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"The environment of automated training with the properties of adaptation based on the cognitive models"

on the specialty 05.13.01 – "The system analysis, control and information processing" (the adaptive systems of automatic control with the determined entrance influences and the reference cognitive models of the subject of training and the means of training, the reconstructed models of the cognitive processes)

The autoabstract
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The work was performed at "The Saint-Petersburg state electrotechnical university "LETI" named after V.I. Ulyanov (Lenin)" ("SPbSETU "LETI"") in 2005 y.

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The defence of dissertation will take place on the "___" of _____ 201 __ y. at ____ hours at the meeting of "The dissertation council (D.212.232.50)" of "The Saint-Petersburg state university" ("SPbSU") at the address: RF, 199034, Saint-Petersburg city, Universitetskaya emb., h. 7-9, lecture hall ____.

It is possible to look through the dissertation in the library of "SPbSU" and "SPbSETU "LETI"".

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GENERAL CHARACTERISTIC OF THE WORK

The relevance of the theme of research is explaining by the evolution of priorities from the outside of the state and international bodies regulating the policy of development of the system of education and informatization of educational sphere, the extension of requirements to the synthesis of information environments of educational establishments, the imperfection of scientific-methodical and technological device for support the analysis and assessment of efficiency of information exchange between the subjects and means of training in educational process, the absence of universal scientific approach (method and technology) to the assessment of quality of training, developed in the context of applied bases of physiology, psychology, linguistics and etc., and also continuous development and emergence of innovations in the field of the inf. technologies (IT) and environments of programming, the emergence of the set of problems in various spheres of social activity, influencing on consumer preferences of educational services.

The globalization of information environment of post-industrial society and high rates of scientific-technical progress cause the exponential growth of flows of information as cumulative unit of knowledge on various subject areas, that defines the specifics of educational process, covariant to limited time of training and opportunities (physiological, psychological and linguistic) of the subjects of training, a consumer preferences of which in a mediated way also influence on organizational-methodical and technological bases of educational process in the automated information-educational environment (IEE).

There is a need of creation of approaches, methods and technologies for the research of opportunities of the automated IEE and assessment of quality of functioning of the adaptive training means developed in it, allowing to generate information-educational influences based on the individual features of the person of the subjects of training (IFPST).

The theoretical-methodological basis of research is reflecting in scientific works of the Russian and foreign scientists: questions of organization, technical and methodical supply of the automated training in the sphere of the higher education (Yershov A.P., Kashitsin V.N., Sovetov B.Ya. and others); programmed training and development of training systems (Briggs L., Harrison N. and others); technologies of distance training (Knowles M.S., Moore M.G. and others); perception of electronic inf. (Dillon A., Salomon G. and others); mathematical methods and models of the analysis and synthesis of the automatic control systems (Yzerman M.A., Besekersky V.A. and others); theory of open systems (Moiseyev N.N., Haken G. and others); theory of modeling of training process (Bespalko V.P., Mashbits E.I. and others); theory of intellectual systems and lang. of representation of knowledge (Ivashchenko K.I., Pospelov D.A. and others), theory of algorithms (Gurevich I.B., Zhuravlev U.I. and others), object-oriented paradigm in integrated environments of programming (Zikhert K., Davies S.R. and others).

The problem of synthesis of IEE of "the adaptive" training based on a new IT is not widely solved, though many its aspects, including and not related with it directly, but extremely important owing to their fundamental nature, *were developed* by teachers, physiologists, psychologists, linguists, experts in the field of IT: the systems of training and innovative processes in education (Galperin P.Y., Zagvyazinsky V.I., Makhmutov M.I. and others); personal-oriented education (Amonashvili Sh.A., Bondarevskaya E.V., Yakimanskaya I.S. and others); modeling and programmed training (Bespalko V.P., Gershunsky B.S., Talyzina N.F. and others); psychophysiology of perception (Izmaylov Ch.A., Croll V.M., Smirnov V.M. and others); cognitive psychology (Druzhinin V.N., Zinchenko T.P., Holodnaya M.A. and others); applied linguistics (Geek M. L., Kobrina N.A., Potapova R.K. and others).

The analysis of the modern stage of development of technologies (automated) training has allowed to reveal **the most essential various contradictions**:

- the existing technologies *of* creation of the automated means of training and training-methodical complexes (TMC) *practically do not consider* the features of information processing by the trainee as the subject of process of training;

- the improvement of organization and technology of the process of the automated training *causes need of the analysis* of efficiency of functioning of the information-educational environment with taking into account of individual features of the subjects of training (physiological, psychological, linguistic and etc.);

- the requirements to modern IEE *initiate* monitoring, the realization of accumulation and expeditious data processing, characterizing individual dynamics of change of indicators of quality of formation of knowledge of trainees.

The object of research is the information-educational environment of the automated (remote) training (ART) system of educational establishment.

The subject of research performs the automated training system with the properties of adaptation based on the parametrical cognitive models block.

The hypothesis of research is based on the assumptions about continuity of the development of a new IT and expansion of the sphere of their use in education, providing a possibility *of realization* of means of the adaptive training in the automated IEE, considering physiological, psychological, linguistic and other features of the subjects of educational process, allowing to increase efficiency of formation of knowledge of the trainee with the minimum loadings, transaction and temporary expenses, and also to sustain the required level of his preparation.

The purpose of research is increase of efficiency of functioning of IEE ART due to realization of individually-oriented formation of knowledge of the trainee with the use of the adaptive generation of educational influences based on the parametrical cognitive models block (CM).

According to the hypothesis and purpose the following **research tasks** were solved:

1. *The analysis* of theoretical bases of construction of the automated IEE of the adaptive training with the model of the subject of training on the base of the theory of automatic control, organizational models and technologies of interaction of the subjects with the means of training, and also the main actions at the organization of individually-oriented formation of knowledge: models of representation of information-educational influences, algorithms of training, specifics of realization of monitoring of progress and assessment of the level of residual knowledge of the trainee.

2. *The synthesis* of structure of IEE of ART system with the properties of adaptation based on the parametrical CM block: features of channels of information interaction of the subjects and means of training; specifics of organization, main technological stages of training as the operated process and components of ART system.

