МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
ХЕРСОНСЬКИЙ НАЦІОНАЛЬНИЙ ТЕХНІЧНИЙ УНІВЕРСИТЕТ

ЗАСТОСУВАННЯ ІНФОРМАЦІЙНИХ ТЕХНОЛОГІЙ В ЕКОНОМІЦІ, ОСВІТІ ТА УПРАВЛІННІ ПРОЕКТАМИ

колективна монографія

ХЕРСОН – 2018

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Колективна монографія
за загальною редакцією

кандидата технічних наук, доцента

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Колективна монографія розрахована на фахівців у галузі економіки, інформаційних технологій, фінансів, банківництва, державного управління, науковців, викладачів, аспірантів, магістрів та студентів.

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ЗМІСТ

1.	Khodakov V.Ye., Veselovskaya G.V., Sokolov A.Ye.	The Information Technologies Application For The Masters Teaching In The Process Of Acquiring Competences On Disciplines With A Complex And Dynamically Changing Subject Field (On Example The Methodologies Of Scientific Research, Artificial Intelligence Systems, And Complex Systems Control)	4
2.	Чаговець Л.О., Чаговець В.В., Яцура О.В.	Оцінка нерівномірності розвитку регіону як загрози економічній безпеці	21
3.	Соколов А.Е., Соколова О.В.	Влияние природно-климатических условий и социально-экономических факторов на развитие образования	35
4.	Повод Я.О., Райко Г.О.	Переваги та недоліки використання шейп-файлів	55
5.	Данилець Є.В.	Проектування автоматизованого робочого місця методиста учбово-методичного відділу	65
6.	Григорова А.А.	Використання інформаційних технологій для аналізу конкурентоспроможності малого підприємства	89
7.	Райко Г.О., Чебукін Ю.В.	Онтологічне моделювання та його використання в управлінні територіальними громадами	108
8.	Сидорук М.В.	Ресурси та ресурсні стратегії в сучасних проектах інформатизації	116
9.	Хапов Д.В.	Аналіз інформаційних потоків в управлінні готельним господарством	137
10.	Карамушка М.В.	Застосування соціальних мереж для створення нових продуктів	157
11.	Федоренко О.О., Гапонов В.О., Райко Г.О.	Інтенсифікація процесу стратегічного управління територією	169
12.	Зайчик Н.А.	Визуализация данных в RSTUDIO	184

THE INFORMATION TECHNOLOGIES APPLICATION FOR THE MASTERS TEACHING IN THE PROCESS OF ACQUIRING COMPETENCES ON DISCIPLINES WITH A COMPLEX AND DYNAMICALLY CHANGING SUBJECT FIELD (ON EXAMPLE THE METHODOLOGIES OF SCIENTIFIC RESEARCH, ARTIFICIAL INTELLIGENCE SYSTEMS, AND COMPLEX SYSTEMS CONTROL)

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Statement of the problem in general terms and its connection with important scientific and practical tasks. The use of modern information technologies in the training of specialists (professionals) with higher education and, in particular, masters has become an integral part of educational processes, significantly increasing their efficiency and the relevance of their results to the requirements of the labor market.

At the same time, the high complexity and dynamic variability in subject areas for a number of master's training disciplines require further improvement of existing approaches to the introduction of information technology in the educational sphere.

Analysis of recent research and publications on the subject. The study of the peculiarities in evolution, the current state and trends of the perspective development for information technologies and information systems (works [1-4], and others), as well as their applications in the field of education (works [5-8], and others), allowed us to conclude that, in the framework of the above general problem, relevant, but not sufficiently worked out questions are the study of specificity and the search for ways to optimize the information interaction of computerized technical training means users with information sources.

The works performed in this direction ([9-10] and a number of others), need further development.

Selection of unresolved parts of the general problem, the decision of which is devoted to research. Within the framework of the considered general problem, the sub problem of searching for ways to optimize (minimize) resource consumption of

information interaction processes for target categories of computerized technical training means users with information sources containing educational information, in preparation of masters from those disciplines characterized by complex and dynamically changing subject areas, is relevant.

Formation of research goals (task setting). The dynamics of social and economic processes, scientific and technological progress will persist in the systematic flexible adaptation of educational technologies to the peculiarities of the science and practical activity development, the demands of society on the specialists training, and the concepts of educational activity improvement.

Computerized technical training means play an important role in the success of this adaptation, which, at the present time, has a sufficiently wide range of modern classes and models, but at the same time, is constantly being improved [9-10].

In this paper, improved approaches to the actual problem of identifying reserves for improving the information interaction of users with computerized technical training means, based on emerging concepts and models for improving the effectiveness of interaction with information sources will be proposed.

