

**THE PROGRAM COMPLEX FOR THE TASKS OF RESEARCH
OF THE ADAPTIVE ENVIRONMENT OF THE AUTOMATED TRAINING
BASED ON THE COGNITIVE MODELS**

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The program complex is intended for the automation of the system analysis of the information environment of automated training with the properties of adaptation based on the parametrical cognitive models and includes: the electronic textbook based on the adaptive representation of information fragments processor, taking into account the individual features of the subjects of training and the potential technical capabilities of the means of training; the basic diagnostic module for the testing of the level of residual knowledge of the trainees and the applied diagnostic module for the providing of automation of the process of research of the parameters of the cognitive models of the subjects of training

**The cognitive model, the cognitive modeling technology,
the adaptive representation of information fragments processor**

The informatization of the information-educational environments (IEE) causes to the emergence of a new scientific problems and private applied tasks, actualizes the need of creation, introduction and use of the various means of automation for the system analysis and the increase of efficiency of the information interaction between the diverse subjects and means of the controlled technological process of the formation of knowledge of the trainees in the automated information environment of educational establishment, including the sequence of technological gaps on each of which the organizational, hardware, program, methodical and other support is used [1].

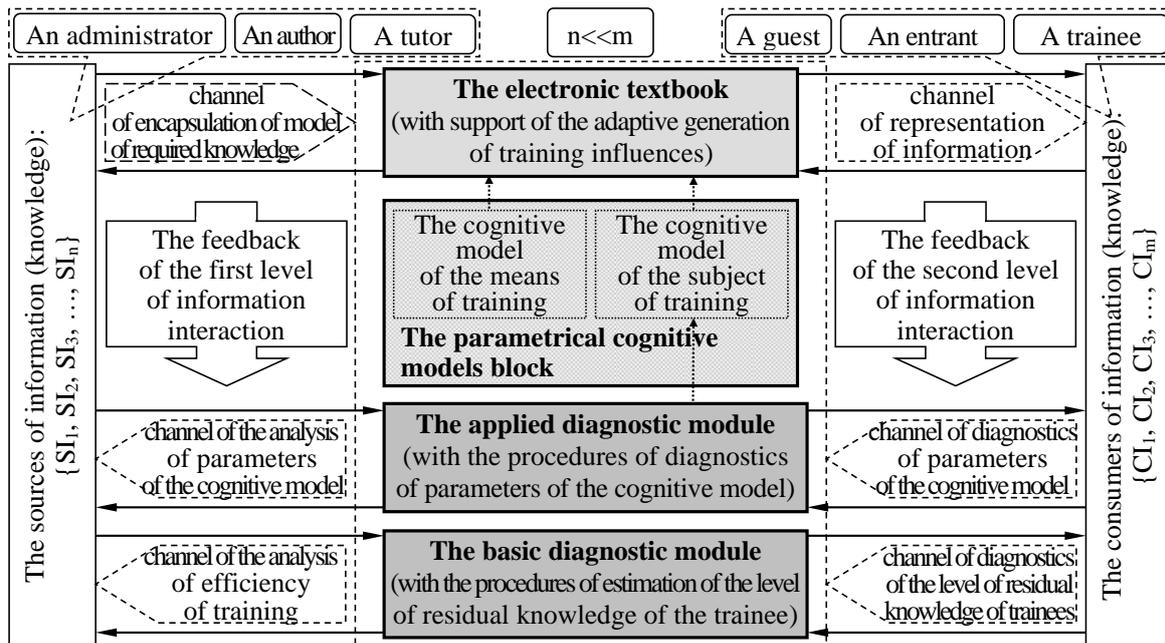
The traditional approaches, methods, algorithms and information technologies in the basis of the automated IEE significantly lose their primary actuality, that initiates the rapid emergence of innovative adaptive models and the individually oriented technologies for the support of the process of training in the establishments of secondary (general) and special education, the higher professional education (higher educational institutions – HEIs) and the professional retraining and improvement of qualification [2, 3].

The author directly was independently developed and proposed: the approach to the creating, system analysis and improving in the efficiency of functioning of the automated training system with the properties of adaptation based on the cognitive models, the cognitive modeling technology for the system analysis of IEE and the complex of programs for the automation of the tasks of research [3-11].

The features of the automated training system with the properties of adaptation based on the parametrical cognitive models block

The automated training system (ATS) with the properties of adaptation based on the parametrical cognitive models (CM) [1, 3-5, 9] was created by the author by means of the cognitive modeling technology (CMT) [2, 5, 8], includes the six channels of communicative duplex information exchange at the two levels of information interaction between the different subjects and means of controlled technological process of the formation of knowledge (pic. 1):

- the first level – between the sources of information and the components of ATS;
- the second level – between the components of ATS and the consumers of information.



Pic. 1. The structure of the automated training environment with the properties of adaptation based on the cognitive models

Direct the communicative duplex information interaction between the diverse sources of information and the consumers of information in ATS with the properties of adaptation based on the parametrical CM is mediated and occurs at the two independent levels: the subjects of training interact through the technical means of training, that acts a significant drawback of any existing ATS (at distance), which need be technologically eliminated by means of introduction (using) of the various means of automation based on a modern achievements in the area of the new information and communication technologies, actualizes the research of the individual features of the contingent of trainees.

The sources of information are divided on the two independent categories: the natural origin (the qualified specialists – experts), the artificial origin (the traditional and electronic books, servers, databases, the drives of information on the floppy and hard magnetic disks, the optical disks and electronic memory cards).