3. *The creation* of the cognitive modeling technology (CMT) for the system analysis and the increase of efficiency of functioning of the automated IEE.

4. *The formation* of CM of the subject of training and CM of the means of training at the basis of IEE of ART.

5. *The development* of software for automation of research tasks.

The main methods of research are:

- theoretical – the theory of systems, the system analysis and modeling, the theory of control, structuring and representation of knowledge, engineering psychology and pedagogics;
- experimental – the applied methods of theory of information, the physiology of sensory systems (analyzers), cognitive psychology and applied linguistics.

The main scientific results, submitted to the defence and their novelty:

1. The structure of IEE and principles of functioning of components of ART system with the properties of adaptation based on the parametrical CM block – differ in a possibility *of realization* of the additional contour of adaptation on the basis of IFPST, allowing to increase the efficiency of functioning of IEE of ART system.

2. CMT, including the technique of its use, the algorithm of formation of the structure of CM, the techniques of research of the parameters of CM and the algorithm of processing of a posteriori data of testing – allows *respectively to formalize* the sequence *of the use* of technology, *to receive* the structure of CM, *to provide* a statement of the experiment and diagnostics of the parameters of CM of the subject of training, *to form* function of estimation and to calculate the indicators of quality of test on the basis of results of testing and in general *to carry out the complex analysis* of efficiency of functioning of IEE of ART system in the context of series of the chosen scientific aspects.

3. The structures of CM of the subject of training and CM of the means of training – accumulate respectively the parameters, characterizing IFPST and technical opportunities of the means of training, *providing* the adaptive generation of educational influences.

4. The complex of programs, including the adaptive electronic textbook, the basic and applied diagnostical modules – provide the opportunity according to the automated individually-oriented generation of information fragments, assessment of level of residual knowledge and diagnostics of parameters of CM of the subject of training.

The theoretical and practical importance of research consists of:

1. The bases of reorganization of IEE with taking into account realization of adaptation to individual features (parameters) of the subjects of training were offered: the structure of ART system with the properties of adaptation; specifics of training as operated process; features of the structure of components of ART system; bases of extraction of subject knowledge for the purposes of construction of theoretical-reference modules of electronic textbooks and parameters of their assessment; specifics of the use of means of multimedia in the IEE of ART.

2. The organizational and technological modifications of IEE, and also the principles of functioning of the components of ART system at realization of a contour of adaptation based on the parametrical CM block were allocated.

3. The channels of information exchange of the subjects and means of training in ART system with the properties of adaptation based on the block of CM were considered, the key parameters, influencing on efficiency of formation of knowledge of the trainee in IEE were allocated.

4. The developed cognitive modeling technology provides the analysis of IEE.

5. The received structures of CM of the subject of training and CM of the means of training by means of the algorithm of formation of the structure of CM allow to provide generation of information fragments adequately of IFPST.

6. The developed technique of research of the parameters of CM and algorithm of processing of a posteriori data of testing formalize according to the sequence of statement of the experiment and processing of a posteriori data.

7. The complex of programs provides automation of the adaptive generation of information fragments on discipline on the basis of previously diagnosed parameters of CM and the subsequent assessment of level of residual knowledge of the trainee.

The reliability of scientific results is provided by the system approach to the description of the object of research, correct use of fundamental propositions of the theory of information, physiology of sensory systems, cognitive psychology, applied linguistics and ergonomics, approbation of basic propositions of the dissertation on seminars and conferences of the various level, results of the statistical processing of a posteriori data of the series of experiments.

The introduction of the results of research was carried out in "The Saint-Petersburg state electrotechnical university "LETI"" ("SPbSETU "LETI"") and "The International banking institute" ("IBI"), that is confirmed with the relevant acts about practical use.

Publications. On the theme of dissertation there were publ. 43 on 2007 y. (80 on 2012 y.) scientific works: 01 textbook and 03 methodical instructions to the lab. works on the discipline "Computer science"; 02 units in 01 coll. scientific monography of "IHEAS" (with form. coauthors-teachers); 08 (16) training manuals and scientific monographies (without coauthors); 01 (02) report(s) on the individual initiative SRW (2003-2005 y. and 2006-2008 y.); 05 (12) scientific articles in the scientific journals recommended by "HAC of RF", from them 00 (05) scientific articles were deposited in ""VINITI" of "RAS""; 22 (43) scientific reports in the materials of 11 (24) international scientific conferences, and also 04 copyright certificates about deposition and registration of the works – the objects of the intellectual property in "RAS" (RF, Moscow city).

The structure and volume of dissertation. The manuscript on the rights of monography consists of the introduction, seven chapters, conclusion, bibliographical list, including 68 nomens (without appendixes). The main part of the work is stated in 272 pages of the typewritten text and contains 77 pictures and 29 tables.

THE MAIN CONTENTS OF DISSERTATION

In the introduction informatization of establishments of the system of education acts as the complex scientific problem initiating consideration of a wide range of scientific areas, and also creation of the innovative approaches, methods, technologies and algorithms at realization of the automation means at the base of IEE, which provide the possibility of the analysis and increase of efficiency of functioning of ART system.

In the first chapter "The condition of the problem of creation of the adaptive intellectual environments of training" there are proved the relevance of creation of the adaptive intellectual means and environments of automated training, the analysis of the condition of problem and the existing contradictions, degree of readiness of the problem of creation of the adaptive intellectual technologies and means of training, the purpose and tasks of creation of the adaptive IEE of ART system based on CM, stages of creation and the analysis of the environment of the automated training based on the cognitive models and the list of scientific results, submitted on protection.

In the second chapter "The analysis of information technologies and theoretical bases of creation of information-educational environments and automated means of training" there are given the standards in the field of quality IEE, the priority aspects and directions of informatization, the basic principles of ART, the stages of development of the automated means and environments of training, the features of organization of IEE of ART (in distance), the characteristic of opportunities of ART systems, the key parameters of assessment of modern means of training and development of their functional possibilities, the features of information exchange of the subjects and means of training in the automated IEE, the factors influencing to efficiency of formation of knowledge of trainees in the automated IEE, the influence of the components of ART system on health of consumers (subjects of IEE).

