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THE ELECTRONIC TEXTBOOK BASED ON THE ADAPTIVE REPRESENTATION OF INFORMATION FRAGMENTS PROCESSOR IN THE AUTOMATED EDUCATIONAL ENVIRONMENT

The electronic textbook functions by means of the developed the adaptive representation of a sequence of information fragments processor and acts as the innovative component of the created by the author automated (remote) training system with the properties of adaptation based on the parametrical cognitive models

Keywords: the information-educational environment, the cognitive model, the automated (remote) training system, the adaptive representation of a sequence of information fragments processor, the cognitive modeling technology (for the system analysis)

The introduction and setting of scientific task

The informatization of the information environments of educational establishments and the development of the components of the automated training systems (at distance), taking into account the individual features of the contingent of trainees is the actual scientific problem (the complex of scientific tasks) [1, 2, 3, 4].

The author proposes the new approach to the carrying out of the system analysis of the classical and innovative information-educational environment (IEE) and the creation of the automated (remote) training system (ART) with the properties of adaptation based on the parametrical cognitive models (CM) [3, 5], involving the introduction of minor changes into the organization and technology of the controlled technological process of the formation of knowledge of the contingent of trainees, the use of new cognitive modeling technology (CMT) and the innovative parametrical cognitive models block (PCMB), the use of the complex of programs for the increasing in the efficiency of functioning of the means of training and the resultativity of training (at distance) of the subjects of training.

The scientific article contains the description of the electronic textbook (ET), functioning by means of the adaptive representation of information fragments processor based on PCMB [5, 6].

The structure of IEE of ART system with the properties of adaptation based on the parametrical CM (pic. 1) – directly the closed contour (with the feedbacks), including 2 levels and 6 channels of information interaction between the diverse subjects of training and the means of training: the first level – the channel of encapsulation of the structured information, providing the technological process of the formation of knowledge of the contingent of trainees by means of use of the semantic model of the subject of studying, the channel of analysis of the parameters of CM of the subject of training and the channel of analysis of the efficiency of ADO; the second level – the channel of representation of the structured information, providing the formation of knowledge of the trainees on the basis of the adaptive model, the channel of diagnostics of the individual features of personality of the subjects of training (IFPST) and the channel of testing of the level of residual knowledge of the trainee (LRKT) [3, 5].
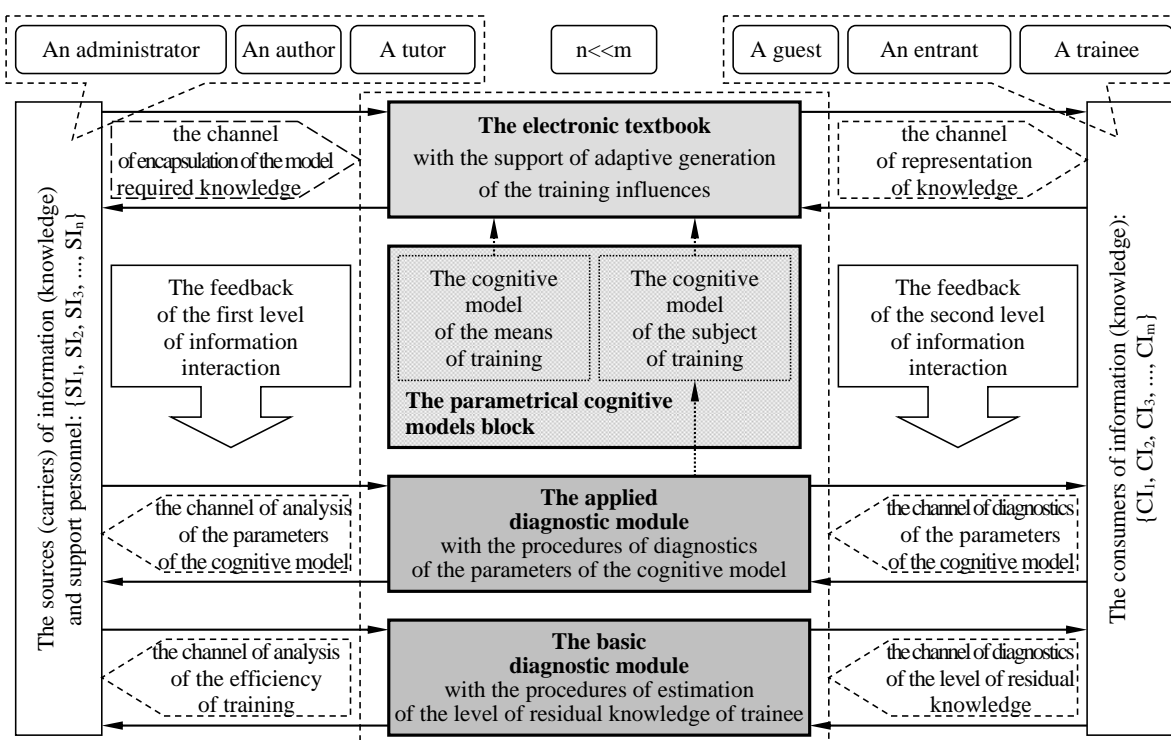
Pic. 1. The structure of the automated (remote) training system

with the properties of adaptation based on the parametrical cognitive models

The process of information interaction as an information exchange with a set of information fragments (information messages) between the subjects of training and the means of training in IEE of ART system is the significantly mediated (the organizational disadvantage) – the sources of information (the experts in the subject area, teachers, methodists and others) interact with the consumers of information and the different educational services (entrants, trainees and others) by means of hardware and software components [1, 4].

A set of functions and tasks allows to distinguish the certain components of IEE of ART system:

- the electronic textbook (ET) – provides the individually-oriented generation of educational influences, reflecting the content of the subject of studying to the contingent of trainees based on the adaptive model of the formation of knowledge by means of the adaptive representation of information fragments processor [6, 7];

- the basic diagnostic module (DM) – realizes the automated testing of LRKT based on the modified interval scale and the function of estimation, the recording of values of the key parameters into DB with a posteriori results;

- the applied DM – allows to carry out the automated diagnostics of nominal values of the parameters of CM of the subject of training, characterizing IFPST by means of using of a set of the methods of research, contained in DB of tests of IFPST;