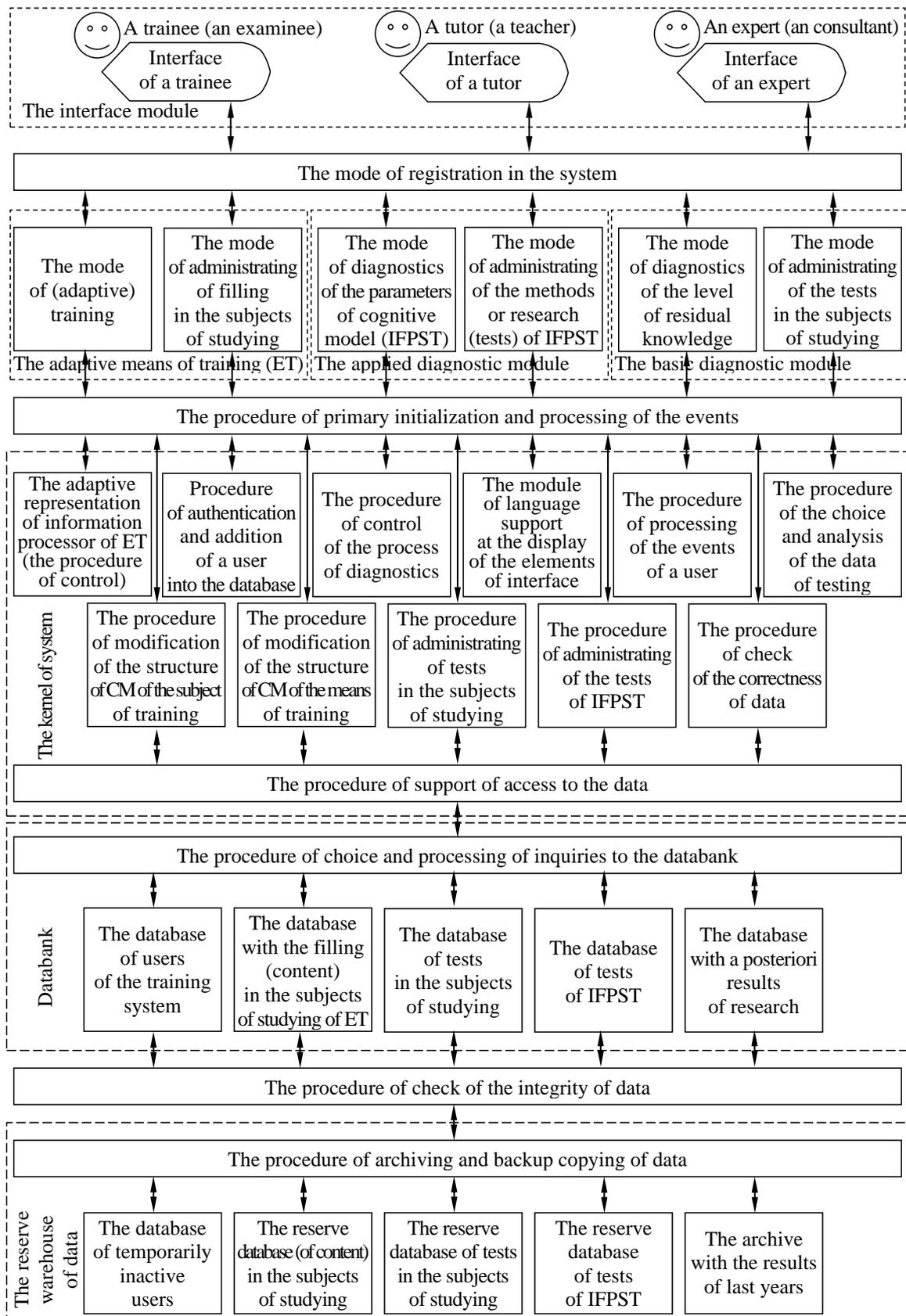
The consumers of information: the authors of courses, tutors, trainees and employees.

**The structure of the complex of programs for the support of functioning
of the automated training systems with the properties of adaptation
based on the parametrical cognitive models block**

The complex of programs (the means of automation) developed by the author [3-6, 9] is intended directly for the support of functioning of ATS with the properties of adaptation based on the parametrical CM block [3-6] and the automation of the tasks of research of the information environment of educational establishment [1, 3, 5], at the same time its structure includes the several main program components, realizing the certain set of functions and the tasks of final users [6, 7, 10] (pic. 2):

- the adaptive electronic textbook (ET) [3, 5-7, 9, 10] – realizes the individually-oriented generation of a sequence of the diverse educational influences to the trainee by means of the developed adaptive representation of information fragments processor based on the parametrical CM block;
- the basic diagnostic module (DM) [3-6, 9] – realizes the automation of testing of the level of residual knowledge of the contingent of trainees (LRKT) by means of the use of a set of tests in the different subject areas based on the function of estimation and the two interval scales, which independently allow to take into account the quantity of valid answers on the questions and the sum of the scored (penalty) points for each selected (in)valid variant of answer on the question of the method of research (test) by the examinee;
- the applied DM [3, 5, 6, 9] – provides the automation of diagnostics of the values of parameters of CM of the subject of training in the form of testing based on the previously selected set of the applied methods of research from the area of physiology of analyzers, cognitive psychology and applied linguistics;
- the parametrical CM block [3-5, 8, 11] – includes the two main types of different CM:
 - the parametrical CM of the subject of training – concentrates the parameters, which reflect the individual features of personality of the trainee (IFPST) at the primary sensory perception (the physiological portrait), the secondary cognitive processing (the psychological portrait) and the understanding of diverse content (the linguistic portrait) of a sequence of information fragments in a given language;
 - the parametrical CM of the means of training – aggregates the set various parameters, reflecting the potential technical capabilities of the means of training at the generation of educational influences of the different kind by the different way: the text, static flat or volumetric scheme (the graphical representation), the static or dynamic audio- or video-stream (the multimedia representation) with the possibility of selection of the color and typeface of font and background, the color scheme for the trichromats, protanopes, deuteranopes and tritanopes.

The architecture of the complex of programs follows directly in pic. 2, includes the level of interface of interaction with the user, the level of the micro-program kernel (the computing kernel of the system) and the level of data bank for the (quasi-)dynamic storage and backup of a posteriori results of diagnostics in the form of testing [9].



Pic. 2. The structural-functional scheme of the complex of program

for the tasks of automation of research of the adaptive environment of automated training

The components of the complex of programs function in the three various modes:

- the administrating – allows to modify the content of the database;
 - the administrating of the database of users – allows to change the parameters of accounts of the final users (the subjects of training) and to view a posteriori data of testing of the level of residual knowledge and the diagnostics of individual features of the contingent of examinees by means of the diverse set of the methods of research (tests);
 - the administrating of the database of the methods of research – provides the changing of the values of each method of research (test) in the interface and database, realizing the diagnostics of nominal values of the parameters of the physiological, psychological and linguistic portraits of the parametrical CM of the subject of training (see the parametrical CM block);
 - the administrating of the database of the adaptive ET – realizes the modification of the structured sequence of information fragments, reflecting the content of a certain subject of studying (discipline): module, section, subsection and paragraph (the information fragment);
- the adaptive training – realizes the individual-oriented generation of a sequence of information fragments of the different types by the various way by means of using the innovative adaptive representation of information fragments processor created by the author, calculating the optimal nominal values of the parameters of displaying;
- the analysis of data – allows to view a posteriori data, which were obtained in the course of the automated training (at distance), the testing of the level of residual knowledge of the contingent of trainees and the diagnostics of individual features of the contingent of examinees, and then directly to realize the mathematical processing of a posteriori data by means of using of a set of mathematical methods of the statistical analysis.