These approaches will be considered taking into account those educational disciplines, where the system of information support is formed on the basis of a sufficiently voluminous, complex and dynamic information environment that has to flexibly adapt to the current state for certain objects of information activity – information needs and information requests of users, existing systems and sources of information support.

For high efficiency of interaction with the specified system of information support, it is necessary to increase the intensity, efficiency and economy (reduce resource consumption and overall cost) of work with information sources [9-10].

An important role is played by optimizing the planning of the interaction processes between users of the computerized technical training means with the current base set of various information sources, which are carried out within the framework of the specified organizational forms in conducting the educational process, on the minimizing criterion for the total cost of work with information sources [9-10].

An overview of the main research material justifying the results. In the conditions of growth of the information load of professional activity and informational saturation of professional training, the volume and problem in effective support for the study of professionally oriented educational disciplines, which are characterized by the following features, is increasing [9-10]:

1) the need for a dynamic change of training programs in accordance with current progressive tendencies, social orders, the state of the labor market, the needs of individual enterprises and organizations in a certain sense of the training of specialists;

2) the branching in the hierarchy of themes, subtitles and basic concepts corresponding to professionally-oriented information needs and information requests of computerized technical training means users;

3) large numbers and variety, general information volume, distribution of key characteristics (information saturation, quality, accessibility and convenience for

users, cost, etc.), average informational overload and redundancy, average hierarchical branching of information sources, which contain teaching materials, relevant professionally oriented information needs and information requests of computerized technical training means users;

4) the need for flexible joint use of cardinally different information sources global classes: electronic and traditional (on paper and tiled carriers);

5) the need to limit the subject and volume of study programs through the limit of hours allocated to the discipline curriculum, which leads to the need for expert ranking of topics and their content in order to sample a limited number of educational materials;

6) the need to provide in the programs, content and technologies of training substantial volumes and information load as the main teaching materials for the implementation of compulsory types on classroom and non-auditing academic work, as well as the general informational background of the disciplines.

Accordingly, it is important to optimize the information consumption of computerized technical training means users, designed to support the study of those disciplines characterized by the following set of problem areas: the need for a dynamic change in the subject and content of training in accordance with current criteria of relevance and practical value; the initial lack of a single, centralized and well-organized system for the numerous information sources (and the large amount of information support provided by them) that are consistent with a professionally-oriented information needs and information requests of computerized technical training means users; hard time constraints.

Based on the research carried out, the rapid and significant increase in efficiency (intensification, improvement of performance, decrease in resource intensity and overall cost) of interaction with the information resources for the computerized technical training means users with intensive dynamics, complex structure and a large overall volume of information environment that corresponds to professionally oriented users information needs and information requests, it is possible to reach the search for ways to rationalize the use of abundant, informational redundant and sufficiently costly resources of numerous information sources.

The primary direction in creating reserves for streamlining the use of information sources resources in the process of informational consumption for computerized technical training means users is the development of concepts and models for reducing the cost of users interaction with the information sources (minimizing the total time and cost of access to media, the cost of necessary supplies, etc.) within strictly fixed organizational forms, materially and technical foundations, requirements to the quality of the process and the results of interaction.

Solving this global problem involves the need for a systematic approach and the allocation of a number of local tasks.

One of the key classes of local tasks is to minimize the cost for informational consumption of computerized technical training means users with information sources in the case of a fixed set of information sources, tasks for informational consumption of each information source, organizational forms and time modes of work with the information sources.

We give a statement, concepts and models for solving the problem that belongs to the basic components of the specified class of local tasks, being aimed at minimizing the cost of the implementation plans by computerized technical training means users the tasks for information use as the tasks for the use of information sources resources for the case of hard-fixed sets of information needs, information requests, and conditions for the implementation of information interaction.

The study in the information consumption features for computerized technical training means users showed the relevance and efficiency on a number of concepts in constructing a system of tasks for information consumption as tasks for the use of resources information sources [9-10]:

– obtaining the theoretical preconditions for most tasks of information consumption (at least 75% of tasks) should be carried out in the form of the implementation by computerized technical training means users the independent information requests to a fixed set of information sources, which should be developed in advance by the computerized technical training means developers, and according to the purposes of satisfaction of users information needs, which should be clearly defined in the setting of tasks;

– tasks for informational use of computerized technical training means users should be formed so that they can be easily distributed in a series of mutually independent categories, each of which corresponds to the need to apply for an information requests to a specific type of information source or a specific information source;

– a set of tasks categories on the informational use for computerized technical training means users requiring the execution of information requests for different types of information sources should have a sufficiently wide spectrum to cover all the information sources recognized as optimal.

When implementing the above concepts in the learning process, it should be borne in mind that the implementation of the tasks set for informational consumption should be planned taking into account the organizational forms of conducting classes that envisage, within the general time of conducting, fixed time periods for the implementation of informational consumption and the volumes of possible information load corresponding to these terms.