- PCMB – directly includes the two types of parametrical CM, which (according to the author's definition) act as the reconstructed repertoires of parameters, echeloned on a row of portraits with the certain scientific justification and stratified on a several diverse mathematical sets: the set of kinds of properties, the set of elementary properties, the set of the vectors of parameters and the set of elementary parameters [3, 5, 10], and also a significantly differ from the existing by the structure and content [8, 11]:
  - the parametrical CM of the subject of training directly contains: the physiological portrait – the parameters of the visual sensory system: the anomalies of refraction of the eye (astigmatism, myopia and hypermetropia), the perception of space (the estimation of distance, the field of vision and the acuity of vision), the pathologies of color vision (achromasia, dichromacy: protanopia, deuteranopia and tritanopia), and also the parameters of external, middle and internal ear (the absolute auditory sensitivity and the thresholds of sensitivity); the psychological portrait – concentrates the parameters, which reflect the convergent and divergent and intellectual abilities (the verbal creativity and figurative creativity), the learning-ability (implicit and explicit) and the cognitive styles; the linguistic portrait – the level of proficiency in the language of statement of the material, a set of key terms and definitions and a set of elements in the basis of the interface [2, 3, 5, 6];
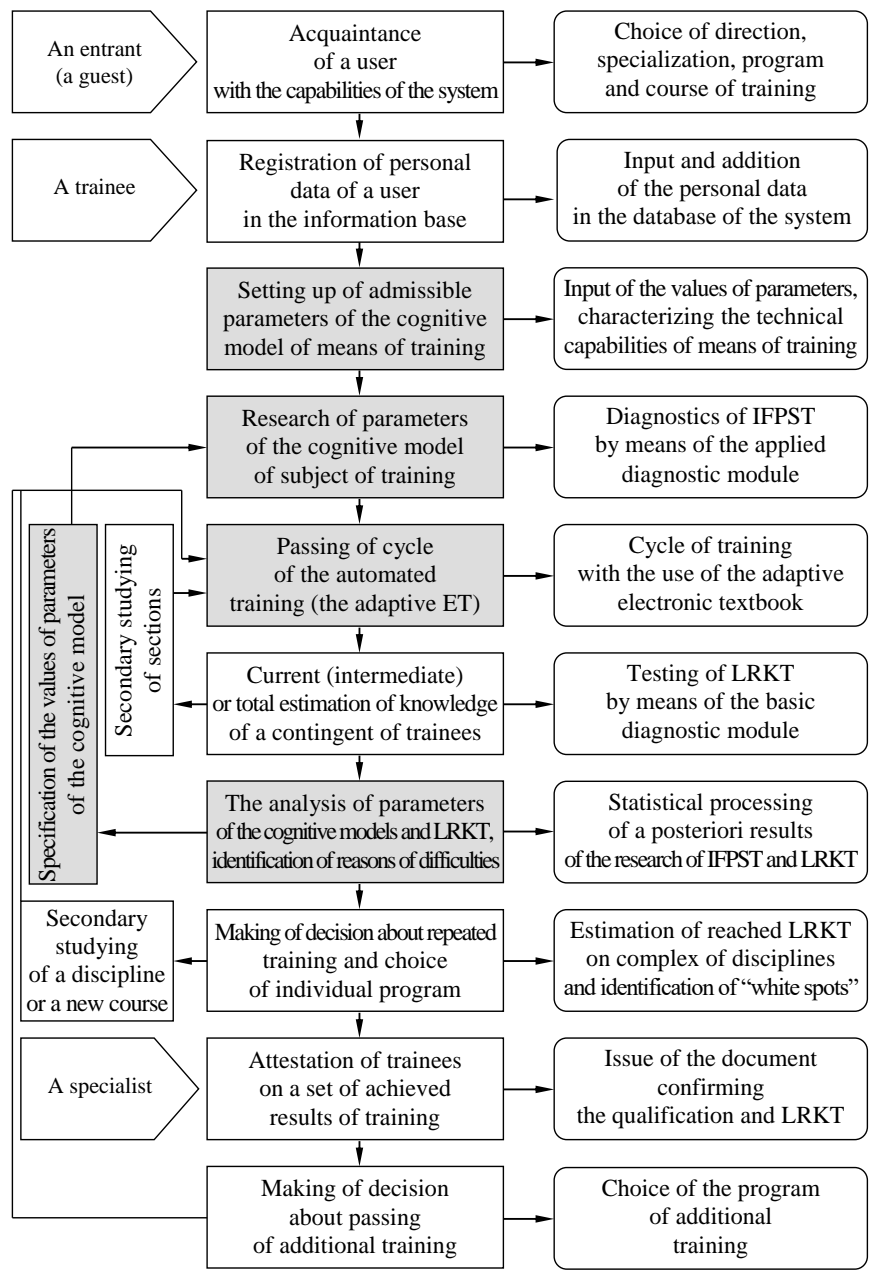
o the parametrical CM of the means of training directly contains: the physiological portrait – the parameters of visual representation of the information: the parameters of background (the type of pattern, the color and combination of colors), the font (the typeface of font, the color and size of the pin of symbol), the color schemes of displaying (for the achromats and dichromats: protanopes, deuteranopes and tritanopes), and also the parameters of playback of the sound stream (the volume, the timbre, the type of stream and the sound scheme); the psychological portrait – characterizes the way of representation of information: the kind of information (the text, the table, the planar scheme, the volumetric scheme, the main sound stream, the accompanying sound stream, the combined scheme and the special scheme), the style of presentation of the information (the holistic and detailed presentation, the automatic and manual switching of information fragments, the constant and variable type of information, the deep concretization and the abstract statement, the simplicity and difficulty of statement, the wide set and the narrow set of terms and definitions); the linguistic portrait – the language parameters of communication in ART system (the level of statement of the content of the subject of studying, the set of keywords and the set of elements in the basis of the interface of the means of training [3, 5, 6].

The classical ET acts as the means of training intended for the displaying of the previously structured and quantified set of information fragments, which act as the training influences, reflecting the content of the subject of studying and form on the basis of the typical information structure of the (electronic) textbook: the title sheet and title, the annotation (description) and preface, the table of contents, the introduction, the main part, the conclusion, the dictionary with the list of key terms and definitions, the alphabetic-subject indicator and the bibliographic apparatus [7, 9].

The educational influences (the information fragments) are generated on the basis of the template, including the main block of information, the additional block of information and the control questions, each from which is formed on the basis of the main part of the subject of studying, reflecting the content of the part, section (module), chapter, paragraph and page [9].

The structure of the cycle of the formation of knowledge of the contingent of trainees in the adaptive environment

The realization of technological cycle of the adaptive training (at distance) in IEE of ART system with the properties of adaptation based on the parametrical CM (pic. 2) involves the organizing and passing of a sequence of technological stages, providing the controlled formation of knowledge of the contingent of trainees taking into account their individual features and abilities (CM of the subject of training), and also the potential technical capabilities of the means of training at the individually-oriented generation of information fragments and direct displaying of training influences (CM of the means of training) [5].

An entrant (a guest)	Acquaintance of a user with the capabilities of the system	Choice of direction, specialization, program and course of training
A trainee	Registration of personal data of a user in the information base	Input and addition of the personal data in the database of the system
	Setting up of admissible parameters of the cognitive model of means of training	Input of the values of parameters, characterizing the technical capabilities of means of training
	Research of parameters of the cognitive model of subject of training	Diagnostics of IFPST by means of the applied diagnostic module
	Passing of cycle of the automated training (the adaptive ET)	Cycle of training with the use of the adaptive electronic textbook
	Current (intermediate) or total estimation of knowledge of a contingent of trainees	Testing of LRKT by means of the basic diagnostic module
	The analysis of parameters of the cognitive models and LRKT, identification of reasons of difficulties	Statistical processing of a posteriori results of the research of IFPST and LRKT
Secondary studying of a discipline or a new course	Making of decision about repeated training and choice of individual program	Estimation of reached LRKT on complex of disciplines and identification of "white spots"
A specialist	Attestation of trainees on a set of achieved results of training	Issue of the document confirming the qualification and LRKT
	Making of decision about passing of additional training	Choice of the program of additional training

(Left vertical labels: Specification of the values of parameters of the cognitive model; Secondary studying of sections)

Pic. 2. The scheme, reflecting the sequence of actions for the supporting of the cycle automated training using the adaptive electronic textbook

The features of functioning of the adaptive electronic textbook

ART – the controlled process of the formation of knowledge of the contingent of trainees by means of diverse set of educational influences, generated on the basis of the model of required knowledge (MRK), formed taking into account the learning-methodical complex in the subject of studying (discipline).