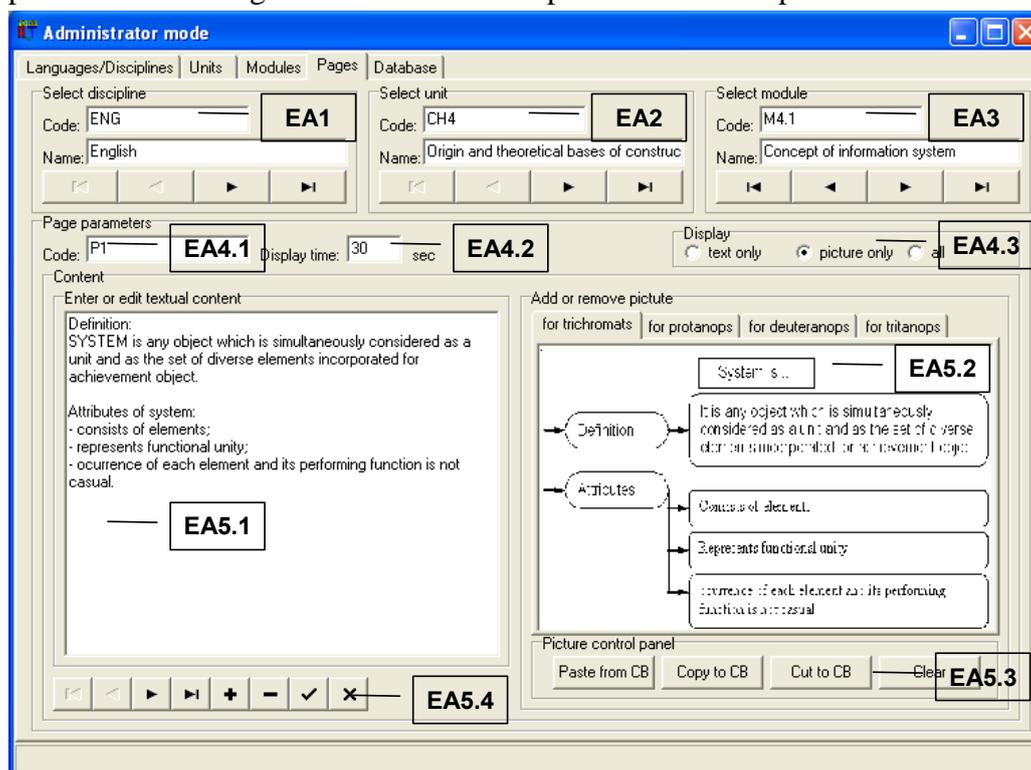
ET acts as the main component of ATS with the properties of adaptation based on CM, realizes the individually-oriented generation of a sequence of educational influences (the structured information) by means of the use of the innovative adaptive representation of information fragments processor developed by the author, which reflect the previously structured content of a set of certain subjects of studying (disciplines) and are stored directly in the database with the content in the subjects of studying and the reserve database.

The switching between the various modes of functioning of the applied DM is carried out by means of using of the main button form of the program realization of ATS with the properties of adaptation based on the parametrical CM block, that allows to activate the mode of administrating, diagnostics and the analysis of data.

Each of the available modes of functioning of the components of the complex of programs realizes the certain limited set of functions and various tasks.

The electronic textbook based on the adaptive representation of information fragments processor

The interface of adaptive ET in the mode of administrating is presented in pic. 3, allows to realize the modification of parameters of the previously structured of content of the available subjects of studying, to enter the list of groups and the list of users, and then directly to realize the editing of parameters of the accounts of users and to provide the viewing of nominal values of parameters of the parametric CM block [10].



Pic. 3. The interface of the adaptive electronic textbook
in the mode of administrating of the database with the parameters of the subject of studying

For the administrating of content of the adaptive ET is used a set of elements of the interface, which are concentrated on the corresponding tabs of the form of interface of the program:

- the tab “Languages / Disciplines” – allows to edit the parameters of discipline, at the same time contains the field of codes and names of the languages of statement of the material of discipline, the code, name and description of the discipline, the parameters of CM of the means of training by default: the values of these parameters are used in the case of absence of the preset nominal values of parameters of CM of the means of training, and in the otherwise case the adaptive representation of information fragments processor is immediately deactivated and the mode of adaptive training is turned off;
- the tab “Units” – directly allows to modify the code, name, the status of displaying and the description of each section of the selected discipline;
- the tab “Modules” – allows to change the codifier, name, the status of displaying and the description of each module in the limits of the selected section of the discipline, displayed in a certain national or foreign language, at the same time the content of discipline is previously entered in the mode of administrating and is available for the subsequent use in the mode of adaptive training;

- the “Pages” – allows to select first a specific discipline and the language of statement of the material (EA1), section (EA2) and module (EA3), and then allows to edit the codifier (EA4.1), the nominal value of the interval of time of the displaying of page (EA4.2), the parameters of displaying of the information page (EA4.3), the textual content of the question (EA5.1) and the graphical content of the question (EA5.2) using the color schemes of replace or the compensation of a certain colors of spectrum on the graphical images for trichromats, full or partial dichromats (protanopes – do not perceive red and half-tones of red, deuteranopes – do not feel green and shades of green and tritanopes – do not distinguish blue and violet, and also their shades);
- the “Database” – allows to change the list of available codes and the names of group, the list of parameters of the accounts of users, and also to view and to edit the parameters of CM of the subject of training and CM of the means of training, measured or defined for the certain user or the means of training.