In the third chapter "The environment of automated training with the properties of adaptation based on the cognitive models" there are considered the essence of approach to the complex solution of the problem and statement of research tasks, the modifications in organization of IEE for realization of accounting of individual features of the contingent of trainees, the modifications in technology of ART for realization of a contour of adaptation based on CM, the structure of environment of ART with the properties of adaptation based on CM (appointment and functions of the adaptive electronic textbook (ET), the basic and applied diagnostical modules (DM), the structure of the parametrical CM block), the processing and extraction of information, structuring of data and representation of knowledge for filling of ET (classification of sources of information, methods of knowledge acquisition on the subject area, the main models of representation of knowledge, information structure of ET, sequence of filling by the structured information of the content of ET), the formal description of the adaptive IEE on the basis of the theory of control.

The realization of IEE of ART based on the block of CM causes the organizational and technological modifications at various stages of educational process (pic. 1).
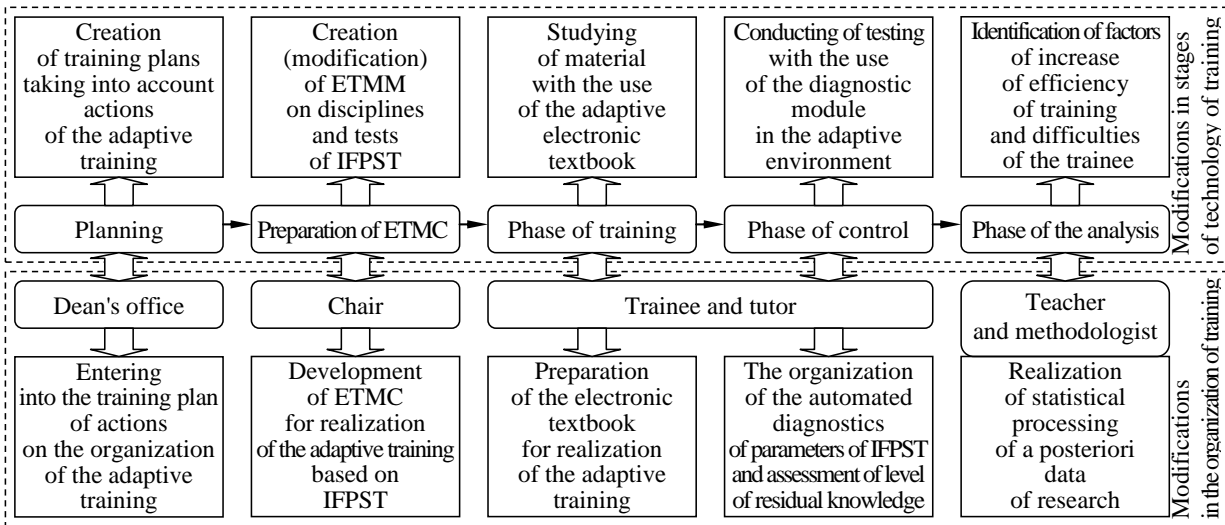
Pic. 1. Modifications in the organization and technology of formation of knowledge at the realization of the adaptive training based on the parametrical cognitive models block

The general structure of ART system with the elements of adaptation based on the parametrical cognitive models block (pic. 2) represents the closed contour, including two levels of information interaction and several channels of exchange of information between two categories of subjects.
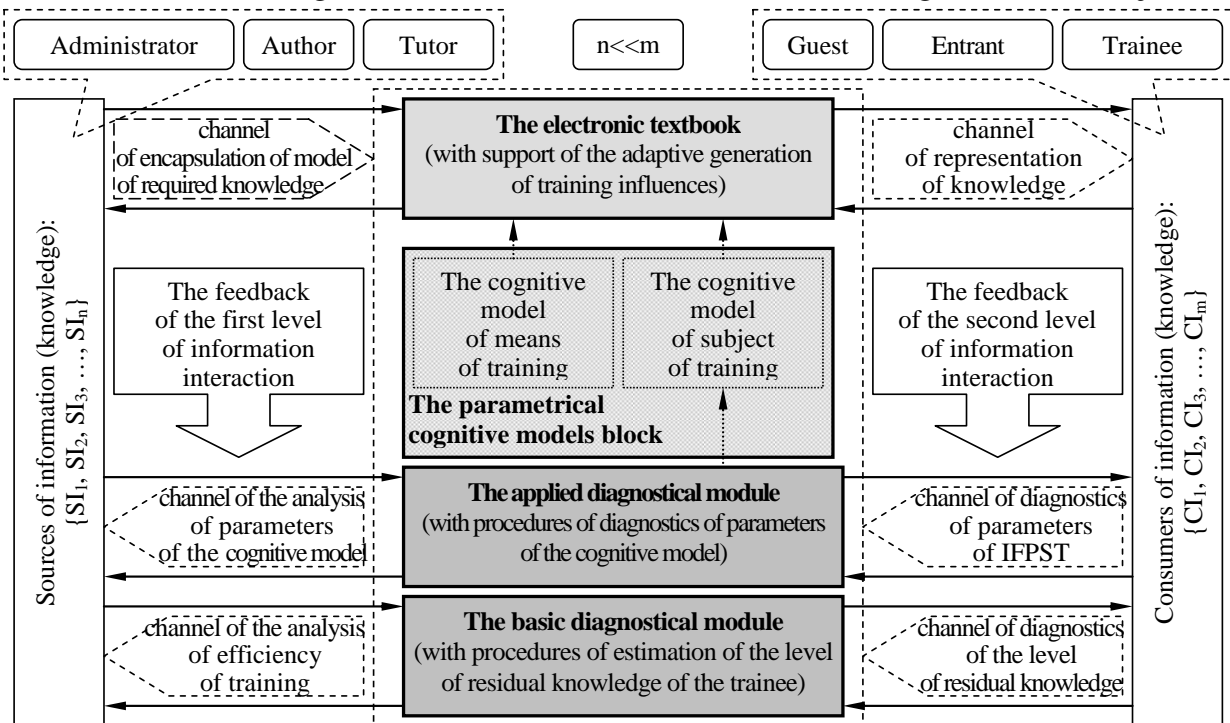
Pic. 2. The automated (remote) training system with the properties of adaptation based on the parametrical cognitive models block

Training represents the process of the operated formation of knowledge of the trainee and includes the sequence of stages of information processing: visual representation, perception, understanding, formation of skills, aggregation of the obtained information in knowledge. The level of residual knowledge of the trainee depends on the quality of perception and understanding of information fragments, the display of which provides the adaptive representation processor in the base of ET (pic. 3).

