching methods using demonstration material. A decision making error occurs after the process of modeling an external situation, which is time-consuming but is a more efficient technique. Information comes from the outside world as an ordered set and is transmitted for its presentation by the image and model only after being processed by the operator.

The third task of perception is associated with the processing of logical structures – model building algorithms. Here we look for an optimal algorithm for constructing a model, which allows us to find a minimal general description of the methods for models constructing. Operations are defined on the elements of sets by enumeration. We have an algorithm for searching the algorithm for models constructing, which are described by logical functions and the task of finding the best model representation:

$$\begin{aligned} M\{I_\varepsilon\} = H_\varepsilon = M\{a(I_A, I_B)\}; \\ \xi^* \to W^*. \end{aligned} \quad (8)$$

Let us proceed to the consideration in the issue of information perception levels and models. Received three options for objective problems to be solved in the information perception process. The first level is information processing at the first stage of perception. The second level of information perception is associated with the formation of models and the determination of their proximity to reality, which allows us to obtain a different truth criterion – the attainability of the distance минимальности. We have a level of images and situations analysis. This level requires clarity and imaginative of information presentation. The third level operates with logical structures and algorithms for constructing models at the set level, which are given by enumeration. Here the problem of building models is solved and the algorithms for building images are formed. We have a level of logical thinking.

Thus, the algorithm of information perception (Figure 4, Figure 5) is quite simple. When perceiving information (Figure 4), a signal is always defined as an ordered set. To check the correctness of information perception (Figure 5), it is necessary to compare the message of the teacher with the message that the student creates on the basis of his

knowledge. Here the reverse process is performed, namely: based on the description, a set of elements is built and an internal image is formed, which is compared with the external image. Differential information flow, which is generated when comparing, allows you to adjust the knowledge gained. When forming the student's message flow, at each step they turn to the model, getting the following: for the operator – just a quasi-appeal; for the level of image processing – image recovery from its fragments; for the hypothesis formation – the list and image fragments link`s formation.

Let us dwell on the question analysis in the educational systems theoretical foundations. Based on the preceding, we can talk about the main principles of learning, such as the formation of exclusively true, concise and completed images that should be reproduced. Moving from the problem of information perception to the theory of educational systems, one can see that the control task is set, in which the formation of goals is of top priority. The principle of optimality is the fundamental principle of learning: we form the information flow of the trainer so as to minimize the student's error. Next, measures are identified that ensure the best achievement of the goal, which is a classic optimization problem. The most difficult is the construction of a student model [2, 4, 6, 14-46]. The models of the information perception dynamics are built and the time for training is predicted. The information systems theory assumes knowledge in the dynamic models of the student and the teacher, and the teacher is the central figure of the educational process.

The first specific feature of the modern information environment is that the teacher ceases to be the main source of knowledge since all knowledge is available on the computer network. The second feature of the modern computerized network information environment is noise, which is primarily created by: empty websites, Internet echoes from reposts, various informational nonsense; oversaturation with literature, which naturally arises due to the availability of access to virtually all existing technical and fiction literature in the absence of a proper unified organization for such an electronic information fund. A rather complicated question arises: how exactly to choose among the numerous information noise that which is necessary and useful?

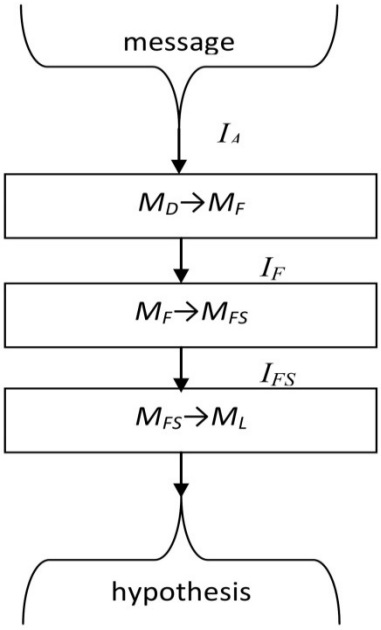

Figure 4 – Information flows in the message perception

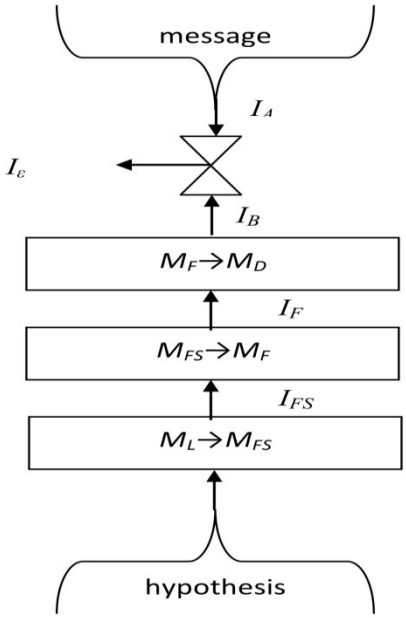

Figure 5 – Information flows when checking the put forward hypothesis correctness