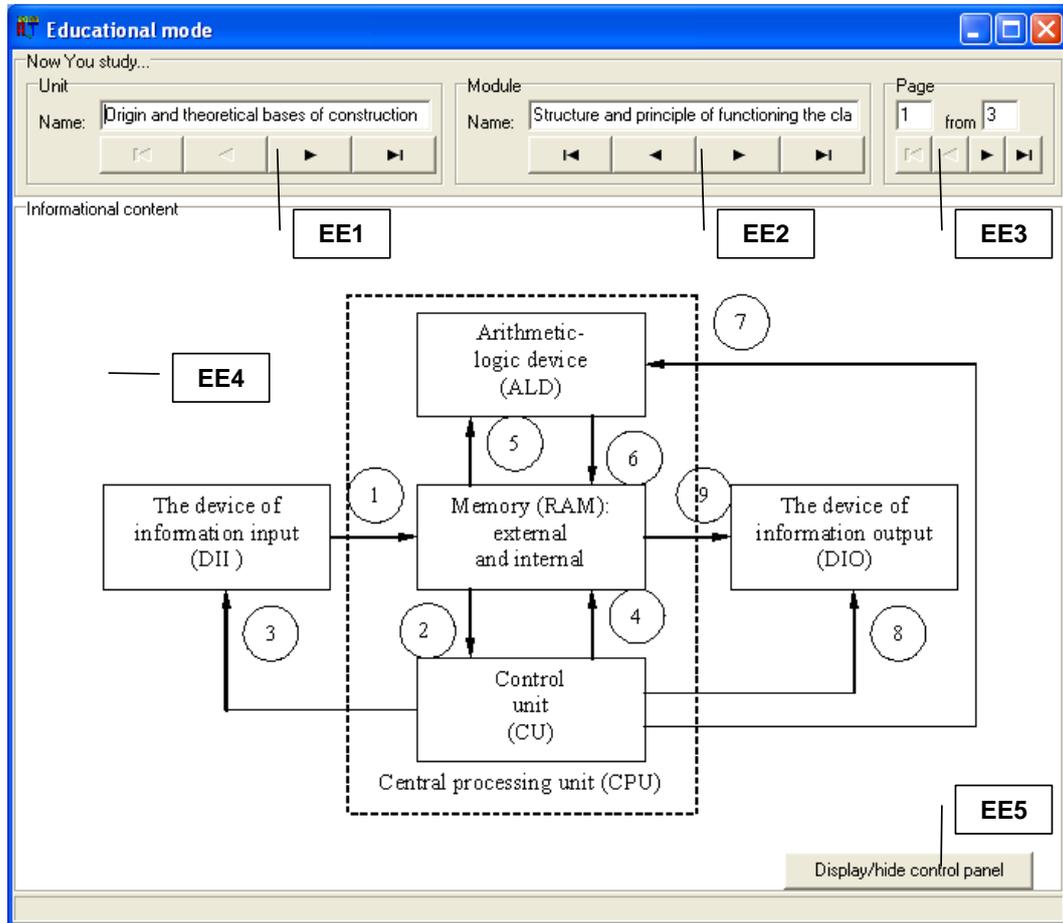
The values of parameters of CM of the subject of training are diagnosed using the methods of research by means of the applied DM at the basis of the complex of programs.

For the diagnostics of the values of parameters of CM of the subject of training, the technique of research of the parameters of CM of the subject of training is used in the basis of CMT, which allows to form an actual set of different parameters in the experimental structure of the parametrical CM, and then to select the new and to improve the existing methods of research of a certain parameters of the physiological, psychological or linguistic portrait of CM in the view of a set of various developed procedures (the algorithms for the automation of diagnostics) for the further realization of automation of the process of research of IFPST.

The values of parameters of CM of the means of training are set (automatically or manually) and are systematically updated on the basis of the existing technical description in the course of the life cycle of the developed program realization of the means of training.

For the diagnostics of the nominal values of parameters of CM of the means of training uses a certain technique of research of the parameters of CM of the means of training in the basis of CMT, which allows to modify the existing actual set of parameters based on the given theoretical structure of the parametrical CM, and also to realize the addition of new and the removal of outdated parameters of CM and the corresponding their methods of research (presented in the form of different tests).

For the realization of difficult controlled technological process of the automated formation of knowledge of the contingent of trainees the innovative adaptive ET developed by the author is used (pic. 4), functioning on the basis of the adaptive representation of information fragments processor, which directly reflect the content of one or several subjects of studying.



Pic. 4. The interface form of the electronic textbook

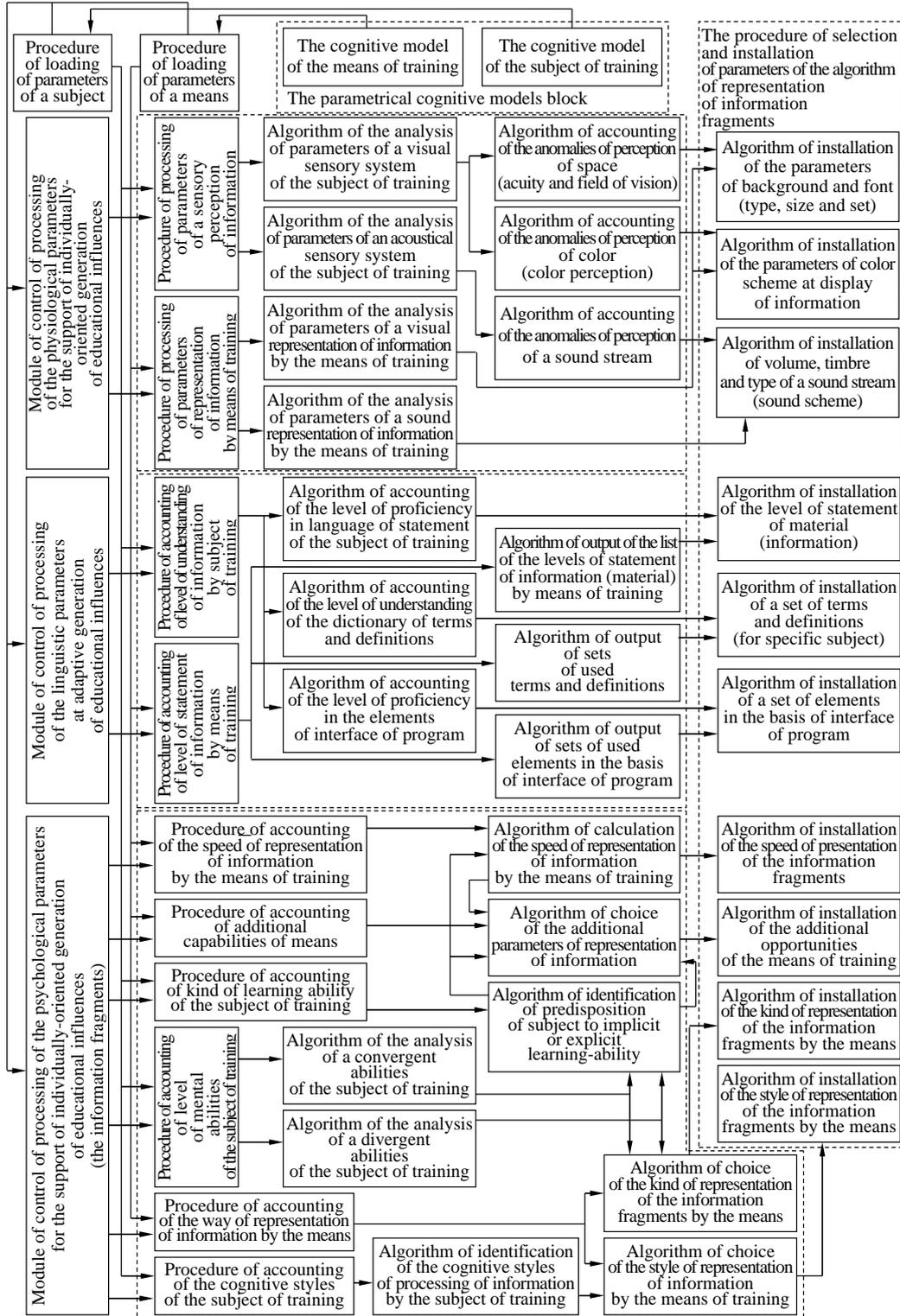
in the mode of adaptive training at the displaying of information in the view the flat scheme