Thus, the developers must perform the following actions [9-10]:

– created templates for the formation of tasks packages for information consumption, which must be characterized by a certain amount of maximum information download, corresponding to the existing organizational forms of information interaction;

– a plan on the activation order (filling and launching) of the templates for the formation of task packets on information consumption, designed for the educational process schedule, has been drawn up.

Accordingly, the results on the formation of task packets for information consumption of the computerized technical training means users must meet the following criteria [9-10]:

1) the task packages must be formed according to the specified patterns and priority sequence of their activation, which are determined by the existing organizational forms and schedule of information interaction specific for a certain learning process;

2) in general, a set of task packages should ensure that users receive the entire amount on information load for each of the information sources;

3) each of the tasks package should cover the maximum possible amount of information boot, which is assumed by the corresponding template.

Thus, we have an urgent task of optimizing the cost: taking into account the restrictive requirements formulated with the above criteria 1-3, minimize the number of requests from the environment from each set of tasks to different information sources, provided that the minimum total cost of applying to the information sources is minimized.

Let us introduce the necessary designations and conceptual provisions.

Assume that the set Q of information consumption tasks contains N independent basic tasks q_i and has a general amount of information load $V^{(Q)}$, and each individual task q_i requires a request for one information source and has a certain amount of information load v_i [9-10]:

$$Q=\{q_1,q_2,...,q_i,...,q_N\};\ V^{(Q)}=f_V(Q)=\sum_{i=1}^{N} v_i\ =\sum_{i=1}^{N} f_v(q_i); \qquad (1)$$

where: i – sum parameter (counter for indexes of basic tasks q_i);

f_v – indication for the function on determining the amount of information load.

We divide the set Q into M independent tasks sets $Q^{(j)}$ with the total volume of information load $V^{(Q)}$, where a separate set of tasks $Q^{(j)}$ has the information load volume $V^{(j)}$ and contains $L^{(j)}$ independent basic problems $q_k^{(j)}$ with the volume of information load $v_k^{(j)}$, the execution of which involves the implementation of information requests to j-th information source $S^{(j)}$ (with the corresponding change in the initial indexation of tasks) [9-10]:

$$Q=\{Q^{(1)},Q^{(2)},...,Q^{(j)},...,Q^{(M)}\};\ Q^{(j)}=\{q_1^{(j)},q_2^{(j)},...,q_k^{(j)},...,q_\eta^{(j)}\mid \eta=L^{(j)}\};\ N=\sum_{j=1}^{M} L^{(j)}; \qquad (2)$$

$$V^{(Q)}=f_v(Q)=\sum_{j=1}^{M} V^{(j)}\ =\sum_{j=1}^{M} f_v(Q^{(j)})=\sum_{j=1}^{M}\sum_{k=1}^{\eta} v_k^{(j)}\ =\sum_{j=1}^{M}\sum_{k=1}^{\eta}(f_v(q_k^{(j)})\mid \eta=L^{(j)}), \qquad (3)$$

where: j, k - sums parameters (counters of tasks sets indices and individual tasks within sets).

Select a set of templates for task packages$\{H_*^{(p)} \mid p=1,...,R\}$, agreed with the organizational forms of conducting classes and arranged in accordance with the educational process schedule, where the template $H_*^{(p)}$ has a general amount of information load $V_*^{(p)}$.

Based on the above concepts and notation, we formulate a generalized concept of solving the task.

From the initial set of independent basic tasks for information consumption $Q=\{q_i \mid i=1,...,N\}$ with the total volume of information load $V^{(Q)}=\sum (v_i \mid i=1,...,N)$, it

is necessary to allocate independent sets of tasks $Q^{(j)}$ with the total volume of information load $V^{(j)}$ [9-10]:

$$Q=\{Q^{(j)} \mid j=1,...,M\}=\{q_k^{(j)} \mid j=1,...,M, k=1,...,L^{(j)}; N=\sum_{j=1}^{M} L^{(j)}\}; \quad (4)$$

$$V^{(Q)}=\sum_{j=1}^{M} V^{(j)} = \sum_{j=1}^{M}\sum_{k=1}^{\eta} (v_k{}^{(j)} \mid \eta = L^{(j)}), \quad (5)$$

which execute information requests to information sources $S^{(j)}$, and form such a set of task packages $\{H_*^{(p)} \mid p=1,...,R\}$ with fixed template volumes of the information load $V_*^{(p)}$, in order to achieve the goals and comply with the constraints shown in positions 1-3 below on the text of the list [9-10]:

1) the total cost of handling for informational requests provided by the set of task packages $\{H_*^{(p)} \mid p=1,...,R\}$, to the totality of the informational sources $S^{(j)} \mid j=1,...,M\}$ should be minimized based on the optimization of the requests number with informational requests from the environment of each tasks set $H_*^{(p)}$ (p=1,...,R) to various informational sources, taking into account the cost of work with each specific information source;

2) all N tasks for informational consumption in the process of passing R tasks packets must be performed in full volume of their informational load;

3) all templates for the tasks packets of informational consumption must be maximally filled according to the extent of their possible informational download.