The principle of functioning of the proposed adaptive means of training (ET) with new technical elements in the basis of its architecture (pic. 3) implies the direct performance of a row of actions [3, 5, 6]:

- the selection of the sources of information in the subject of studying from the different subject areas, its structuring and formalization, the filling of the content of ET by the information, reflecting MRK by means of the algorithm of formation and input of MRK (pic. 3);

- the loading of information in DB, the infological scheme of which is agreed at the level of presentation of data with the semantic model of saving and extracting of data;

- the research of the individual features of the contingent of trainees by means of the applied DM and the formation of CM of the subject of training for each trainee;

- the setting up of the parameters of displaying of ET and the selection of values of CM of the means of training;

- the individualized displaying of diverse information fragments, including the main and additional blocks of information by means of the adaptive representation of a sequence of information fragments processor (pic. 3), functioning on the basis of the high-technological innovative PCMB;

- the processing of events, initiated by the program environment and the user, displaying him warnings and clarifications in case of incorrect actions.
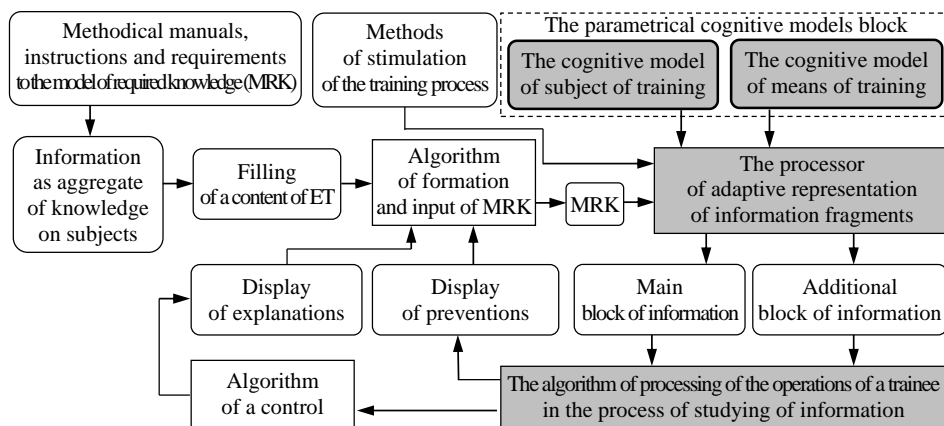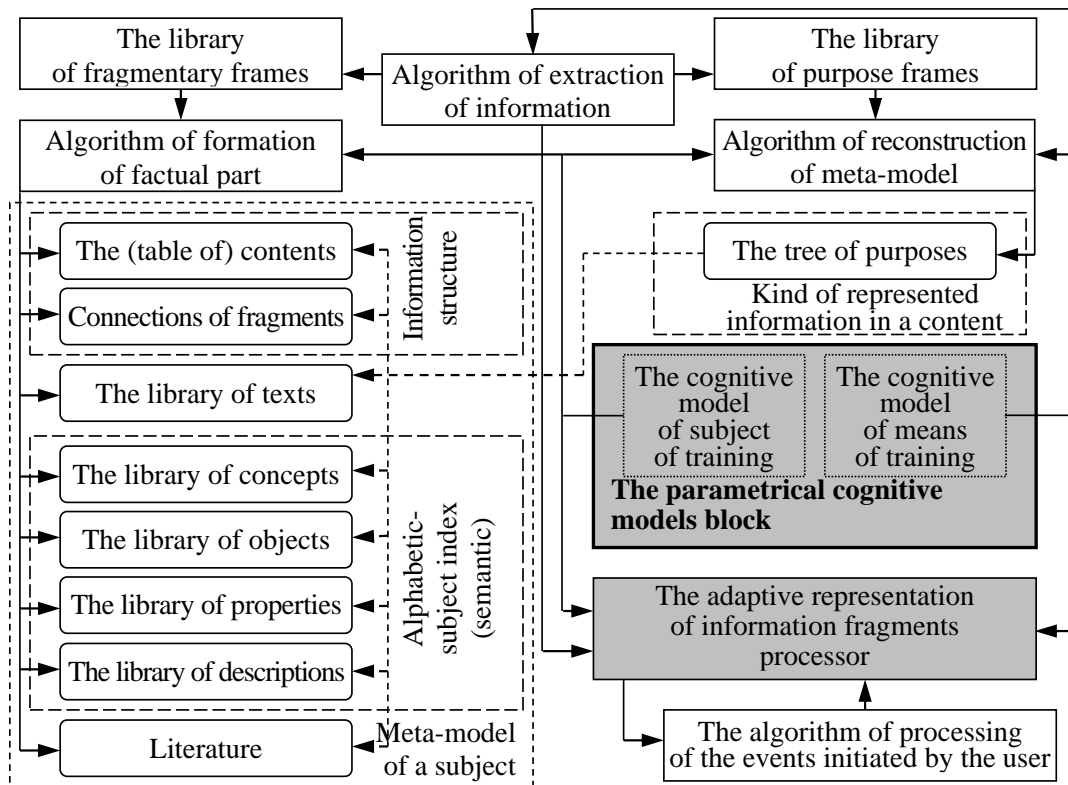

Pic. 3. The scheme, reflecting the principle of functioning of the adaptive electronic textbook

The semantic model of saving and extracting of the information fragments

For the realization of the automated processing of diverse information, which reflects the typical information structure of the subject of studying in ET proposes the semantic model of saving and extracting of the information [6], acting as the high-technological universal structure of data, allows the dynamically modernizing of the infological scheme of BD of the means of training (ET), and also providing the saving and extracting of the previously structured information (pic. 4):

- the procedural part – realizes the loading, saving and extracting of information;
  - the algorithm of extracting of the information – selects the template of displaying of the information from the library of fragmented frames based on the purposes of training (at distance);
  - the algorithm of formation of the factual part – selects the information elements of the meta-model of the subject of studying (discipline) for the subsequent displaying, which is directly dynamically (re)constructed by the algorithm of reconstruction of the meta-model of the subject of studying;
  - the algorithm of reconstruction of the meta-model – forms the tree of the purposes of training and the meta-model of the subject of studying adequately to the assigned purposes of training and the tasks of training;
  - the adaptive representation of information fragments processor (pic. 5) provides the selection of the optimal combination of nominal values of the parameters of displaying of the diverse information (the information fragments) based on the nominal values, containing in the parametrical CM block;
  - the algorithm of processing of the events and operations, initiated by the user;
- the declarative part – the optimization of storage of the information based on the structures of data;
  - the library of fragmentary frames contains a set of information templates, determining the location of elements of the interface of the means of training (ET) at the displaying of information (the information fragments) of different types;
  - the library of purpose frames contains the list of the purposes of training (at distance) and directly their various combinatorial combinations, which determine the features of mechanism of the automated processing of data by the adaptive representation of information fragments processor;
  - a set of the purposes of training (at distance) is presented the hierarchy, which directly includes the main and additional (auxiliary or alternative) purposes of training (at distance);
  - the meta-model of the subject of studying includes the information structure (the table of contents, the cross-references between the information fragments), the library of texts containing of the content of information fragments, the library of images reflecting the content of information fragments, the alphabetical-subject index (a set of key words and definitions, the diverse graphic objects and pictograms of the means of training, the library of properties and descriptions of the studied objects and the subjects of studying);
 - the parametrical CM block contains CM of the subject of training and CM of the means of training.

The library of fragmentary frames	Algorithm of extraction of information	The library of purpose frames
Algorithm of formation of factual part		Algorithm of reconstruction of meta-model

Information structure
- The (table of) contents
- Connections of fragments

The library of texts

Alphabetic-subject index (semantic)
- The library of concepts
- The library of objects
- The library of properties
- The library of descriptions

Literature — **Meta-model of a subject**

The tree of purposes — Kind of represented information in a content

The cognitive model of subject of training | The cognitive model of means of training

The parametrical cognitive models block

The adaptive representation of information fragments processor

The algorithm of processing of the events initiated by the user

Pic. 4. The semantic model of the subject of studying in the basis of the electronic textbook

The mode of adaptive training of the means of training (ET) is realized by means of the adaptive representation of a sequence of information fragments processor and PCMB only after filling by the nominal values of two parametrical CM.

The adaptive representation of information fragment processor

The architecture of the adaptive representation of information fragments processor [5, 6] is made by the principle of parallel architecture and the block-modular principle (pic. 5), includes the three software modules, providing respectively the control of processing of the various physiological, psychological and linguistic parameters of the parametrical CM of the subject of training and the parametrical CM of the means of training for the providing of the automated individually-oriented generation of the diverse educational influences to the contingent of trainees.