In the mode of adaptive training the trainee is given the capability of a sequentially selecting of the section (EE1), module (EE2) and page (EE3), containing a certain information fragment in the discipline (EE4), and the button (EE5) realizes the hiding or displaying of the panel of navigation respectively for the increasing or decreasing of the effective size of the viewed working area of the window of interface of the program realization.

There is the possibility of automatic and manual switching between the information fragments of a certain subject of studying by means of using of the different panels of navigation of the two main types: the first type – the multilevel hierarchical tree (the analogue of hierarchical tree of directories), which reflects the structure of one or several subjects of studying and the second type – the panel of instruments for the providing of automation of the effective sequential linear switching of a section, a module, a page with the elementary information fragment on a certain subject of studying.

The adaptive representation of information fragments processor

The structure of the adaptive representation of information fragments processor is made on the basis of the principle of parallel and block-modular architecture, at the same time it includes the three main modules and the several procedures and algorithms for the providing of the potential possibility of calculating of the optimal combination of nominal values of the parameters of displaying of the structured information based on the values of parameters of CM of the subject of training and CM of the means of training (pic. 5).

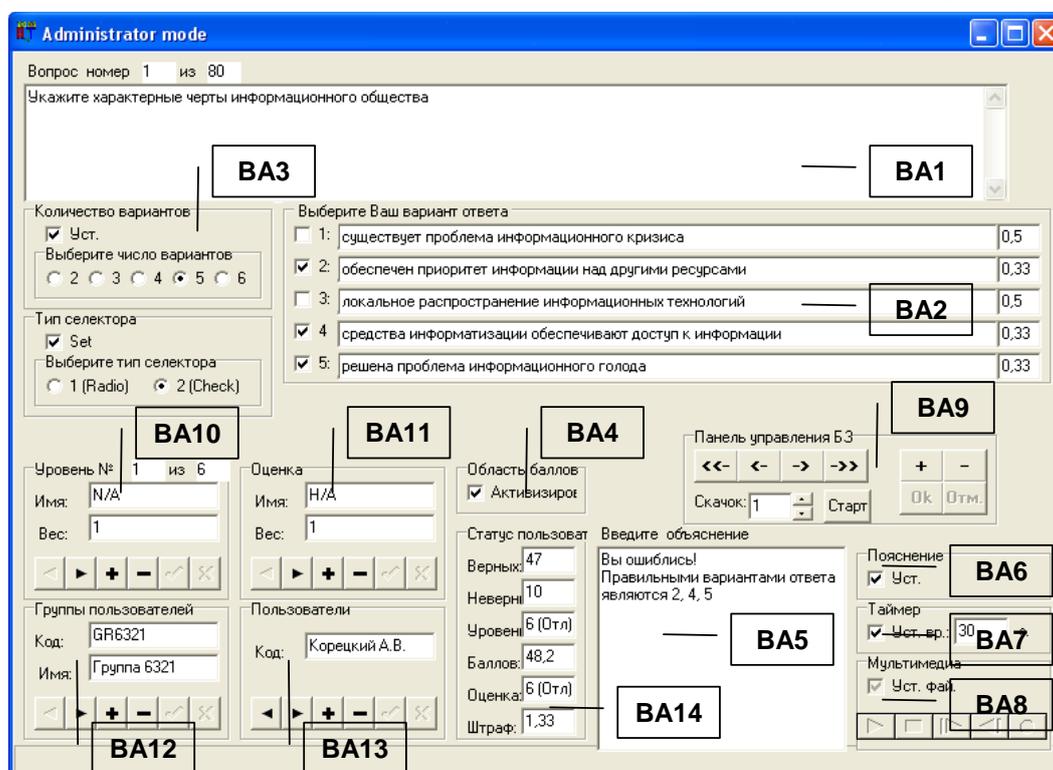


Pic. 5. The structure the adaptive representation of information fragments processor

The main diagnostic module

for the testing of the level of residual knowledge of the contingent of trainees

The basic DM is the main component of ATS with the properties of adaptation based on CM, realizes the automated testing of LRKT by means of using of a set of tests in the different subject areas in basis of the database (pic. 6) [3, 5].