Since the network is a sets union of weakly correlating sources, we get the information space with the norm in the form of trust information. The above provides an opportunity to build strategies for selecting information according to the method, which is based on taking into account the ratio of the information saved number to the information calls number, which allows us to single out the

expected useful information. Using the Hartley measure, you can choose the information that has a minimum of hits and therefore can potentially be new. Further, it is useful to use information systems theory. The following actual properties are required: logical connectivity, which is achieved by the interactive organization; the truth that can be achieved by the above method of information sampling; general accessibility provided by an open, non-commercial project. Attention should be paid to the fact that this exists (for example, in the format of Wikipedia and other similar network information resources), is a logical consequence of the global information system development. It remains only to ensure the availability and overcoming of language barriers, which is also solved. Returning to normal, it should be noted that the trainer becomes a mentor not only in the world of knowledge as such, but also in the computer network, where he offers his (most often, encyclopedic) knowledge in a format adapted for computerized network information interaction.

In general, as a result of the study, the following conclusions can be formulated. Learning processes are basically information processes, subject to the objective laws of the information systems functioning. The task of creating an education system is the control task, and the theoretical foundations of education systems building are based on control theory. Principles and methods of training, formed over a long period of practice, reflect the objective laws of the information systems functioning. The theorem of the information flow one-sided orientation and the limited types of sets, together with the principle of optimality, limits the number of information perception levels in the learning process to three levels. The development of the global information network leads to the unified knowledge system formation in the electronic encyclopedia`s form, which is the result of an objective process on the global network information flow compressing.

Conclusions. The study was aimed at further improving the methodological apparatus of computerized information training technology to ensure the optimal development of education systems in the context of the continuous strengthening for the socio-economic globalization trends, carried out by identifying those links for the composite technological components of modern computerized information learning processes with elements of the information technologies theoretical foundation that allow perfection develop learning and education systems in general based on information, information processes, and information systems theories. The basis for the processes of conducting and processing the results in scientific research was the methodological toolkit of theories in information and coding, probabilities and mathematical statistics, information processes, information technologies, feedback control, multi-criteria optimization, information systems, expert assessment.

As a result of the analysis in the features of the information processes globalization in the education systems based on modern computerized information and communication training technologies, its advantages, problematic aspects and factors of negative manifestations compensating were revealed. The study in the theoretical foundation of the education and training tasks showed the following dominants: typical problems of optimal control for systems, given descriptions, where functional dependencies of goals on control vectors, learning trajectories and parameters are formed; problem statements are vague, have numerous limitations and goals, requiring multi-criteria optimization; to solve problems, build models of objects and apply methods of control theory.

The results on monitoring the increasing relevance for conceptual categories of information, information objects, processes, technologies and systems in the training and education tasks in the globalization context have shown the desirability of increasing attention to their consideration as tasks of information systems control. Since information theory, as the basis of information systems, requires adaptation to the information systems control and training tasks, the article explores the feasibility for appropriately using elements of information theory in learning tasks as tasks of interacting with information systems and control of them.

In the context of the problem`s category to be solved, an analytical (functional) dependence on information for the norm defined above the event space is adopted in order to assess the degree of causal relationships. In probabilistic space, it is possible to represent the norm by a power series and to obtain, using a linear approximation, a generating differential equation, the solution of which allows, given initial conditions, to obtain an informational estimate based on the inverse functional dependence. A generalized formalized form is proposed: the probabilistic functional

dependence of the norm over the probabilistic event space on information; generating differential equation; an analytical expression for estimating information based on the solution of the indicated equation. By applying elements of information theory, processes of different essence can be put into correspondence with different types of methods for evaluating information and producing equations, measuring information as the degree of causal relationships. Determining the method for estimating the informational proximity of events (metrics) allows us to obtain a normalized metric information space induced over the event space, which is described by a simple mathematical construction. Events, information connections evaluations, and distances between events, the construction of information models should be considered in the information space. When modeling information systems, first of all, physical models and operators are needed.