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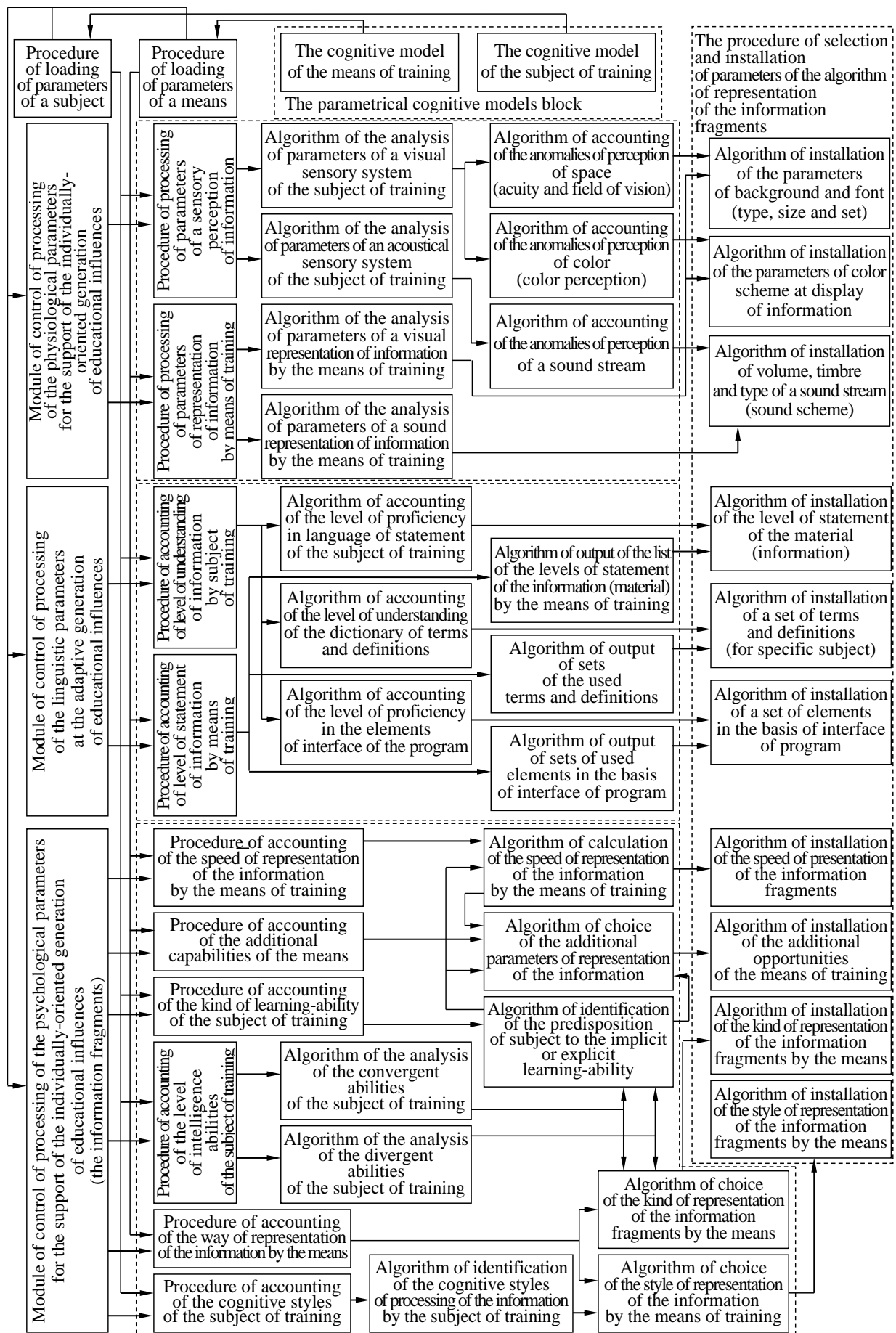
Pic. 5. The structure of the adaptive representation of information fragments processor

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The selection of optimal combination of values of the parameters of displaying of the information

The selection of optimal combination of nominal values of the parameters of displaying of the information directly provided in parallel by the three program modules, each from which contains the necessary set of procedures and algorithms for the automated processing of data, contained in PCMB (pic. 5). At the same time realizes the taking into account the diverse nominal values of parameters of the parametrical CM of the subject of training and the parametrical CM of the means of training [5, 6].

The structure of the module of control of the process of processing of the physiological parameters of CM:

- the procedure of processing of the parameters of the sensory perception of information by the subject of training – the algorithm of the analysis of parameters of the visual sensory system, the algorithm of accounting of the anomalies of perception of space (the acuity of vision and the field of vision), the algorithm of accounting of the anomalies of color-perception (the choice of color scheme), the algorithm of the analysis of parameters of the auditory sensory system and the algorithm of accounting of the anomalies of perception of sound;

- the procedure of processing of the parameters of representation of the information by the means of training – the algorithm of the analysis of parameters of the visual representation of information by the means of training and the algorithm of the analysis of parameters of the sound representation of information.

The selection of parameters of background and font (the type, size and typeface), color scheme (for the trichromats, protanopes, deuteranopes and tritanopes), volume, timbre, and sound scheme.

The structure of the module of control of the process of processing of the linguistic parameters of CM:

- the procedure of accounting of the level of understanding of the content of information fragments – the algorithm of accounting of the level of proficiency in the language of statement of the information, the algorithm of accounting of the level of understanding of the dictionary of terms and definitions and the algorithm of accounting of the level of proficiency in the elements of interface of the means of training;

- the procedure of accounting of the level of statement of the information by the means of training – the algorithm of output of the list of levels of statement of the information (material), the algorithm of output of a set of used terms and definitions (based on the available level of statement and the way of presentation of the information) and the algorithm of output of a set of used elements in the basis of the interface.

At the same time the setting of optimal nominal values of parameters is provided, determining the certain level of statement of the information (material), the set of terms and definitions and the set of elements in the basis of the interface of program for the concrete category of final users of the means of training (ET).

The structure of the module of control of the process of processing of the psychological parameters of CM:

- the procedure of accounting of the speed of presentation of the information by the means of training – the algorithm of calculating of the speed of presentation of the set of information fragments;

- the procedure of accounting of the additional capabilities of displaying of the means of training – the algorithm of selection of the additional parameters of representation of the information used directly in the adaptive means of training (ET);

- the procedure of accounting of the kind of learning-ability of the subject of training – the algorithm of revealing of the predisposition of the subject of training to the implicit or explicit learning-ability (the parameters of algorithm of ART);

- the procedure of accounting of the level of intellectual abilities of the subject of training – the algorithm of analysis of the convergent intellectual abilities of the examinee and the algorithm of analysis of the divergent intellectual abilities of the trainee;

- the procedure of accounting of the way of presentation of the information by the means of training – the algorithm of selection of the kind of presentation of information fragments by the means of training (text – the textual content, table, scheme – the graphical content and others);

- the procedure of accounting of the nominal values of parameters of CM of the subject of training – the algorithm of revealing of the cognitive styles of processing of the information of the examinee and the algorithm of selection of the style of presentation of the information by the means of training.

The setting of the speed of presentation of a sequence of information fragments, the additional parameters of the algorithm of training, the kind of presentation of the information and the style of presentation of the information fragments by the means of training (ET) are achieved.

In the mode of adaptive training the individual-oriented generation of educational influences is realized by means of using of the innovative adaptive representation of a sequence of information fragments processor, which directly realizes the automated execution of a row of tasks:

- loads the nominal values of parameters of CM of the means of training, which characterize the potentially possible kinds, types and ways of presentation of the information by the means of training;

- loads the nominal values of parameters of CM of the subject of training, which reflect IFPST (separately for certain each subject of training);