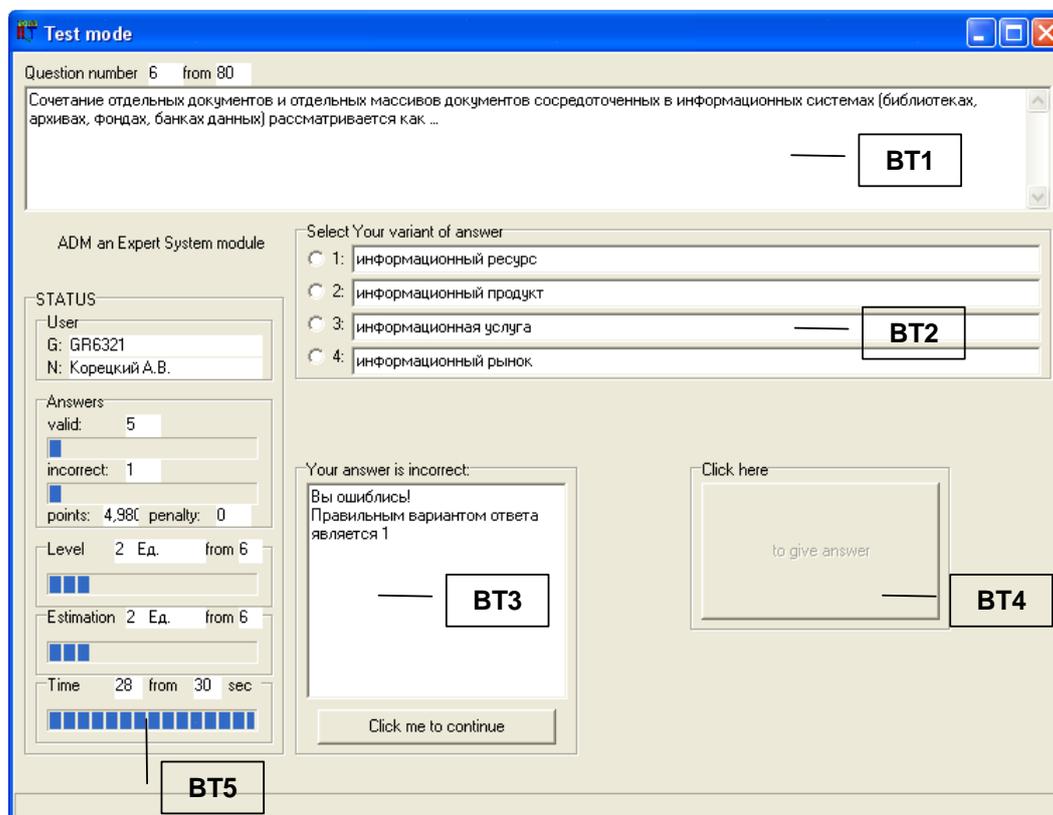


Pic. 6. The structure of interface of the basic diagnostic module

in the mode of administrating of the sample of question-answers structures and the list of examinees

For the administrating of parameters of the test a row of elements of the interface are used: the field of editing of the textual content of the question (BA1); the field of editing of the sign of correctness, the textual content of the variants of answer and the weight coefficients for the activation of exact scale based on the sum of scored points (BA2); the field of editing of the quantity of the variants of answer and the type of selector of the variants of answer (BA3); the field of modification of the status of activation of the exact scale based on the weight coefficients (BA4); the field of editing of the wording of explanation (displaying at the invalid answer) (BA5); the field of modification of the status of displaying of the explanation in case of invalid answer on the question (BA6); the field of modification of the status of activation of the timer for the accounting of the interval of time of the displaying of question (BA7); the field of modification of the status of activation of the multimedia accompanying from the file with the streaming audio (BA8); the field of indication the status of examinee containing the quantity of valid and invalid answers, the nominal of the level of proficiency in the material on a rough scale based on the quality of valid answers, the sum of scored points for all valid variants of answer on the questions, the estimation of LRKT by means of the exact scale based on the sum of scored points and the sum of scored penalty points for all invalid variants of answer on the question (BA14).

The interface of the basic DM in the mode of diagnostics of LRKT with the sample of control questions in the discipline “Informatics” for the testing is presented in pic. 7.



Pic. 7. The interface of the basic diagnostic module in the mode of diagnostics of the level of residual knowledge of the contingent of trainees in the discipline “Informatics”

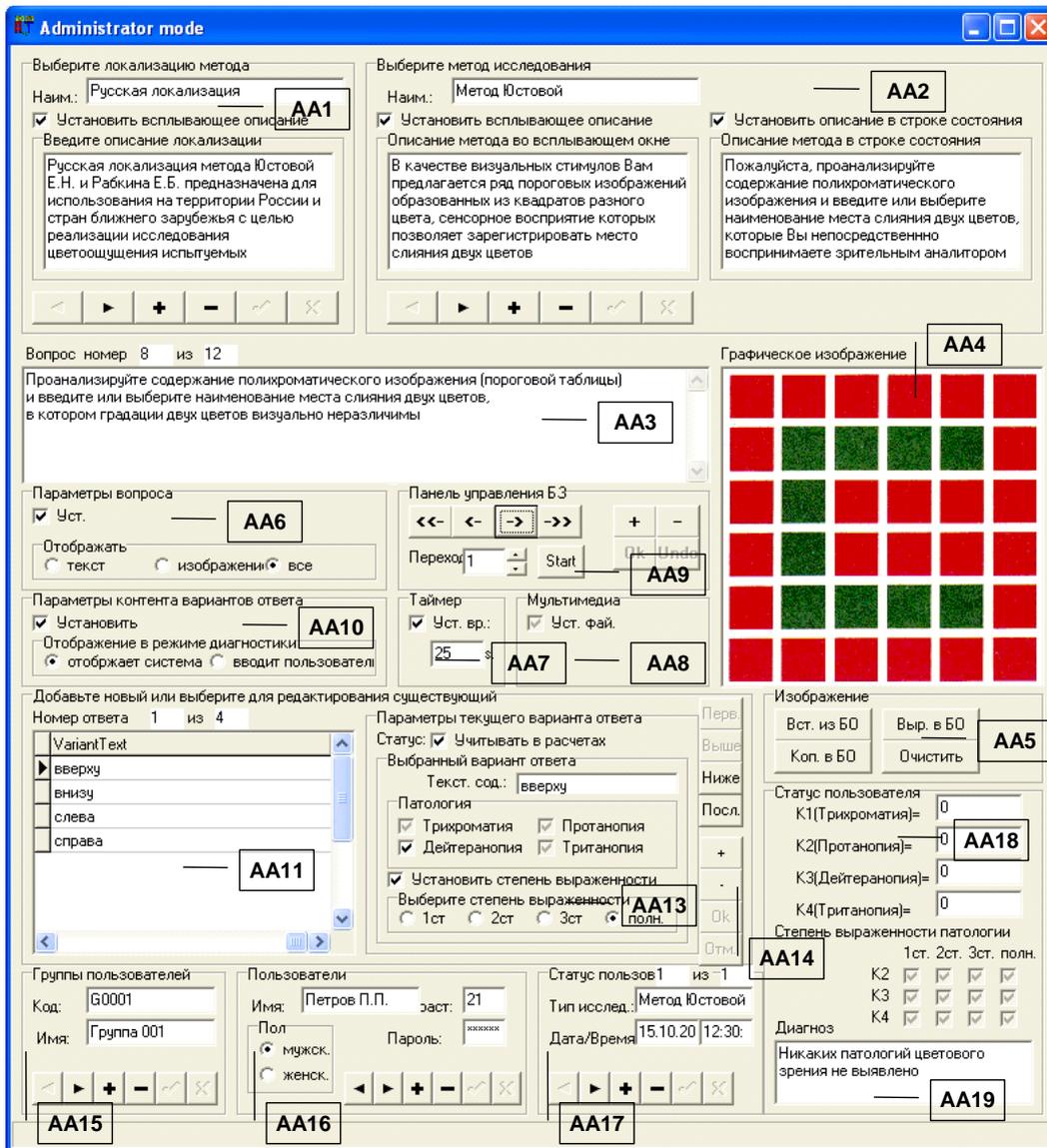
In the mode of diagnostics of LRKT there is the possibility of using of the various elements of interface for the providing of automation of the sequential selection and input of the valid variants of answer to each question, and also the realization of confirmation of the choice of the variants of answer on the question for the initialization of start of the algorithm of checking and transition to the following task: the field of displaying of the text (the textual content) of the formulation of question (BT1); the field of displaying of the text (the textual content) of the variants of answer (BT2); the field of displaying of the text of explanation in case of invalid variant of answer of the examinee (BT3); the button for the confirmation of the selected variants of answer on the current question initiating the transition to the next question of the method of research (test) (BT4) and the information panel of displaying of the status of examinee (the subject of training) (BT5).