Procedure of loading of parameters of a subject

Procedure of loading of parameters of means

The cognitive model of means of training

The cognitive model of subject of training

The parametrical cognitive models block

The procedure of selection and installation of parameters of the algorithm of representation of information fragments

Module of a control of processing of physiological parameters for support of individually-oriented generation of educational influences

Procedure of processing of parameters of a sensory perception of information

Algorithm of the analysis of parameters of a visual sensory system of the subject of training

Algorithm of the analysis of parameters of an acoustical sensory system of the subject of training

Procedure of processing of parameters of representation of information by means of training

Algorithm of the analysis of parameters of a visual representation of information by means of training

Algorithm of the analysis of parameters of a sound representation of information by means of training

Algorithm of accounting of anomalies of perception of space (acuity and field of vision)

Algorithm of accounting of anomalies of perception of color (color perception)

Algorithm of accounting of anomalies of perception of a sound stream

Algorithm of installation of parameters of background and font (type, size and set)

Algorithm of installation of parameters of color scheme at display of information

Algorithm of installation of volume, timbre and type of a sound stream (sound scheme)

Module of a control of processing of linguistic parameters at adaptive generation of educational influences

Procedure of accounting of level of understanding of information by subject of training

Algorithm of accounting of level of proficiency in language of statement of the subject of training

Algorithm of accounting of level of understanding of the dictionary of terms and definitions

Procedure of accounting of level of statement of information by means of training

Algorithm of accounting of level of proficiency in elements of interface of program

Algorithm of output of the list of levels of statement of information (material) by means of training

Algorithm of output of sets of used terms and definitions

Algorithm of output of sets of used elements in the basis of interface of program

Algorithm of installation of level of statement of material (information)

Algorithm of installation of a set of terms and definitions (for specific subject)

Algorithm of installation of a set of elements in the basis of interface of program

Module of a control of processing of psychological parameters for support of individually-oriented generation of educational influences (information fragments)

Procedure of accounting of speed of representation of information by means of training

Procedure of accounting of additional capabilities of means

Procedure of accounting of kind of learning ability of the subject of training

Procedure of accounting of level of mental abilities of the subject of training

Algorithm of the analysis of a convergent abilities of the subject of training

Algorithm of the analysis of a divergent abilities of the subject of training

Procedure of accounting of way of representation of information by means

Procedure of accounting of the cognitive styles of the subject of training

Algorithm of calculation of speed of representation of information by means of training

Algorithm of choice of additional parameters of representation of information

Algorithm of identification of predisposition of subject to implicit or explicit learning ability

Algorithm of identification of cognitive styles of processing of information by the subject of training

Algorithm of choice of kind of representation of information fragments by means

Algorithm of choice of style of representation of information by means of training

Algorithm of installation of speed of presentation of information fragments

Algorithm of installation of additional opportunities of means of training

Algorithm of installation of kind of representation of information fragments by means

Algorithm of installation of style of representation of information fragments by means

Pic. 3. The structure of the adaptive representation of information fragments processor

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The limitation of communicative duplexity of (virtual) information interaction of the subjects of different categories is caused by the mediation of representation of educational influences by means of means of IEE (ET and DM). This shortcoming is inherent in ART systems and influences on process of formation of knowledge, therefore it needs to be researched and technologically eliminated.

The process of training in IEE of ART can be structurally decomposed (Semyonov V.V., Rastrigin L.A., Ehrenstein M.H. and others) and described in the context of the formal device of the classical theory of automatic control (pic. 4).
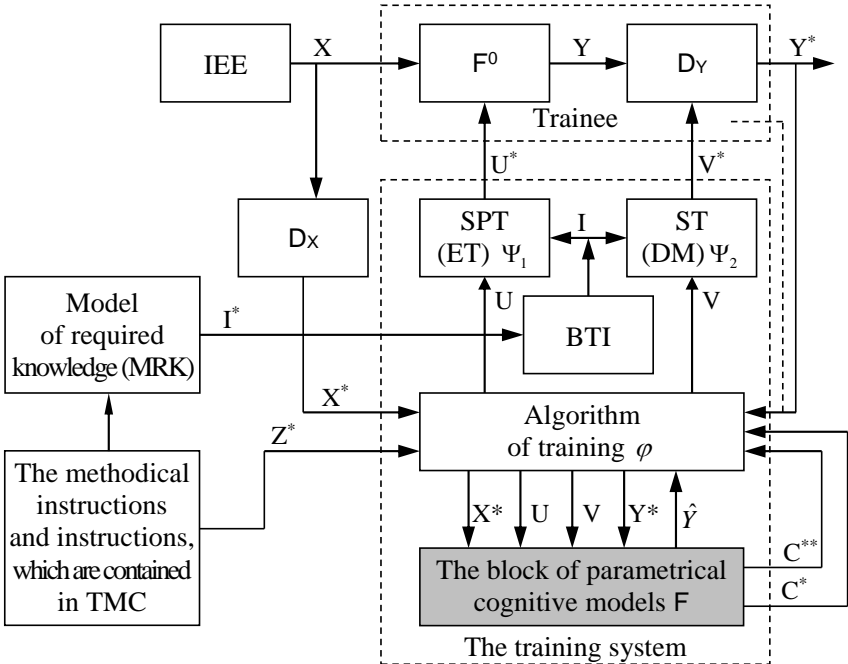
Pic. 4. The block diagram of ART system with the elements of adaptation based on the parametrical cognitive models block

In the offered scheme ART system includes a set of the components:

The cognitive model – describes assessment $\hat{Y}$ of the vector of condition Y of the subject as a function of condition of environment X and information influence U : $\hat{Y} = F(X^*, U)$, and the condition Y of the subject is defined by its operator F^0: $Y = F^0(X, U)$, where the operator F of the model of subject is the subject of definition and adaptation in the process of training.