- calculates the optimal combination of nominal values of the parameters of displaying of the information for a certain trainee taking into account the technical capabilities of ET, compares them with (the admissible in the context of the given subject of studying (discipline)) the nominal values of the parameters of displaying of the information fragments contained directly in the parametrical CM of the means of training.
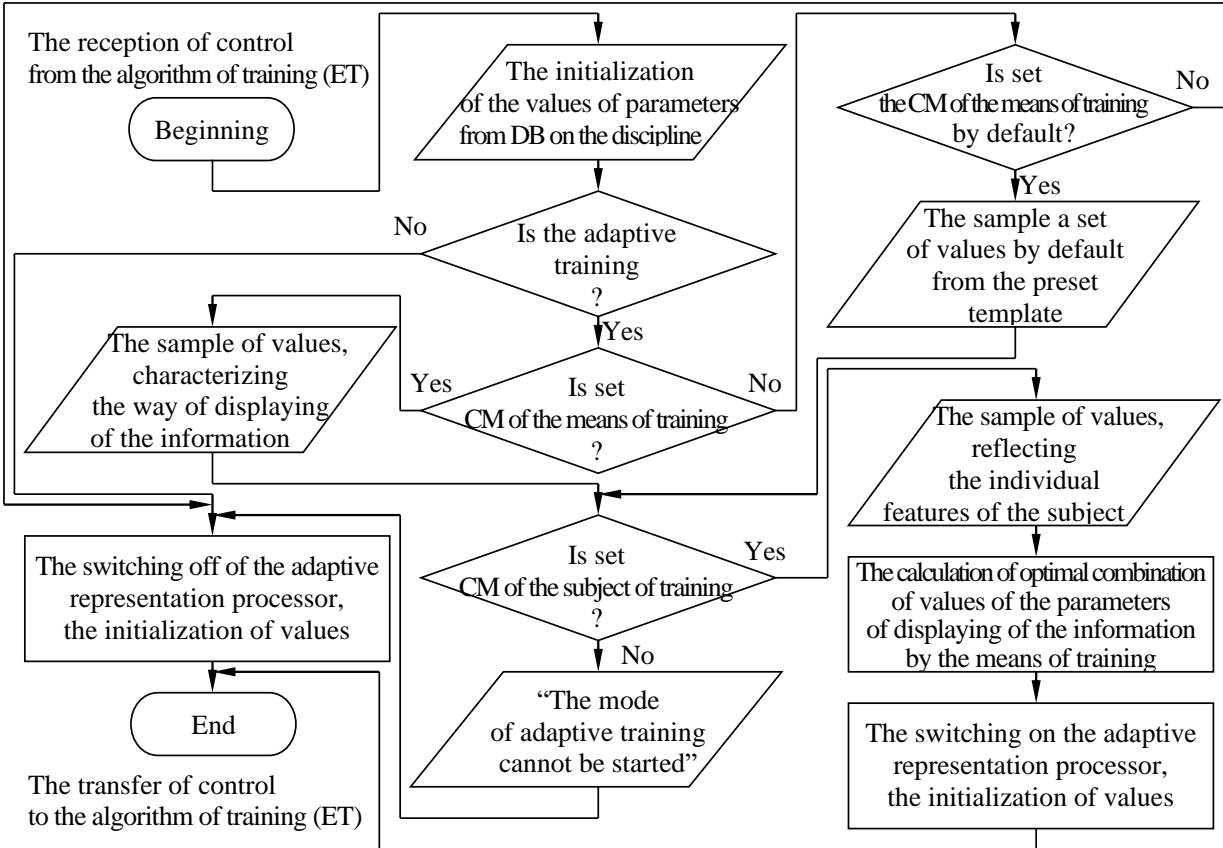
Pic. 6. The algorithm of primary initialization of the values
at the choosing of the mode of functioning of the electronic textbook

The adaptive representation of information fragments processor is automatically turned off and the adaptive means of training (ET) functions as a regular electronic textbook in the case of impossibility of the loading and setting up of the nominal values of parameters of CM of the means of training and CM of the subject training for the several various reasons:

- the absence in DB of the nominal values of parameters of CM of the means of training, previously determined for the given subject of studying (discipline) taking into account the potential technical capabilities (characteristics) of ET, which determine the possibility of displaying of the information by the different ways (as the content of some certain subjects of studying cannot be represented in all possible and permissible ways, then the given parameters limit the quantity of ways of the displaying of information regardless from the factual quantity of ways, supported by ET);

- the absence in DB of the nominal values of parameters of CM of the subject of training, obtained on the technological stage of the preliminary automated diagnostics by means of using of the applied DM and characterizing IFPST at the perception, processing and understanding of the content of a set of information fragments in the certain subject of studying (discipline) in the given language of statement.

The features of modification of the content of the adaptive electronic textbook

At the filling of content of the adaptive means of training (ET) it is proposed to follow the following sequence of actions and operations, to be performed directly by the final user [6, 9]:

- the accumulation of information in the subject of studying is realized by means of using of one from the methods of obtaining (extracting) of data and knowledge of the specialist (expert);

- the formation of MRK on the basis of the learning-methodical complex and received information in the given subject of studying: the purposes, tasks, requirements, restrictions and other;

- the structuring of information in the subject of studying on the basis of MRK, allocating the modules, the quants of information and the information fragments (the certain chapters, sections, modules, paragraphs and pages) and the control questions (tasks) for the testing LRKT and IFPST, at the same time the formed samples of control questions (tasks) are subsequently used in the basic or applied DM;

- the input by the teacher of the formed information model of the subject of studying (the meta-structure of data) into DB by means of the mode of administrating of ET, functioning on the basis of the semantic model of saving and extracting of the information;

- the issuing of recommendations to the teacher on the formation of the information model of the subject of studying according to the technical capabilities of the means of training (ET);

- the modernization of the semantic model of saving and extracting of data taking into account the introduced novations in the course of the life cycle of the program realization of ET;

- the checking of a set of parameters in the basis of the structures of CM of the means of training and CM of the subject of training.

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The program realization of the adaptive electronic textbook

ET [6] supports the working of the different categories of users in the different modes (pic. 6):

- the mode of administrating (pic. 7) – enter the accounts, the parameters of CM of the subjects of training and he structured information, reflecting the content of the subject of training;

- the mode of the (adaptive) training (pic. 8) – realizes the possibility of the individually-oriented formation of knowledge of the contingent of trainees by means of the adaptive representation of information fragments processor (pic. 5).