The mathematical formulation for this concept of solving a problem will consist of a target function and two additional conditions-restrictions of its application.

The objective function for the formulated problem on optimizing the requests number with information requests to the information sources will look like [9-10]:

$$\sum_{p=1}^{R}\sum_{j=1}^{M} \beta_p^{(j)}\, u_p^{(j)} \rightarrow \min, \quad (6)$$

where: p is the sum parameter, which is the counter for the indexes of task packages $H_*^{(p)}$ (p=1,...,R);

j is the sum parameter, which is the counter for the indexes of information sources $S^{(j)}$ (j =1,...,M), to which the task packets $H_*^{(p)}$ (p = 1,...,R) may have access;

$\beta_p^{(j)}$ is a coefficient that can take values from the set {0,1} and performs the function of the flag (set to 1 or resets to 0 depending on whether the p-th package was included in the tasks envisaged access to j-th information source);

$u_p^{(j)}$ is the work expense of the p-th task package with the j-th information source (cost of access to the source, obtaining information services, etc.) – an integrated indicator for costs of time, materials, human resources, finance, etc.

The following mathematical formulas will have the restrictive conditions [9-10]:

$$\forall(j=1,...,M)\sum_{p=1}^{R} \beta_p^{(j)}\, \tilde{v}_p^{(j)} = V^{(j)}; \quad \forall(p=1,...,R)\ \sum_{j=1}^{M} \beta_p^{(j)}\, \tilde{v}_p^{(j)} = \tilde{V}^{(p)}, \quad (7)$$

where: $\tilde{V}_p^{(j)}$ – the total information download for the tasks sets of the p-th tasks package requiring access to the j-th information source;

$V^{(j)}$ – full (maximum planned) information download of j-th information source;

$\tilde{V}^{(p)}$ – complete (as much as possible) informational download of the p-th task package according to the given template.

The further development of the above method involves: carrying out a preliminary analysis of the semantics in complex, dynamically changing disciplines subject fields of identifying the key semantic components for the specified subject areas, such as semantic categories (SC), semantic subcategories (SSC), semantic elements (CE); consideration of the revealed semantic components as vertices for the semantic network of the subject field objects.

The semantic analysis of subject areas should be based on the research principles: information needs and information requests for target categories of computerized technical training means users; expert knowledge obtained by the method of extracting knowledge from specialized texts; needs of the labor market.

As a tool for collecting the information provided, it is suggested that World Wide Web technologies be used.

The basic semantic analysis (based on the summary of complex subject areas to simpler ones) and further extended semantic analysis (on the basis of the gradual integration in the results obtained for simpler subject sub-sectors, to the more complex ones) is envisaged.

The following are examples of the semantic analysis basic stage results in the subject fields on the disciplines dealing with the questions of the methodology in scientific research, artificial intelligence systems, and the complex systems control.

As a result, the study of the semantics in the scientific research methodology subject field [11-14, etc.], two semantic categories (with corresponding ciphers in the form of letters and digits) were allocated for further consideration:

1) the semantic category SC_1 "Concept of scientific research and requirements to it, the concept of the scientific research methodology and its types, empirical and theoretical methods of scientific research" with seven semantic subcategories and corresponding semantic elements:

– SSC_1.1 "The review in the subject matter of the scientific research methodology":

a) SE.1.1.1 "General provisions of the scientific research methodology. Review of defining literary sources from the scientific research methodology. Major definitions in the subject matter of the scientific research methodology";

b) SE_1.1.2 "Basic concepts of science as activity, functions of science, directions of scientific research, scientific communities, scientists, development of the scientific attestation system, scientific degrees, scientific workers, scientific and pedagogical workers, scientific activity, features of a scientist creativity, methods of scientific research, methods of scientific knowledge, characteristics of research methods, mathematical apparatus for constructing mathematical models, products of creative activity, models and methods of research of large systems, problematic

aspects of the science and education development in Ukraine, international scientific organizations and institutes, scientific medals and awards, the most important scientific discoveries of mankind";