The algorithm of formation of portions of information has dual appointment: at-first, it defines the training influence: $U = \varphi(X^*, \hat{Y}, Z^*, R)$, where – φ algorithm of training; $\hat{Y}$ – assessment of a condition of knowledge of the subject, received by means of the (cognitive) model F; Z^* – the purpose of training; C – the resource of training, consisting of two components: $C = (C^*, C^{**})$, where C^* – external resource, determined by the opportunities of the system of training, C^{**} – internal resource, allocated by the subject F^0 on training (for example, time on training); secondly, algorithm of training defines tests V, answers on which carry information about the cognitive model F of the subject: $V = \Psi(X^*, \hat{Y})$, where Ψ – algorithm of synthesis of the test V.

The bank of training information (BTI) contains a set of the data I, which are necessary for assimilation by the subject in the process of training.

The shaper of a portion of training (SPT) defines the portion of information, transferred to subject for studying at this stage of training: $U^* = \Psi_1(U,I)$, where Ψ_1 – algorithm of formation of a portion. We will notice, that a difference between U and U^* same as, for example, between the reference to some page of text, i.e. its number, and text of this page. In other words, U – addresses in BTI, and U^* – their content.

The shaper of tests (ST) works similarly: $V^* = \Psi_2(V,I)$. The subject in the training system represents "converter" of the condition of environment X and portion of training information U^* in the state Y. Information about this state can be obtained only by means of test questions V^*: $Y^* = D_Y(Y,V^*)$, where D_Y – operator of transformation of test task V^* and condition Y of subject to his answer Y^*. We'll notice, that in that specific case, it is possible $U = V$, that considerably simplifies the training system.
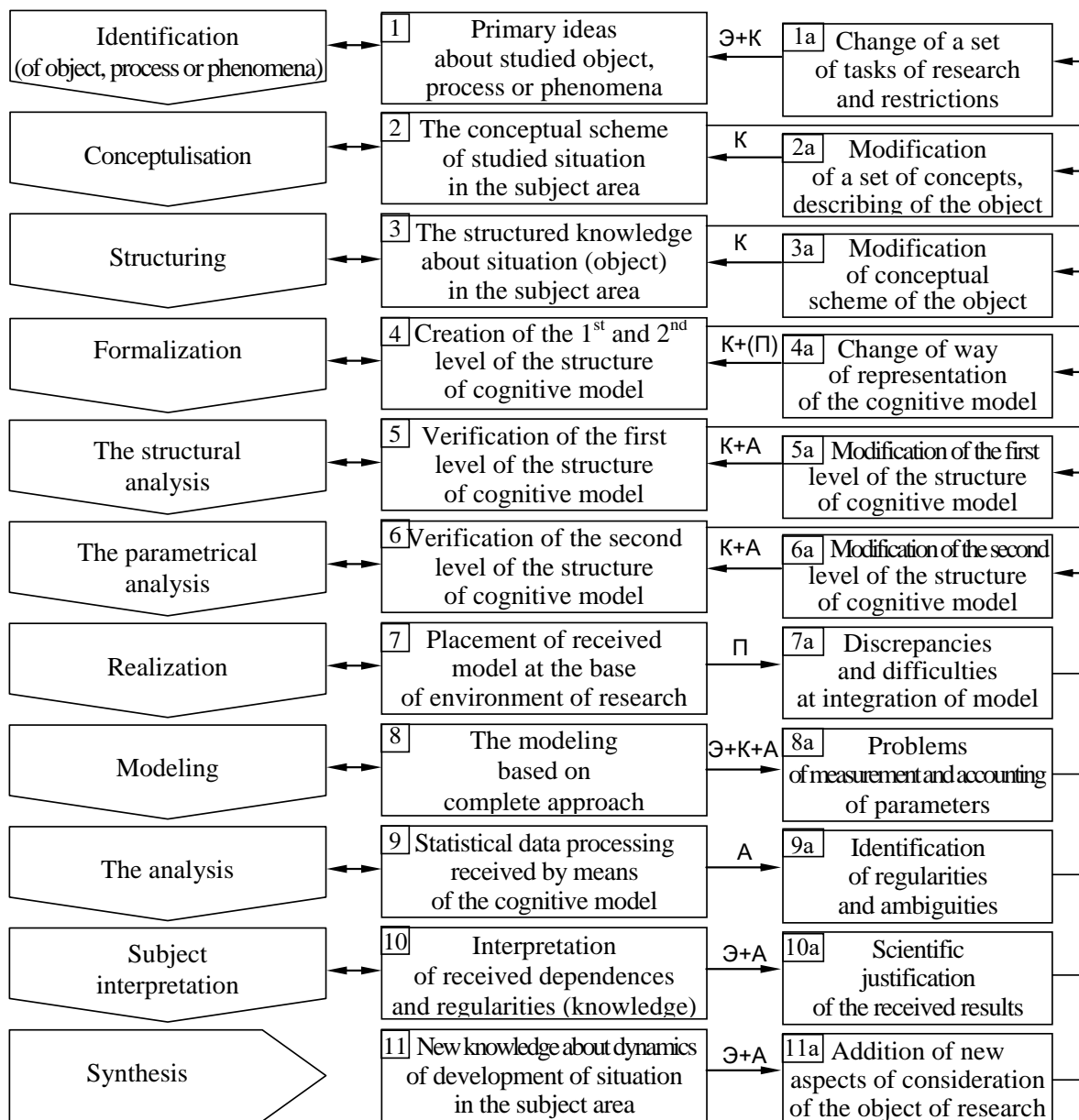
It is obvious, that quality indicators of the process of training depend on parameters of CM of the subject of training F and algorithm of formation of portions of information-educational influences φ, which considers the parameters of CM of the means of training.

In the forth chapter "The cognitive modeling technology…" there are presented the iterative cycle of CMT, the technique of the use of CMT, the ways of representation of the structure of CM, the algorithm of formation of the structure of CM, the techniques of the research of parameters of CM of the subject and means of training, the algorithm of processing of a posteriori data of testing.

CMT provides construction of the structure of CM and its subsequent parametrical filling. The generalized iterative cycle of CMT provides the return to the previous stages of the research: if the purposes and tasks have been corrected, the mistakes made on previous or current stages of the analysis of IEE of ART were revealed (pic. 5).