The mode of administrating (pic. 7) includes the diverse row of constructors allowing to provide the filling of content of the means of training (ET) by the directly previously structured information, reflecting the content of the subject of studying (MRK) and the parameters of its displaying.
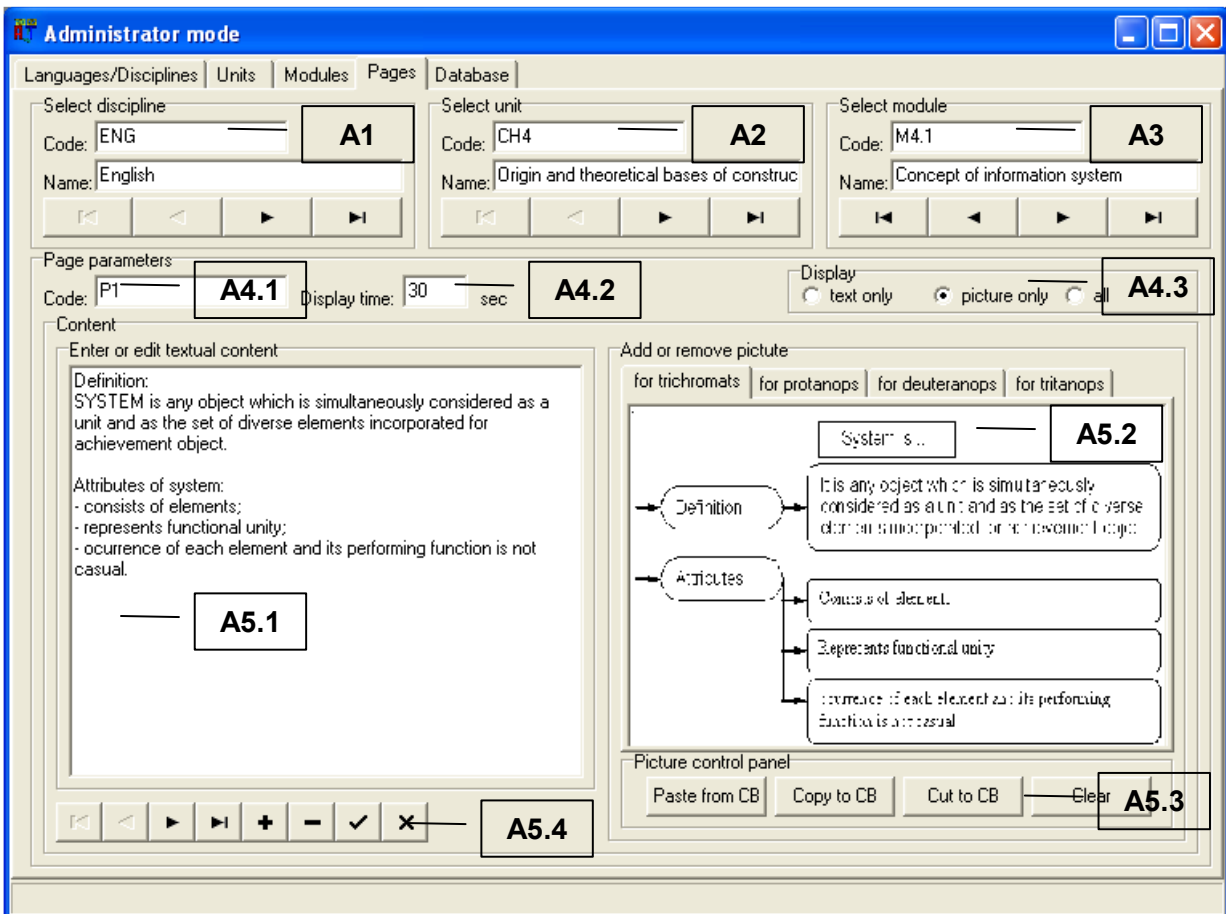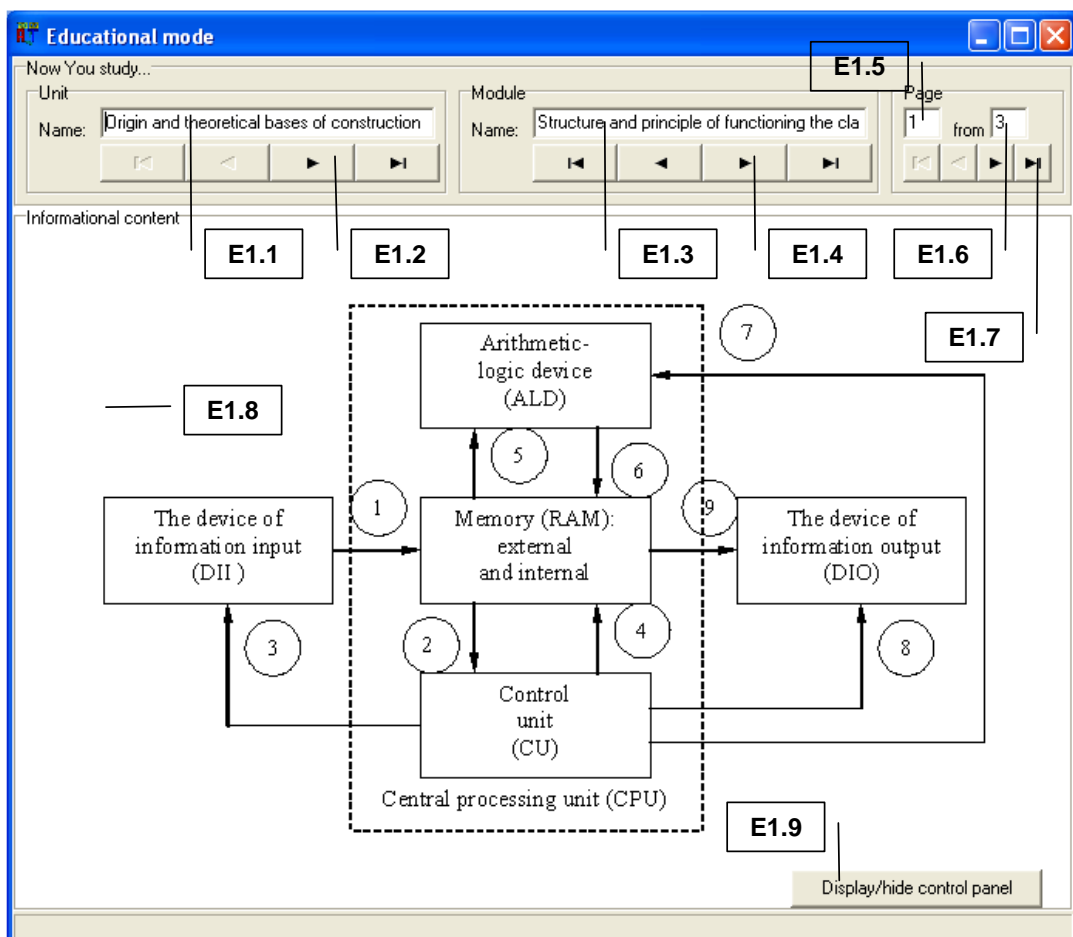

Pic. 7. The interface form of the adaptive means of training

in the mode of administrating of the parameters of page

For the configurating of the parameters of displaying of the information in ET are used:

- the tab "Languages / Disciplines" allows to edit the list of identifiers and names of the languages of statement of the material, the descriptions of each from the disciplines, to set (check) the nominal values of parameters of CM of the means of training, determining a set of possible ways of displaying of the information fragments;

- the tab "Units" allows to modify the identifier, name and description of the list of sections, included into the information structure of the subject of studying;

- the tab "Modules" realizes the possibility of entering and editing of the list of modules, included into a certain (selected by the user) section of the subject of studying;

- the tab "Pages" allows to select the discipline from the previously entered list (area A1), the section of discipline (area A2), the module (paragraph) in the section (area A3), and then to form a set of pages in each module and to modify their parameters: the code of page (field A4.1), the period of displaying of the page by default (field A4.2), the type of displayed information (field A4.3), the textual content of page (field A5.1) and the graphical image for the trichromats, protanopes, deuteranopes and tritanopes (indicator A5.2) by means of the control panel of graphical images (A5.3), the panel of navigation (A5.4) directly provides the transition to the first, previous, next and last page in the module, realizes the addition, deletion, saving and cancellation of changes in the elements (A4-A5).

The mode of (adaptive) training directly involves the displaying of a sequence of educational influences for the realization of the technological process of the individually-oriented formation of knowledge of the contingent of trainees in the subject of studying with turned on or off the adaptive representation of information fragments processor, the switching between which is realized automatically or manually by means of the navigators (the first type – in the view of the hierarchy of elements of the information structure of the subject of studying, the second type – in the view of the several information panels of navigation). The hierarchical presentation provides the maximal visibility at the carrying out of the navigation by the final user in the mode of (adaptive) training [10].

In pic. 8 shows the structure of interface of ET in the mode of adaptive training at the displaying of information in the view of the flat schemes, the manual switching of information fragments by means of the navigator of the second type: the field of indication of the name of section (E1.1), the navigator of section (E1.2), the field of indication of the module (paragraph) (E1.3), the navigator of module (E1.4), the field of indication of the number of page in the section by order (E1.5), the field of indication of the quantity of pages in the given module (E1.6), the navigator of pages (E1.7), the field of display of the graphical image in the view of the flat or volumetric scheme (E1.8), the button (E1.9) of hiding or displaying of the panel of navigation (including the elements E1.1-E1.7).