– SSC_1.2 "Important structures and components of scientific activity":

a) SE_1.2.1 "Basic functions of science";

b) SE_1.2.2 "Scientific communities. Scientists. Scientific organizations. International scientific institutes. Awards and medals at the international level in science";

c) SE_1.2.3 "Borders of scientific knowledge. Academic and scientific degrees and titles. Development of the system for scientific and scientific-pedagogical personnel potential attestation";

г) SE_1.2.4 "Key concepts and definitions in the scientific world";

– SSC_1.3 "Characteristics of scientific activity":

a) SE_1.3.1 "Basic types of scientific activity. Peculiarities of individual scientific activity. The UNESCO concept on the status of a scientific worker. The features of collective scientific activity";

b) SE_1.3.2 "Specificity of the scientist creativity. Principles of scientific knowledge. Means of scientific research (knowledge). Methods of scientific research. The essence and short history in the development of the scientific method";

– SSC_1.4 "Scientific research":

a) SE_1.4.1 "Concept and general characteristic of scientific researches";

b) SE_1.4.2 "Concepts and methods of scientific knowledge, their characteristics. Methods of empirical and theoretical knowledge";

c) SE_1.4.3 "Scientific observation. Direct and indirect observations. Interpretation of observational data";

d) SE_1.4.4 "Experiment";

– SSC_1.5 "Scientific problem":

a) CE.1.5.1 "Research Objectives. Interpretation of the concept of a scientific problem. Selection and formulation of scientific problems. Examples of problem solving. Development and solving of scientific problems. Classification of scientific problems";

b) CE_1.5.2 "Scientific problem in the dissertation. Scientific and pragmatic tasks of the problem in the dissertation. The notion and requirements for the scientific result in the dissertation. Types of scientific results";

– SSE_1.6 "Experimental research (empirical knowledge)":

a) SE_1.6.1 "Basic methods of scientific knowledge";

b) SE_1.6.2 "Observations (concepts and basic functions)";

c) SE_1.6.3 "The concept and functions of the experiment in scientific research. The main components (elements) of the scientific experiment. Classification of experiments. Types of experiments. Thought and material experiment. Passive and active experiment. Planning and construction of the experiment. Development of methods in conducting the experiment. Requirements to experiment results";

– SSC_1.7 "Methods of theoretical research":

a) SE_1.7.1 "The main components of the theoretical level methods. General classification in the methods for theoretical and empirical level of researches. Goals

and tasks of theoretical research. The essence of methods in theoretical research. Stages (steps) of theoretical research";

b) CE_1.7.2 "Mathematical formulation of research tasks. Mathematical apparatus for constructing mathematical models. Description in the transformation of input signals at the output";

2) semantic category SC_2 "Contents and components of the research process, forms for reflection of the scientific research results" with seven semantic subcategories and corresponding semantic elements:

– SSC_2.1 "Dissertation Research":

a) SE_2.1.1 "Requirements for degree applicants preparation in Graduate school. Educational Research Program";

b) SE_2.1.2 "Dissertation as a product of intellectual work. Interrelation between scientific categories. Other intellectual products";

c) SE_2.1.3 "Differences in the results of creative activity. Differences between the dissertation and other types of creative activity. Types of dissertations";

d) SE_2.1.4 "An example of the dissertation content. Examples of doctoral dissertation and candidate dissertation (dissertation of the doctor of philosophy)";

– SSC_2.2 "Processing of the results for experiments and observations":

a) SE_2.2.1 "Interrelation of theoretical and experimental researches. Errors of measurement";

b) CE_2.2.2 "Objectives for mathematical processing of experimental results";

c) CE_2.2.3 "The correctness in the mathematical processing of the experiment results as a guarantee for the reliability of the dissertation scientific provisions";

d) SE_2.2.4 "Preliminary data processing of the experiment. Application of sample estimates";

e) SE_2.2.5 "Classification of errors in the experiment. Accuracy of selective observation";

f) SE_2.2.6 "The concept of a statistical hypothesis and a statistical criterion. A hypothesis test. Types of probabilities distribution laws";

– SPK_2.3 "Methodology of programming in scientific research":

a) SE_2.3.1 "Review of the basic literature on the methodology of programming. Methodology of science and its programming peculiarities";

b) SE_2.3.2 "Programming languages and programming paradigms. Using abstraction and decomposition in programming. Reducing errors in programs";

– SSC_2.4 "Science of Ukraine":

a) SE_2.4.1 "Territorial placement of scientific organizations in Ukraine, scientific and technical potential of Ukraine. Financing of science in Ukraine. Organization of scientific research activities in Ukraine. International scientific and technical cooperation of Ukraine";

b) SE_2.4.2 "Ways of the Ukrainian science outcome from the crisis. Difficulties in solving the problem of increasing the science level. The costs of science in other countries. Possible future of science in Ukraine";