In the process of the automated testing of LRKT the nominal values of coefficients are automatically calculated and the status of examinee is formed, and a posteriori data is stored in real scale of time into the database, that directly allows to provide the mathematical processing of a posteriori data by means of using of a diverse set of the statistical methods: the correlation, dispersion, regression, discriminant and factor analysis.

The applied diagnostic module

for the diagnostics of the individual features of the contingent of trainees

The applied DM is the inherent component of ATS with the properties of adaptation based on CM and realizes the diagnostics of parameters of CM of the subject of training (pic. 8) [3-7, 10].



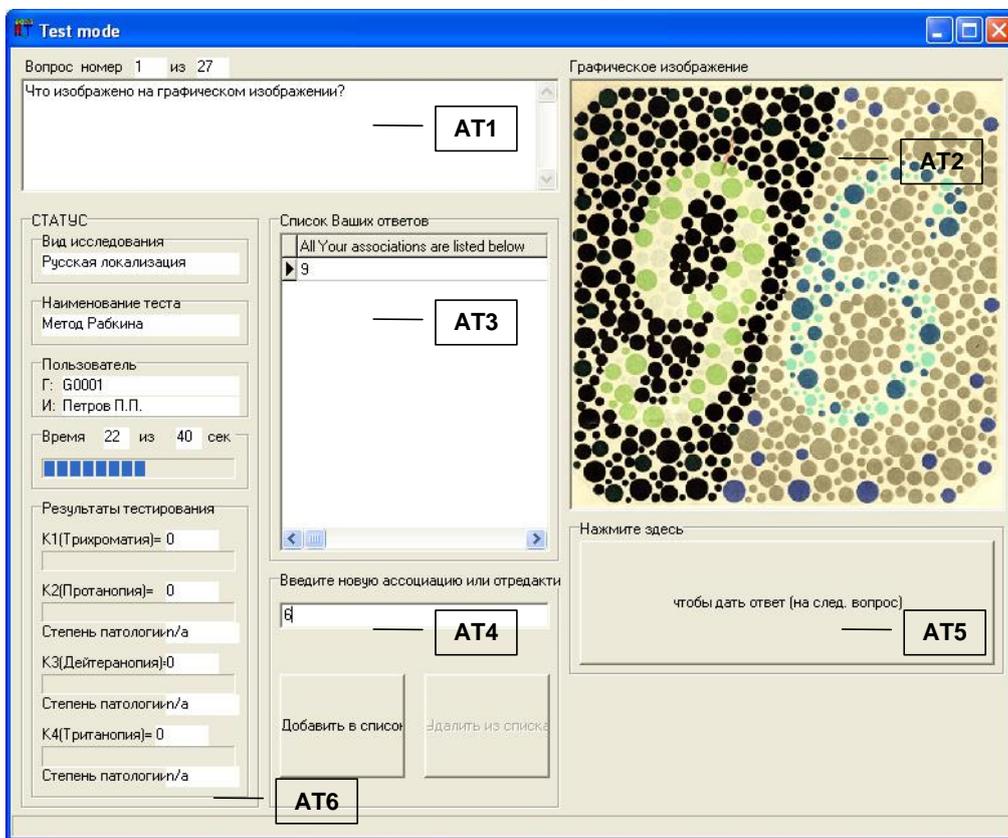
Pic. 8. The structure of interface of the basic diagnostic module

in the mode of administrating of the parameters of the method of research and the list of examinees

For the administrating of parameters of the method of research of the color-perception of Eustova E.N. and Rabkin E.B. a row of elements of the interface are used: the field of editing of the name and description of localization of the method of research (AA1); the field of editing of the name, description of the method of research in the pop-up window, the description of the method of research (test) in the line of status (AA2); the field of editing of the text of question (AA3); the field of graphic accompanying of the question (AA4); the control panel of picture (AA5); the panel of selector of the parameters of displaying of the content of question (AA6); the field of status of the timer for the accounting of the interval of time of the displaying of question (AA7); the field of status of the multimedia (AA8); the panel of navigation of the question (AA9);

the panel of selector of the parameters of displaying of the content of the variants of answer (AA10); the panel of displaying of the list of the variants of answer on the question (AA11); the panel of status of the accounting of the variant of answer in calculations, the modification of text (the textual content) of the variant of answer, the type of pathology (AA12) and the degree of its severity (AA13); the panel of navigation of the variants of answer on the question of the method of research (AA14); the panel of editing of the parameters of the groups of users (AA15); the panel of editing of the parameters of the list of users (AA16); the panel of switching of the attempts of passing of the diagnostics in the form of testing (AA17); the panel of displaying of the nominal values of coefficients, indicating the different pathologies of color-perception and the degree of their severity (AA18) and the panel of displaying and editing of the textual content of diagnosis (AA19).