For difficult IEE of ART CMT provides attraction of the number of consultants, who are designated by letters: methodologist (E) – the expert in the field of pedagogics; cognitologist (C) – the expert in the field of engineering of knowledge, providing correctness of the received structure of CM; system analyst (A) – the expert in the field of the system analysis and modeling of the (automated) IEE of ART; programmer (P) – the qualified specialist, owning methods and approaches of realization of hi-technological means of IEE by means of the modern integrated environments of programming.

CM reflects the most important aspects of information interaction of the subjects and means of training in IEE of ART, allows to qualitatively explain the reasons of difficulties in the process of formation of knowledge. Coherence of generation of information influences and IFPST was reached by means of CM of the subject of training and CM of the means of training in IEE of ART.
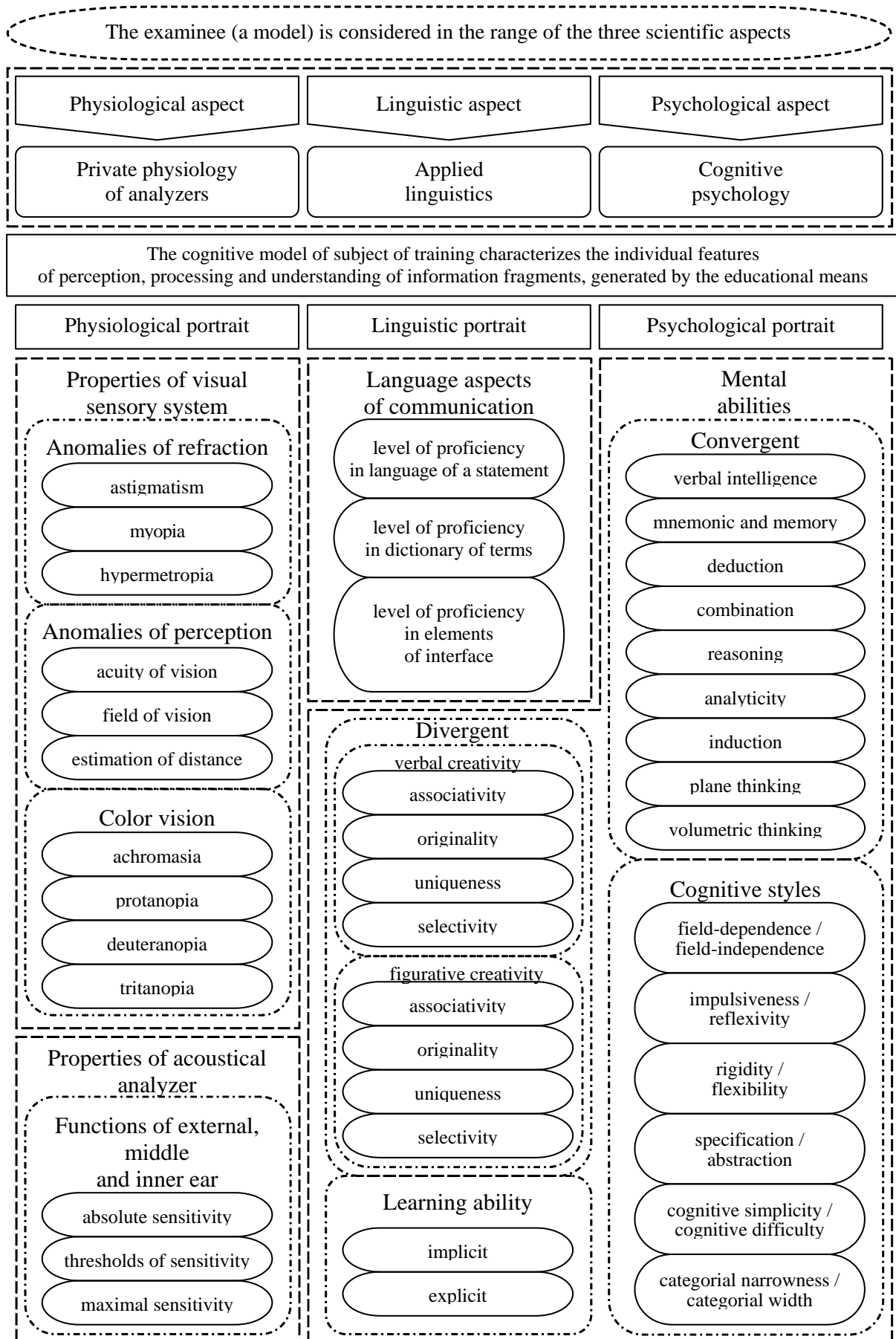
Stage		Connector	
Identification (of object, process or phenomena)	1 Primary ideas about studied object, process or phenomena	Э+К	1a Change of a set of tasks of research and restrictions
Conceptulisation	2 The conceptual scheme of studied situation in the subject area	К	2a Modification of a set of concepts, describing of the object
Structuring	3 The structured knowledge about situation (object) in the subject area	К	3a Modification of conceptual scheme of the object
Formalization	4 Creation of the 1st and 2nd level of the structure of cognitive model	К+(П)	4a Change of way of representation of the cognitive model
The structural analysis	5 Verification of the first level of the structure of cognitive model	К+А	5a Modification of the first level of the structure of cognitive model
The parametrical analysis	6 Verification of the second level of the structure of cognitive model	К+А	6a Modification of the second level of the structure of cognitive model
Realization	7 Placement of received model at the base of environment of research	П	7a Discrepancies and difficulties at integration of model
Modeling	8 The modeling based on complete approach	Э+К+А	8a Problems of measurement and accounting of parameters
The analysis	9 Statistical data processing received by means of the cognitive model	А	9a Identification of regularities and ambiguities
Subject interpretation	10 Interpretation of received dependences and regularities (knowledge)	Э+А	10a Scientific justification of the received results
Synthesis	11 New knowledge about dynamics of development of situation in the subject area	Э+А	11a Addition of new aspects of consideration of the object of research