– SSC_2.5 "The most significant discoveries of mankind":

a) SE_2.5.1 "An overview of the discoveries of mankind throughout the history of mankind. Fire. Wheel and cart. Writing. Paper. Gunpowder and firearms. Telegraph, radio, telephone. Car. Electric light bulb. Antibiotics. Sail and ship ";

b) SE_2.5.2 "Discoveries in the 20-th century (review of ten discoveries)";

– SSC_2.6 "Assessment of research results":

a) SE_2.6.1 "Extensive and intensive ways of development. Reduction of the development level for science and technology";

b) SE_2.6.2 "Need for evaluation of scientific results. Assessment of applied and fundamental research. Index (criterion) of citation. Qualitative methods for assessing scientific activity. Qualitative and quantitative assessment of science. Requirements for the science assessments system";

– SSC_2.7 "Impact of the natural and climatic environment on the development of science, education and industry":

a) SE_2.7.1 "Natural and climatic conditions of Eastern Europe in relation to Ukraine";

b) SE_2.7.2 "Costs for the correction of negative weather conditions at the country level in Ukraine. The cost of overcoming the negative impact of natural and climatic factors at the regional level. Changing the costs for parry of the weather conditions";

c) SE.2.7.3 "Peculiarities of population settlement. Territories of accelerated economic growth";

d) SE_2.7.4 "Necessity of public education in the field of natural conditions. Understanding of differences in natural and climatic conditions";

e) SE_2.7.5 "Basic needs of a person depending on the natural environment. Assessment for the impact of natural and climatic conditions on industrial and agricultural production";

f) SE_2.7.6 "Principles of raising the level of economy, science and education. The role of education for the development of science and economics. Fundamentalism of education. Requirements for the education system. Systemic thinking as the most important quality of the science development".

By analogy with the previous subject field, in the final analysis of the semantics in the subject field on the artificial intelligence systems methodology [15-19, etc.], two semantic categories were selected for further consideration:

1) semantic category SC_1 "Fundamental concepts of artificial intelligence, artificial intelligence systems and research of artificial intelligence systems" with four semantic subcategories:

– SSC_1.1 "Basic concepts of artificial intelligence and artificial intelligence systems";

– SSC_1.2 "Basic concepts of research areas of artificial intelligence systems";

– SSC_1.3 "Neural networks, genetic algorithms, and evolutionary modeling in artificial intelligence systems studies";

– SSC_1.4 "Models of knowledge presentation and intelligent technologies in the World Wide Web in artificial intelligence systems studies";

2) the semantic category SC_2 "The main areas of artificial intelligence systems research" with four semantic subcategories:

– SSC_2.1 "The presentation of problems, solving problems, proving the theorems, and presenting knowledge in the artificial intelligence systems research";

– SSC_2.2 "Expert systems, studying and identifying patterns in the artificial intelligence systems research";

– SSC_2.3 "Communication in the natural language, pattern recognition and computer vision in artificial intelligence systems studies";

– SSC_2.4 "Programming languages in artificial intelligence systems studies".

Tables 1 and 2 show the corresponding semantic elements.

Table 1 – Semantic elements on the category SC_1 in the subject field of the artificial intelligence systems methodology

Ciphers	Names
SE_1.1.1	The concept of the intellectual system, the classification and the fields of application for intelligent systems
SE_1.1.2	Evolution of the development in artificial intelligence
SE_1.1.3	General provisions of the artificial intelligence theory
SE_1.1.4	General concepts and areas of research in the field of artificial intelligence
SE_1.1.5	The notion of an Artificial Intelligence System
SE_1.1.6	Survey of artificial intelligence systems, construction principles and fields of application for artificial intelligence systems
SE_1.1.7	An overview of the underlying technologies in Artificial Intelligence Systems: neural networks; genetic algorithms; evolutionary modeling; models of presentation for knowledge; intellectual technologies in the World Wide Web, etc.
SE_1.1.8	General characteristics in the basics of the artificial intelligence systems design
SE_1.1.9	The main areas of research related to the design of the artificial intelligence systems, and the principles of designing the most common artificial intelligence systems (recognition systems, expert systems, etc.)
SE_1.2.1	Prerequisites, goals and objectives for research in the field of artificial intelligence and artificial intelligence systems
SE_1.2.2	Evolution of development, current state and prospective directions for perfection of the main areas of research in the artificial intelligence systems (presentation of problems and the search for solutions, proofing of the theorems, presentation of knowledge, expert systems, learning and revealing of regularities, communication in natural language, pattern recognition, computer vision, artificial intelligence programming languages etc)
SE_1.3.1	The notion of a neural network
SE_1.3.2	Structure and classification of neural networks
SE_1.3.3	Problems and methods of neural networks constructing
SE_1.3.4	Basic models of neural networks, methods and algorithms for their training