Pic. 8. The interface form of the electronic textbook in the mode of adaptive training

at the displaying of information fragments in the view of the flat scheme

In pic. 9 presents the interface of ET in the mode of adaptive training at the displaying of information in the view of the text and manual way of switching between pages.
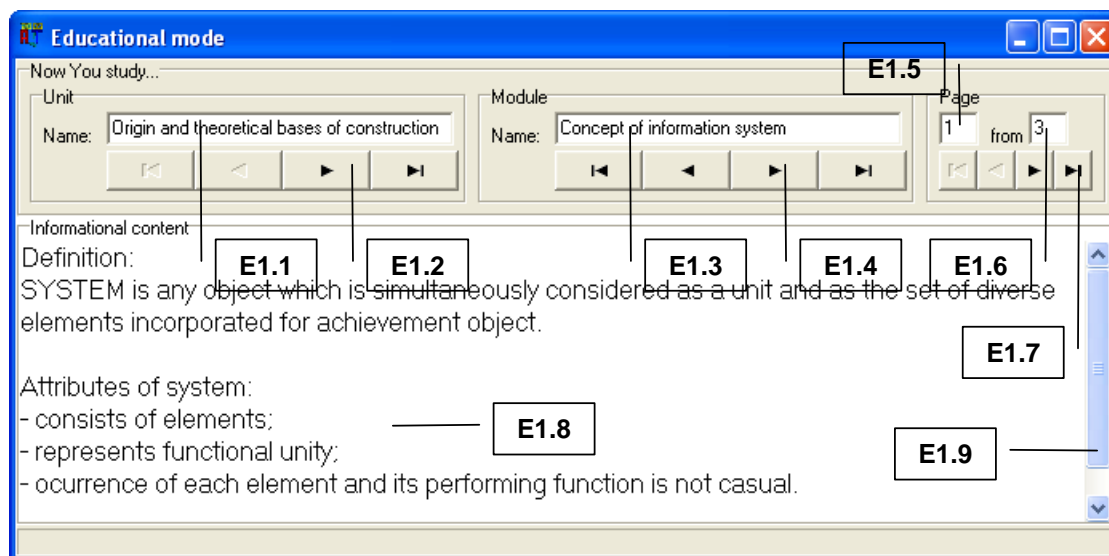
Pic. 9. The interface form of the electronic textbook in the mode of adaptive training at the displaying of information fragments in the view of the text

The structure of the interface of program realization of ET in the mode of adaptive training at the displaying of information fragments in the view of the text and the manual way of switching between the pages with information, reflecting the content of a certain subject of studying involves the presence of several groups of the various elements of interface (pic. 9): the field of indication of the name of section (E1.1), the panel of navigation on sections (E1.2), the field of indication of the module (paragraph) (E1.3), the panel of navigation on module (E1.4), the field of indication of the number of page by order (E1.5), the field of indication of the quantity of pages in the module (E1.6), the panel of navigation on pages (E1.7), the field of indication of the content of page in the view of the text (E1.8) and the bars of scrolling of the information (E1.9) for the providing of navigation.

The procedure of training of the contingent of trainees by means of the adaptive ET includes:

- the procedure of registration of the personal data of the contingent of trainees on their own or the contacting to the system administrator or teacher with the purpose of obtaining of a certain account of the user, which directly allows to use ET and to gain the access to the information resources and other components, included into ART system;
- the passing of preliminary diagnostics of the parameters of CM of the subject of training;
- the registration of user in ART system by means of entering of the data of account;
- the start of the mode of training in the adaptive ET and the research (by the contingent of trainees) of a set of information fragments, reflecting the content of the subject of studying;
- the (non)regulated completion of the mode of training and the exit from ART system.

The conclusion, the results of statistical processing of a posteriori data and conclusions

1. The estimation of efficiency of the introduction of the scientific results of research was carried out using the generally-accepted indicators of the efficiency (resultativity) of training [12]:

$$K = \{k_1; k_2; k_3\} = \left\{ Y_2 - Y_1; \frac{Y_2}{Y_1}; \frac{Y_2 - Y_1}{Y_1} 100\% \right\}.$$

The coefficients k_1, k_2, k_3 are denoted respectively the absolute, comparative and relative indicators of efficiency of the formation of knowledge of the contingent of trainees, and the results of statistical processing of a posteriori data of a series of the automated experiments are summarized in tabl. 1.

Table 1

The results of preliminary statistical analysis of the resultativity of training

The indicator	The number of the group of trainee							
	1	2	3	4	5	6	7	8
The indicators of the resultativity of training for 2004 year								
The size of sample	20	21	25	18	18	15	0	0
The average point Y_1	4,05	4,286	4,24	4,611	4,056	4,4	-	-
AQD of average point	0,686	0,845	0,779	0,502	0,802	0,507	-	-
The indicators of the resultativity of training for 2005 year								
The size of sample	24	22	24	25	24	22	23	21
The average point Y_2	4,333	4,046	4,375	4,16	4,042	4,091	4,696	4
AQD of average point	0,817	0,785	0,824	0,8	0,859	0,811	0,559	0,894
The indicators of the resultativity of training for 2006 year (using CMT in the 3 groups)								
The size of sample	26	23	29	24	25	22	22	22
The average point Y_3	4,5	4,609	4,379	3,708	3,92	3,773	4,455	3,818
AQD of average point	0,707	0,656	0,775	0,751	0,572	0,612	0,858	0,853
The results of statistical analysis								
The indicators, reflecting the change in the efficiency of training for 2004-2005 year								
k_1	0,283	-0,240	0,135	-0,451	-0,014	-0,309	-	-
k_2	1,07	0,944	1,032	0,902	0,997	0,93	-	-
k_3, %	6,996	-5,606	3,184	-9,783	-0,343	-7,025	-	-
The change of AQD	0,13	-0,06	0,045	0,298	0,056	0,304		
The indicators, reflecting the change in the efficiency of training for 2005-2006 year								
k_1	0,167	0,563	0,004	-0,452	-0,122	-0,318	-0,241	-0,182
k_2	1,039	1,1392	1,001	0,891	0,97	0,922	0,949	0,955
k_3, %	3,846	13,923	0,099	-10,857	-3,01	-7,778	-5,135	-4,546
The change of AQD	-0,109	-0,129	-0,049	-0,049	-0,287	-0,199	0,299	-0,042

At the available volumes of sample of homogeneous a posteriori data there is a steady tendency to the increase of the nominal values of indicators, which characterize the resultativity of training (at distance), and also the decreasing of their average quadratic deviation (AQD) is fixed.

2. In result of the regression analysis the obtained nominal values of the coefficient of multiple correlation (CMC = 0.558) and the coefficient of multiple determination (CMD = 0.312) indicate, that 31.2% of the dispersion of the dependent variable Y_i (the estimation of the level of residual knowledge) is determined by the variation of nominal values of the coefficients (predictors) K_i located in the basis of the obtained linear model of multiple regression $Y(K_i)$. At the same time the nominal values of initial (β) and standardized coefficients (β') of the linear model of multiple regression $Y(K_i)$ are presented in tabl. 2 and 3. The constant of the linear equation of multiple regression is 4.653.

Table 2

The nominal values of initial β standardized coefficients β'

The predictor	VOZR	K_7	K_8	K_9	K_{14}	K_{15}	K_{16}	K_{17}	K_{18}	K_{19}
The value of initial β - coefficient	-0,006	-0,002	-0,156	0,121	0,064	-0,029	0,006	-0,074	0,025	-0,009
The standardized β - coefficient	-0,017	-0,010	-0,714	0,611	0,247	-0,104	0,034	-0,262	0,159	-0,052

Table 3

The nominal values of initial β standardized coefficients β'

(continue)

The indicator (predictor)	K_{20}	K_{21}	K_{22}	K_{23}	K_{24}	K_{25}	K_{27}	K_{28}	K_{29}	K_{45}
The value of initial β - coefficient	-0,026	0,001	0,035	0,013	0,009	-0,008	-0,111	-0,008	0,032	0,022
The standardized β - coefficient	-0,147	0,002	0,182	0,052	0,052	-0,113	-0,226	-0,018	0,172	0,037

The predictors in the obtained linear model of multiple regression: *VOZR* – age, color perception parameters (K_7 – achromasia, K_8 – protanopia, K_9 – deuteranopia), the convergent intellectual abilities (K_{14} – verbal intelligence, K_{15} – deduction, K_{16} – combinatorics, K_{17} – reasoning, K_{18} – analyticity, K_{19} – induction, K_{20} – mnemonics, K_{21} – planar thinking, K_{22} – volumetric thinking), the verbal creativity (K_{23} – the index of associativity, K_{24} – the index of originality, K_{25} – the index of uniqueness), the figurative creativity (K_{27} – the index of associativity, K_{28} – the index of originality, K_{29} – the index of uniqueness), the linguistic parameters (K_{45} – the level of proficiency in the language of statement of the material), and the factor (the dependent variable) acts the resultativity of training Y.