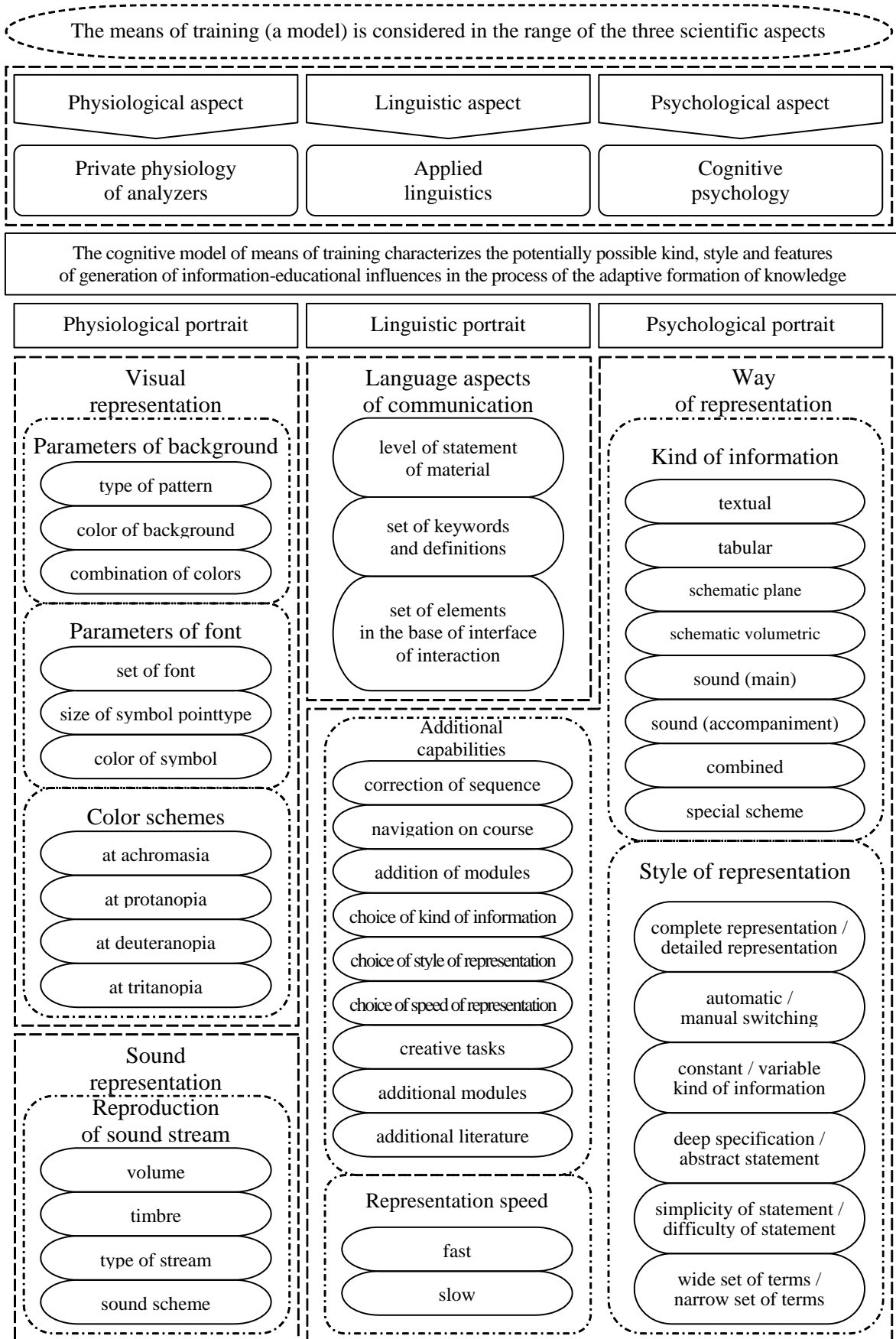Pic. 5. The iterative cycle of the cognitive modeling technology

In the fifth chapter "The parametrical cognitive models block for the analysis and increase of efficiency of functioning of the automated educational environment" the innovative structures of CM of the subject and means of training are formed.

CM of the subject of training (pic. 6) represents the parametrized repertoire, echeloned on a set of portraits: physiological (features of sensory perception of information by the visual and acoustical analyzers), psychological (convergent and divergent intellectual abilities, learning ability and cognitive styles of subject), linguistic (natural-language aspects of virtual communication), in general allow to analyze the efficiency of the process of formation of knowledge of the trainee, coming from the information fragments generated by means of training.

CM of the means of training (pic. 7) is differentiated on a set of portraits: physiological (features of visual representation: parameters of background, font, color schemes of display of content), psychological (way of representation of information-educational influences: type of displayed information, style of representation of information fragments), linguistic (language aspects of communication).

The examinee (a model) is considered in the range of the three scientific aspects

Physiological aspect	Linguistic aspect	Psychological aspect
Private physiology of analyzers	Applied linguistics	Cognitive psychology

The cognitive model of subject of training characterizes the individual features of perception, processing and understanding of information fragments, generated by the educational means

Physiological portrait	Linguistic portrait	Psychological portrait

Properties of visual sensory system

Anomalies of refraction
- astigmatism
- myopia
- hypermetropia

Anomalies of perception
- acuity of vision
- field of vision
- estimation of distance

Color vision
- achromasia
- protanopia
- deuteranopia
- tritanopia

Properties of acoustical analyzer

Functions of external, middle and inner ear
- absolute sensitivity
- thresholds of sensitivity
- maximal sensitivity

Language aspects of communication
- level of proficiency in language of a statement
- level of proficiency in dictionary of terms
- level of proficiency in elements of interface

Divergent

verbal creativity
- associativity
- originality
- uniqueness
- selectivity

figurative creativity
- associativity
- originality
- uniqueness
- selectivity

Learning ability
- implicit
- explicit

Mental abilities

Convergent
- verbal intelligence
- mnemonic and memory
- deduction
- combination
- reasoning
- analyticity
- induction
- plane thinking
- volumetric thinking

Cognitive styles
- field-dependence / field-independence
- impulsiveness / reflexivity
- rigidity / flexibility
- specification / abstraction
- cognitive simplicity / cognitive difficulty
- categorial narrowness / categorial width

Pic. 6. The structure of the cognitive model of the subject of training

The means of training (a model) is considered in the range of the three scientific aspects

Physiological aspect	Linguistic aspect	Psychological aspect
Private physiology of analyzers	Applied linguistics	Cognitive psychology