Ciphers	Names
SE_1.3.5	Practical examples on the implementation of neural networks, tasks of classification and analysis
SE_1.3.6	Features and technologies of neural networks application in artificial intelligence systems studies
SE_1.3.7	Basic concepts in genetic algorithms
SE_1.3.8	Main operations implemented in genetic algorithms
SE_1.3.9	Features of genetic algorithms constructing
SE_1.3.10	Concepts for solving optimization problems using genetic algorithms
SE_1.3.11	Features and technologies for the application of genetic algorithms in artificial intelligence systems studies
SE_1.3.12	Peculiarities of evolutionary methods and technologies of their application in solving intellectual problems in Artificial Intelligence Systems studies
SE_1.3.13	A generalized comparative overview of the basic algorithms based on natural analogs such as evolutionary models, genetic algorithms, collective behavior, etc.
SE_1.4.1	Classification, theoretical principles, comparative analysis, peculiarities of realization, methods and the field of application for knowledge representation models in researches of the artificial intelligence systems
SE_1.4.2	Grounds of relevance, preconditions of appearance and main types of intellectual technologies in the World Wide Web
SE_1.4.3	Features of realization for technologies in virtual interlocutors, search by image, voice interface, handwritten text, face recognition as intellectual technologies in World Wide Web
SE_1.4.4	Features of the intellectual technologies application for the World Wide Web in the artificial intelligence systems study

Table 2 – Semantic elements on the category SC_2 in the subject field of the artificial intelligence systems methodology

Ciphers	Names
SE_2.1.1	Connection of person intellectual activity with the search for solutions of tasks
SE_2.1.2	Characteristics for the ways of representing problems and finding solutions: the fundamental questions of representing problems in the spaces of states and subtasks, in the form of theorems proofs; methods on solutions searching for different models of tasks presentation
SE_2.1.3	Peculiarities on presentation of problems and search of solutions in the researches of artificial intelligence systems
SE_2.1.4	Actuality, specificity and technology for presentation of problems in the form of theorems proofs, the process of finding solutions to these problems
SE_2.1.5	Peculiarities of the theorems proofs application in the artificial intelligence systems research

Ciphers	Names
SE_2.1.6	Basic requirements for knowledge representation models
SE_2.1.7	Characteristics in the basic concepts and mathematical apparatus for the basic models of knowledge presentation (logical, production, semantic, frames, etc.) in the artificial intelligence systems
SE_2.2.1	Justification for the importance of problem-oriented knowledge
SE_2.2.2	Characteristics for the ratio of expert knowledge, theoretical-analytical methods and heuristic rules for solving problems
SE_2.2.3	Basic concepts of deducing models constructing based on deductive approaches and inductive approaches, basic deducing algorithms
SE_2.2.4	Definition, purpose, architecture, tasks, functions, areas of application of the expert systems
SE_2.2.5	Features and stages of development, methods of designing and applying the expert systems
SE_2.2.6	Knowledge engineering as an independent artificial intelligence direction
SE_2.2.7	Principles of acquiring knowledge
SE_2.2.8	Technologies for working with knowledge in the process of the expert systems building
SE_2.2.9	Methods of presentation and processing of knowledge
SE_2.2.10	Technologies of construction and integration for the expert systems basic components
SE_2.2.11	Characteristics of the languages for the expert systems realizations
SE_2.2.12	Technologies of software implementation and practical use of the expert system
SE_2.2.13	Peculiarities of the Expert Systems application in the studies of artificial intelligence systems
SE_2.2.14	Theoretical foundation for the tasks of replenishing and acquiring knowledge on the basis of learning and identifying the laws in the process of artificial intelligence systems functioning
SE_2.2.15	An overview of the latest technologies for practical problems solving that require intuition and use self-learning and self-organizing algorithms
SE_2.3.1	The main problems, components and methods on software and hardware developing for communicating with the computer in a natural language for the research of the artificial intelligence systems
SE_2.3.2	General formulation and ways of solving tasks that fall into the categories of classification, predictive, pattern recognition, etc.
SE_2.3.3	The main purpose of the research, defining examples of problems, and methods for solving problems of pattern recognition
SE_2.3.4	Technologies for research and designing of image recognition systems as one of the most commonly used classes in Artificial Intelligence Systems

Ciphers	Names
SE_2.3.5	Principles of constructing image recognition systems depending on the volume of a priori information about recognition patterns and the nature of information about signs of recognition objects
SE_2.3.6	The main task that is solved when constructing systems of machine vision
SE_2.3.7	The connection of the computer vision systems creating problem with such areas of Artificial intelligence as presentation of knowledge, learning and pattern recognition
SE_2.4.1	Classification, peculiarities, organization, functions, tools, and technology of programming languages using for the purposes of artificial intelligence and artificial intelligence systems research
SE_2.4.2	Overview in the programming language for the creation of artificial intelligence systems research prototypes