The types of information processes (flows) in the elementary training information system, on the basis of which, it is possible to obtain complex information systems and control solutions, are defined. For the expected estimates of information transfer processes based on the norms of information spaces and comparisons of information flows using metrics, functional dependencies are obtained to determine the entropy based on the mathematical expectations of norms and metrics. Information processing is represented by a change in the values of causal relationships by the processes of the event space; formal definitions of the information processing operator and sets of perceived information objects are given.

Received a generalized block diagram of the algorithm for the training information system functioning as a control system with an informative input signal, feedback and an optimization procedure for finding the optimal operator to transform an ordered set into a set by definition with the aim of minimizing for information image perceptual errors, which displays a formalized perception information model at the level of elementary skills and concepts formation, given the characteristic features of the algorithm. For the subsequent stages of perception, the features of the models are also formed and analyzed: when moving from an image given by description by name (set by definition), to the set specified by enumeration (set by specifying by the optimization procedure of finding the best description), a characteristic procedure for deciding whether the input model corresponds to input flow; when working with a set of objects names, the characteristic procedure for analyzing the structure of the object (the set of enumeration allows you to build algorithms for describing the input stream organization).

Training is an informational process with the need to adapt to the requirements and limitations, statements about possible elementary interactions of information flows and structures for perception and accumulation of information are limitations, the information training system is built on the basis of selected fundamental elements, an important role in eliminating errors and the formation of operators-reflexes and images plays information non-redundant repetition.

The result of the analysis in the concept and informational essence of the learning paradigm is the following: the model of the learner as an object is determined relative to the formal knowledge accumulation; information perception process consists of receiving, processing and storing information created by the trainer as an information source; one-sided orientation of the information flow determines two possible forms of information interaction, transmission, and comparison of information; the above determines the formation of algorithms for the information perception; a limited number of methods for specifying specialized sets sufficient to form models of the external world determines the number for levels and tasks of information perception; the cornerstone is the principle of optimality.

The features are analyzed and formalized (analytical, algorithmic) descriptions are obtained for the main tasks of informational perception in training: for the formation of reactions and habits – a model for finding an operator that minimizes differences in the information of the trainer and the trainees; for the formation and determination of realism for the external world models on the basis of figurative and situational thinking – a model for finding the optimal sequence of informational influences and control, minimizing the expected perception error; for processing logical structures and algorithms for models constructing at the level of sets specified by enumeration, based on logical thinking – the optimal algorithm for finding algorithms of constructing models and images described by logical functions and problems of finding the best representations of models, which finds the minimum general description of methods for models constructing. An algorithm for infor-

mation perception has been developed, which takes into account information flows in perceiving messages and checking the correctness of hypotheses. The generalized structural schemes for formalized algorithms of information promotion between the message and the hypothesis are presented, taking into account the passage of perception levels models.

The analysis of the information perception tasks together with the theoretical foundations of educational systems allowed: to identify the main principles of information learning processes, based on the requirement to form true, concise and complete information images to be reproduced; to set the task of information training systems control as a classical optimization task, in which the fundamental are the goals formation and the optimality principle, which requires minimizing the error of the learner and measures to ensure the best achievement of the goal. To build a student model, the models of the information perception dynamics are built and the time of training is predicted. The information systems theory assumes knowledge of the dynamic models for the student and the teacher (the central figure of the educational process).

Highlighted current features and necessary properties of modern computerized network learning information environment, analyzed the sources and proposed ways to resolve their problem aspects and further improve on the basis of the developed information sampling techniques using the information systems theory.

In general, new concepts, algorithms, and models were developed that made it possible to formalize the identified interrelations of the learning information processes components with elements of the theories in information and information systems optimization control, achieving on this basis improvements in computerized information training technologies taking into account the features of the education systems globalization.

The obtained theoretical developments regarding the improvement of control in information training systems based on computerized information technologies make it possible, when introducing them into the practice of education systems in the context of globalization, to significantly improve the effectiveness of learning information processes.

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ДОСЛІДЖЕННЯ КОМП'ЮТЕРИЗОВАНИХ ІНФОРМАЦІЙНИХ ТЕХНОЛОГІЙ ЯК ОСНОВ НАВЧАННЯ ТА СИСТЕМ ОСВІТИ