The cognitive model of means of training characterizes the potentially possible kind, style and features of generation of information-educational influences in the process of the adaptive formation of knowledge

Physiological portrait	Linguistic portrait	Psychological portrait

Visual representation

Parameters of background
- type of pattern
- color of background
- combination of colors

Parameters of font
- set of font
- size of symbol pointtype
- color of symbol

Color schemes
- at achromasia
- at protanopia
- at deuteranopia
- at tritanopia

Sound representation
Reproduction of sound stream
- volume
- timbre
- type of stream
- sound scheme

Language aspects of communication
- level of statement of material
- set of keywords and definitions
- set of elements in the base of interface of interaction

Additional capabilities
- correction of sequence
- navigation on course
- addition of modules
- choice of kind of information
- choice of style of representation
- choice of speed of representation
- creative tasks
- additional modules
- additional literature

Representation speed
- fast
- slow

Way of representation

Kind of information
- textual
- tabular
- schematic plane
- schematic volumetric
- sound (main)
- sound (accompaniment)
- combined
- special scheme

Style of representation
- complete representation / detailed representation
- automatic / manual switching
- constant / variable kind of information
- deep specification / abstract statement
- simplicity of statement / difficulty of statement
- wide set of terms / narrow set of terms

Pic. 7. The structure of the cognitive model of the means of training

CM of the subject of training is technologically applicable in the contour of IEE of ART, if means of training are capable to generate information-educational influences in coordination with CM of the means of training.

For the purpose of automation of the research tasks of IEE the specially realized complex of programs was used.

In the sixth chapter "The complex of software for automation of research tasks" there was developed the complex of programs for automation of the research tasks, in particular adaptive ET, the basic and applied DM.

In the seventh chapter "The statistical substantiation of the practical use of the received results" there are allocated the factors influencing on the efficiency of the formation of knowledge of the trainee in the automated IEE, the features of organization and the plan of carrying out of the experiment, the features of the research of the parameters of physiological, psychological and linguistic portraits of CM of the subject and means of training, the specifics of preliminary processing of a posteriori results of diagnostics, the features of choice of methods of the statistical analysis of formed data sets, the analysis of dynamics of resultativity of the training for several years, the results of the regression and discriminant analysis. The technique of research of parameters of CM has provided statement and carrying out of experiment.

At the first stage of the research there was carried out the diagnostics of IFPST – features of perception, processing and understanding of information. The considered technology provides the automated research of parameters of physiological, psychological and linguistic portraits of CM. During diagnostics of the parameters of physiological portrait of CM among the contingent of examinees was not revealed the subjects with various anomalies of perception of information by the visual sensory system. The research of linguistic portrait of CM is directed to detection of compliance between the level of material statement by educational means and the level of proficiency of the language of subject.

At the second stage there was carried out the automated representation of information fragments by means of ET considering parameters of IFPST, which were contained in the parametrical CM of the subject of training. At representation of the training material as the main information-educational influences of several types were used: textual, tabular and schematic (plane).

At the third stage there was performed the automated diagnostics of the level of residual knowledge of trainees with the use of the developed software, containing in the basis two scales of assessment (standard and point).

The researches were carried out in "SPbSETU "LETI"" and "IBI" on a set of the disciplines: "Computer science", "Intellectual technologies of representation of knowledge", "Banking", "Accounting and audit", "Taxes and taxation", "Management accounting" and "Insurance".

Assessment of efficiency of introduction of the results of research was made with the use of the standard criteria of the efficiency of training:

$$K = \{k_1; k_2; k_3\} = \left\{ Y_i - Y_{i-1}; \frac{Y_i}{Y_{i-1}}; \frac{Y_i - Y_{i-1}}{Y_{i-1}} 100\% \right\}.$$

The coefficients respectively designate absolute, comparative and relative indicators of efficiency. During the practical use of CMT the experiment was carried out in the context of a set of groups of examinees. The results of the primary statistical data processing of the experiment are presented in the tabl. 1.

Tabl. 1. The results of statistical data processing of experiment

The name of indicator	The experimental group of examinees							
The number of group	1	2	3	4	5	6	7	8
Quant. of examinees	26	28	22	25	27	23	21	24
Experiment №1 (without use of CMT)								
Average point Y_1	3,850	3,414	3,224	3,678	4,036	3,643	3,790	3,645
AQD of av. point	0,867	0,178	1,958	0,879	0,577	0,783	1,679	1,047
Experiment №2 (with use of CMT, personal adaptation)								
Average point Y_2	4,041	3,674	3,357	3,786	4,157	3,853	3,821	3,743
AQD of av. point	0,723	0,127	1,743	0,743	0,446	0,654	1,538	0,986
The summary of research								
k_1	0,191	0,26	0,133	0,108	0,121	0,21	0,031	0,098
k_2	1,049	1,076	1,041	1,029	1,029	1,057	1,008	1,026
k_3, %	0,049	0,076	0,041	0,029	0,029	0,057	0,008	0,027
Change of AQD	-0,144	-0,051	-0,215	-0,136	-0,131	-0,129	-0,141	-0,061

The scientific-methodical researches and experimental check of efficiency of functioning of IEE of ART based on CMT with the use of CM will allow: at-first,- to reveal features of sensory perception (physiological portrait), subsequent processing (psychological portrait) and understanding (linguistic portrait) of the different types of information, presented to the contingent of trainees by means of the electronic educational means; secondly,- to develop and to integrate in the educational process the adaptive means of training and electronic training-methodical complexes, providing individually-oriented training.

The statistical analysis of a posteriori data and the practical use of the results of research in the training process allow to make the following conclusions:

- the effective use of CM in the automated IEE assumes designing of the electronic training-methodical manuals;
- the extent of influence of CM parameters on the efficiency of training depends on the contingent of trainees and has individual character;
- the efficiency of training with the use of CMT is determining by opportunities of means of IEE, the content of ET on a cycle of disciplines and purposes of training, varied according to the training plans and working programs.

In the conclusion of dissertation work there are summed up the research results, is given its assessment, are specified the possible directions of the use of the received results in IEE. During acquaintance with the manuscript of monography it is possible to notice, that the presented materials are basing on the fundament of IT of training, the theory of automatic control, pedagogics, psychology, physiology and applied linguistics.

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