Then the linear equation of multiple regression takes the view:

$$Y = 4{,}653 - 0{,}006VOZR - 0{,}002K_7 - 0{,}156K_8 + 0{,}121K_9 + 0{,}064K_{14} - 0{,}029K_{15} + 0{,}006K_{16} -$$
$$- 0{,}074K_{17} + 0{,}025K_{18} - 0{,}009K_{19} - 0{,}026K_{20} + 0{,}001K_{21} + 0{,}035K_{22} + 0{,}013K_{23} + 0{,}009K_{24} -$$
$$- 0{,}008K_{25} - 0{,}111K_{27} - 0{,}008K_{28} + 0{,}032K_{29} + 0{,}022K_{45}$$

3. The developed CMT allows to realize the additional contour of adaptation based on the innovative parametrical CM block, conducting the complex system analysis of IEE, to provide the increasing in the efficiency of functioning of ART system and the resultativity of training (at distance) of the contingent of trainees.

4. In the course of the discriminant analysis carrying out of the several groups of trainees directly in dependence from the indicator, characterizing the resultativity (efficiency) of training (the estimation of LRKT): "5" – the group of "excellent-students", "4" – the group of "good-students" and "3" – the group of "mediocre-students".

On pic. 10 presents the geometrical interpretation of the relative location of the centroids of classes in the space of coordinate of the two canonical discriminant functions corresponding the groups of "excellent-students", "good-students" and "mediocre-students" allocated for the system analysis.
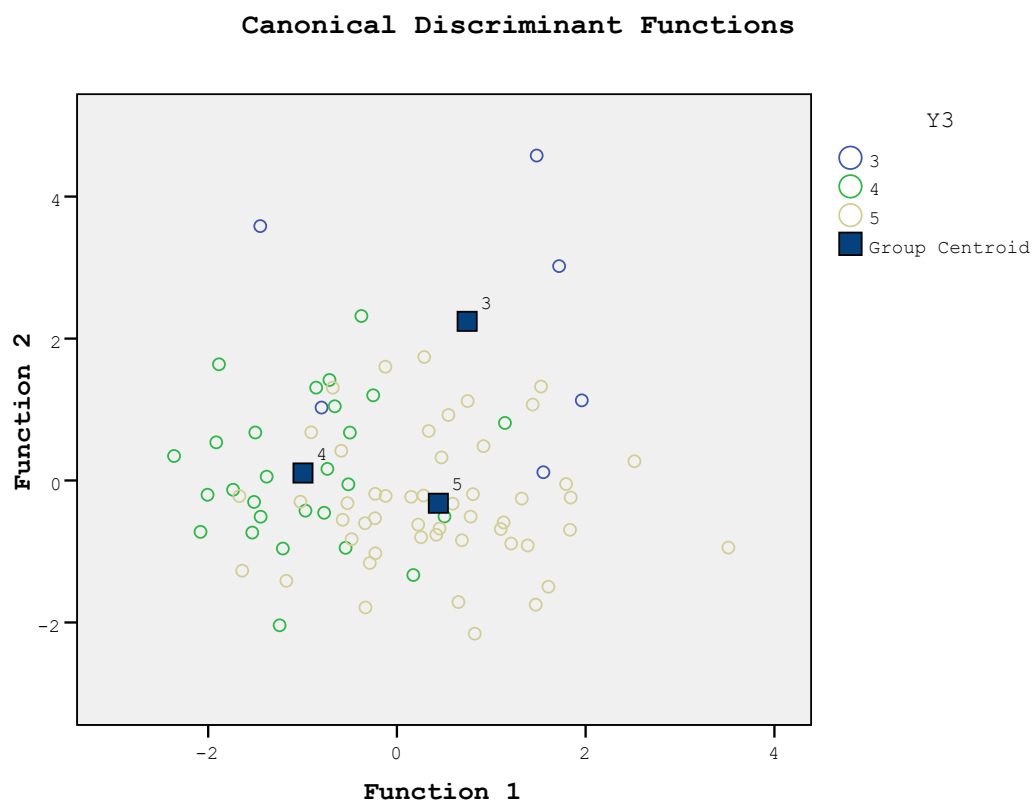
Pic. 10. The position of the centroids of classes "excellent-students", "good-students" and "mediocre-students" in the space of two canonical discriminant functions

5. The practical use of scientific results was carried out in the learning process of "The Saint-Petersburg state electrotechnical university "LETI"" and "The international banking institute" (Saint-Petersburg city), the acts about the practical use and 3 copyright certificates was received.

Literature

1. Bashmakov A.I. The development of computer textbooks and training systems. – M.: "Filin", 2003. –630 p.
2. Vetrov A.N. The factors of success in the educational activity of modern HEI: The tendencies of development of the information environment of remote education / A.N. Vetrov, N.A. Vetrov; the collective monography edited by the member-corr. of "The international HE academy of sciences" I.N. Zakharov. – SPb.: The publ. house of "IBI", 2004. – P.54-65 (148 p.).
3. Vetrov A.N. The features of the information environment structure of the adaptive RT systems / A.N. Vetrov, N.A. Vetrov // "Actual problems of economics and new technologies of teaching", the section "Innovative technologies of education": the materials of the IVth intern. sci.-pract. conf., Saint-Petersburg city, the 15th-16th of March 2005 y. – SPb.: "IBI", 2005. – P.45-46.
4. Vetrov A.N. The features of evolution of the theory of information and information technologies on a threshold of the XXIst century: Monography / A.N. Vetrov; S.-Petersburg. state. electricaltechn. un-t. – SPb. – 2007. – 141 p.: pic. – Bibliogr. 16 names. – Rus. – Dep. in "RAS".
5. Vetrov A.N. The environment of automated training with the properties of adaptation based on the cognitive models: Monography / A.N. Vetrov; S.-Petersburg. state. electricaltechn. un-t. – SPb. – 2007. – 256 p.: pic. – Bibliogr. 69 names. – Rus. – Dep. in "RAS".
6. Vetrov A.N. The adaptive means of training in the automated educational environment based on the parametrical cognitive models block / A.N. Vetrov // "Quality management in modern High school (HEI)": the materials of the Vth intern. sci.-method. conf., Saint-Petersburg city, the 21st-22nd of June 2007 y. – SPb.: The publ. house of "IBI", 2007. – Ed. 5. – P.110-113.
7. Okulov S.M. Cognitive informatics. – Kirov.: "VyatSTU", 2003. – 219 p.
8. Krol V.M. Psychophysiology of human. – SPb.: "Peter", 2003. – 302 p.
9. Lobanov Yu.I. The preparation of information for the automated training systems. – M.: "HS", 1986. – 175 p.
10. Novikov F.A. The interpretive dictionary of modern computer vocabulary. – SPb.: "BHV", 2004. – 604 p.
11. Kholodnaya M.A. Psychology of intelligence: paradoxes of research. – M.: "Bars", 1997. – 391 p.
12. Heredov A.D. The mathematical methods of psychological research. – SPb.: "Speech", 2004. – 392 p.

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ЭЛЕКТРОННЫЙ УЧЕБНИК НА ОСНОВЕ ПРОЦЕССОРА АДАПИВНОЙ РЕПРЕЗЕНТАЦИИ ИНФОРМАЦИОННЫХ ФРАГМЕНТОВ В АВТОМАТИЗИРОВАННОЙ ОБРАЗОВАТЕЛЬНОЙ СРЕДЕ

Электронный учебник функционирует посредством разработанного процессора адаптивной репрезентации последовательности информационных фрагментов и выступает инновационным компонентом созданной автором системы автоматизированного (дистанционного) обучения со свойствами адаптации на основе параметрических когнитивных моделей

Ключевые слова: информационно-образовательная среда, когнитивная модель, система автоматизированного (дистанционного) обучения, процессор адаптивной репрезентации последовательности информационных фрагментов, технология когнитивного моделирования (для системного анализа)