Анотація. Мета статті полягає в удосконаленні методологічного апарату комп'ютеризованих інформаційних технологій навчання для оптимізації систем освіти в умовах глобалізації на основі виявлення і формалізації нових зв'язків технологічних компонентів інформаційних процесів навчання з елементами теорій інформації та управління інформаційними системами. Методи дослідження. Основою досліджень є теорії інформації, інформаційних систем та процесів, управління, оптимізації. Основні результати дослідження. Виявлено специфіку глобалізації систем освіти на базі комп'ютеризованих інформаційних технологій навчання, адаптації теорії інформації до взаємодії і управління в інформаційних системах навчання. В даному контексті, отримані: норма над простором подій як функціональна залежність від інформації для оцінки причинно-наслідкових зв'язків, що виробляє диференціальне рівняння, аналітичний вираз для оцінки інформації; концепція нормованого метричного інформаційного простору; види інформаційних процесів систем навчання; функції визначення ентропії на основі математичних очікувань норм і метрик для оцінок процесів передачі інформації; оператор обробки інформації; безлічі інформаційних об'єктів; схема дії інформаційної системи навчання як управління з оптимизационной зворотним зв'язком для мінімізації помилок інформаційного сприйняття; процедури прийняття рішень про відповідність моделей сприйняття інформаційних потоків, аналізу структур інформаційних об'єктів; концепція інформаційної суті процесів навчання з адаптацією до вимог і обмежень; формалізовані описи інформаційного сприйняття в навчанні; алгоритми сприйняття і просування інформаційних потоків; опрацювання оптимізаційної задачі управління інформаційними системами навчання; концепція вдосконалення сучасних інформаційних середовищ навчання із

застосуванням теорій інформації, інформаційних систем. Наукова новизна. Розроблено нові концепції, алгоритми і моделі, що дозволили формалізувати виявлені взаємозв'язку складових компонентів інформаційних процесів навчання з елементами теорій інформації та оптимізаційного управління інформаційними системами, досягаючи вдосконалення комп'ютеризованих інформаційних технологій навчання з урахуванням глобалізації систем освіти. Практична значимість. Впровадження отриманих теоретичних напрацювань щодо вдосконалення управління в інформаційних системах навчання на основі комп'ютеризованих інформаційних технологій в практику систем освіти в умовах глобалізації дозволяє істотно підвищувати ефективність інформаційних процесів навчання.

Ключові слова: *інформаційна технологія, комп'ютер, мережа, система, процес, навчання, освіта.*

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ИССЛЕДОВАНИЕ КОМПЬЮТЕРИЗИРОВАННЫХ ИНФОРМАЦИОННЫХ ТЕХНОЛОГИЙ КАК ОСНОВ ОБУЧЕНИЯ И СИСТЕМ ОБРАЗОВАНИЯ

Аннотация. Цель статьи состоит в совершенствовании методологического аппарата компьютеризированных информационных технологий обучения для оптимизации систем образования в условиях глобализации на основе выявления и формализации новых связей технологических компонентов информационных процессов обучения с элементами теорий информации и управления информационными системами. Методы исследования. Основой исследований являются теории информации, информационных систем и процессов, управления, оптимизации. Основные результаты исследования. Выявлена специфика глобализации систем образования на базе компьютеризированных информационных технологий обучения, адаптации теории информации к взаимодействию и управлению в информационных системах обучения. В данном контексте, получены: норма над пространством событий как функциональная зависимость от информации для оценки причинно-следственных связей, производящее дифференциальное уравнение, аналитическое выражение для оценки информации; концепция нормированного метрического информационного пространства; виды информационных процессов систем обучения; функции определения энтропии на основе математических ожиданий норм и метрик для оценок процессов передачи информации; оператор обработки информации; множества информационных объектов; схема действия информационной системы обучения как управления с оптимизационной обратной связью для минимизации ошибок информационного восприятия; процедуры принятия решений о соответствии моделей восприятия информационным потокам, анализа структур информационных объектов; концепция информационной сути процессов обучения с адаптацией к требованиям и ограничениям; формализованные описания информационного восприятия в обучении; алгоритмы восприятия и продвижения информационных потоков; проработка оптимизационной задачи управления информационными системами обучения; концепция совершенствования современных информационных сред обучения с применением теорий информации, информационных систем. Научная новизна. Разработаны новые концепции,

алгоритмы и модели, позволившие формализовать выявленные взаимосвязи составных компонентов информационных процессов обучения с элементами теорий информации и оптимизационного управления информационными системами, достигая совершенствования компьютеризированных информационных технологий обучения с учетом глобализации систем образования. Практическая значимость. Внедрение полученных теоретических наработок по совершенствованию управления в информационных системах обучения на основе компьютеризированных информационных технологий в практику систем образования в условиях глобализации позволяет существенно повышать эффективность информационных процессов обучения.

Ключевые слова: *информационная технология, компьютер, сеть, система, процесс, обучение, образование.*

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