Like the two previously discussed subject areas, the result on study of the semantics in the complex systems control methodology subject area [15-19, etc.] was the allocation for further consideration of two semantic categories:

1) the semantic category SC_1 "Fundamental concepts and theoretical approaches to methods of complex systems control" with three semantic subcategories and corresponding semantic elements":

– SSC_1.1 "Basic concepts of modern complex systems and methods of complex systems control":

a) SE.1.1.1 "Definition, features, fields and illustrative examples on the practical application of advanced complex systems and methods of complex systems control";

b) CE_1.1.2 "Concepts of mathematical modeling, hardware and software tools, perspective directions on development of modern complex systems and methods of complex systems control";

– SSC_1.2 "General approaches to the theory of nonlinear feedback":

a) SE_1.2.1 "The theory of nonlinear feedback in application to systems with one input and one output";

b) SE_1.2.2 "The theory of nonlinear feedback in application to systems with multiple inputs and multiple outputs";

– SSC_1.3 "General approaches to the theory of sliding modes and applied problems of systems with continuous control":

a) SE_1.3.1 "The theory of sliding modes and mathematical description of movements in the continuous limits";

b) SE_1.3.2 "Connections in systems with continuous control";

2) semantic category SC_2 "Methods for intellectual control of complex systems based on heuristic, cognitive, and robust approaches" with three semantic subcategories and corresponding semantic elements:

– SSC_2.1 "Principles of constructing intelligent control systems. Methods for control of complex systems based on fuzzy logic technologies":

a) SE_2.1.1 "Establishment of a control problem under uncertainty, defining the fields of application and principles of building intelligent control systems";

b) SE_2.1.2 "Theoretical bases in complex systems management on the basis of fuzzy logic technologies: the basis of the fuzzy sets theory; features of fuzzy logic output in the tasks of dynamic objects control; fuzzy controllers (principles of construction, phasification and dephasing, folding fuzzy control rules); technical and software tools for the implementation of fuzzy control; the basis of analytical design in fuzzy control regulators, synthesis of fuzzy controllers based on probabilistic models";

c) SE_2.1.3 "Basic methods of managing complex systems based on fuzzy logic technologies";

– SSC_2.2 "Methods of managing complex systems based on expert systems technologies and associative memory technologies":

a) SE_2.2.1 "Theoretical bases of complex systems control on the basis of Expert Systems technologies: basic concepts, formal bases and classification of expert systems; static and dynamic expert systems in control, structure of soft expert systems, expert systems development methodology; expert regulators for automatic control systems of dynamic objects, basic concepts about adaptive electric drives and mechatronic devices with expert regulators; basic concepts in planning of displacements and movement control of manipulation robots on the basis of the expert systems technologies;

b) SE_2.2.2 "Fundamentals of complex systems control on the basis of the expert systems technologies";

c) SE_2.2.3 "Theoretical bases of complex systems control on the basis of associative memory technologies: methods of implementing associative memory; especially the functioning of control systems with associative memory under uncertainty; basic concepts in motion control of precision technological robots and mechatronic devices on the associative memory basis; adaptive control based on associative memory technologies; combining robust and adaptive control with intelligent systems; basic notions of absolute stability for control systems mechatronic devices with associative memory";

d) SE_2.2.4 "Fundamentals in complex systems control on the basis of associative memory technologies";

– SSC_2.3 "Methods of complex systems control based on the technologies of neural networks":

a) SE_2.3.1 "Theoretical bases of complex systems control on the basis of neural networks structures technologies: artificial neural networks and their classification; neural network regulators for the management of dynamic objects, identification dynamic objects based on neural network technologies; genetic algorithms; intelligent control systems with expert-neural network regulators; self-learning control systems based on neural networks";

b) SE_2.3.2 "Concept of cognitive and synergetic management, paradigm of hybrid intellectual control";

c) CE_2.3.3 "Fundamentals of complex systems control based on the technologies of neural networks".

Conclusions and recommendations. According to the results of the carried out researches, a method in resource efficiency optimization for information interaction processes of computerized technical training means users with educational assignment information sources in the conditions of masters preparation on disciplines with complex and dynamically changing subject areas is proposed.

Appropriate approaches, mathematical models and their software were tested on the basis of the Kherson National Technical University for a number of disciplines that belong to the subject areas of the scientific research methodology, artificial intelligence systems methodology, complex systems control methodology, etc.

As a result, the effectiveness of learning processes related to interaction with information sources has increased by 80 percent.

Further development of research is seen in the more thorough development for approaches to semantic analysis of subject areas.

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