On pic. 9 shows the image of interface of the applied DM in the mode of diagnostics.



Pic. 9. The interface of the applied diagnostic module

in the mode of diagnostics of the parameters of color-perception of examinee by the method of Rabkin E.B.

In the mode of diagnostics of the parameters of color-perception the interface of the applied DM contains: the field of displaying of the textual content of the formulation of question (AT1); the field of displaying of the graphical image in the formulation of question (AT2); the field of displaying of the list of the variants of answer of examinee on the given question (AT3); the field of displaying and deleting of the selected and the adding of a new variant of answer of the examinee (AT4); the button for the confirmation of the entered list of variants of answer on the given question, initiating the transition to the next task (AT5) and the panel of status of examinee (AT6).

The conclusions and results of practical use

1. The informatization of IEE is achieved due to the creation, introduction and use of the diverse means of automation of the technological process of controlled formation of knowledge, which allow to significantly increase the efficiency (resultativity) of production and non-production activity of the qualified specialists in the various spheres based on the innovations in the field of new information technologies.
2. The traditional approaches, methods and technologies are losing their actuality, that causes the emergence of the adaptive and individually-oriented environments and means.
3. Since 2003 y. in the result of many-years scientific work and the writing of dissertation, the author can develop the complex of programs for the automation of the tasks of research of IEE and the improving of efficiency of ATS with the properties of adaptation based on the parametrical CM block, which includes the different main components: ET, the basic and applied DM.
4. There was the successful practical use of the previously developed ET, providing the individually-oriented generation of educational influences based on the adaptive representation of information fragments processor.
5. The complex of programs is made by the block-modular principle and acts as the modernized by means of the replacing of various program modules: it provides the addition of new and removal of existing outdated procedures for the realization of diagnostics of the nominal values of the parameters of CM of the subject of training.
6. The technical description of the complex of programs for the various categories of users has been developed.
7. The practical use of theoretical and practical scientific results obtained by the author was directly carried out in the learning process of "The international banking institute" (Saint-Petersburg city) since 2004 y. and "The Saint-Petersburg state electrotechnical university "LETI"" since 2003 y., and in the course of the automated experiments and researches conducted by the author the acts about the practical use and the three copyright certificates were obtained [12].
8. The estimation of efficiency of ATS with the properties of adaptation based on the parametrical CM block was carried out using the generally-accepted indicators of efficiency (resultativity) of the controlled technological process of the automated formation of knowledge:

$$\mathbf{K} = \{k_1; k_2; k_3\} = \left\{ Y_2 - Y_1; \frac{Y_2}{Y_1}; \frac{Y_2 - Y_1}{Y_1} 100\% \right\}, \text{ where the coefficients } k_1, k_2, k_3$$

respectively denote the absolute, comparative and relative indicators of efficiency (resultativity) of the formation of knowledge of the trainee [12, 13], and the results of statistical processing of a posteriori data of a series of experiments are summarized in tabl. 1. The absolute, comparative and relative indicators of efficiency of the controlled technological process of the formation of knowledge of the contingent of trainees reflect on how many, in how many and on how much percents the nominal value of the result (LRKT) has changed relative to the base period.

Table 1

The results of primary statistical analysis of the resultativity of training

The indicator	The number of the group of trainees							
	1	2	3	4	5	6	7	8
The indicators of the resultativity of training for 2004 y.								
Size of sample	20	21	25	18	18	15	0	0
Average point Y_1	4,05	4,286	4,24	4,611	4,056	4,4	-	-
AQD of av. point	0,686	0,845	0,779	0,502	0,802	0,507	-	-
The indicators of the resultativity of training for 2005 y.								
Size of sample	24	22	24	25	24	22	23	21
Average point Y_2	4,333	4,046	4,375	4,16	4,042	4,091	4,696	4
AQD of av. 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 y. (with the use of CMT in 3 groups)								
Size of sample	26	23	29	24	25	22	22	22
Average point Y_3	4,5	4,609	4,379	3,708	3,92	3,773	4,455	3,818
AQD of av. point	0,707	0,656	0,775	0,751	0,572	0,612	0,858	0,853
The results of the primary statistical analysis								
The indicators, reflecting the change of efficiency of training for 2004-2005 y.								
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	-9,781	-0,345	-7,023	-	-
Change of AQD	0,131	-0,06	0,045	0,298	0,057	0,304		
The indicators, reflecting the change of efficiency of training for 2005-2006 y.								
k_1	0,167	0,563	0,004	-0,452	-0,122	-0,318	-0,241	-0,182
k_2	1,039	1,139	1,001	0,891	0,97	0,922	0,949	0,955
$k_3, \%$	3,854	13,915	0,091	-	-3,018	-7,773	-5,132	-4,55
Change of AQD	-0,11	-0,129	-0,049	-0,049	-0,287	-0,199	0,299	-0,041

9. The application of the correlation and dispersion analysis did not reflect the significant and interesting scientifically-based tendencies, dependencies and regularities.

10. In the result of the conducted regression analysis of a posteriori data 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 \hat{Y}_i (the estimation of LRKT) is determined by the variation in the nominal values of the coefficients (predictors) K_i located in the obtained linear model of multiple regression $\hat{Y}(K_i)$.

The nominal values of the initial (β) and standardized coefficients (β') of the linear model of multiple regression $\hat{Y}(K_i)$ are presented in tabl. 2-3. The constant is 4.653.

Table 2

The values of initial β and standardized coefficients β'

The predictor	Vozr	K_7	K_8	K_9	K_{14}	K_{15}	K_{16}	K_{17}	K_{18}	K_{19}
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 - coefficients	-0,017	-0,010	-0,714	0,611	0,247	-0,104	0,034	-0,262	0,159	-0,052

Table 3

The initial β and standardized coefficients values β' (continue)

The predictor	K_{20}	K_{21}	K_{22}	K_{23}	K_{24}	K_{25}	K_{27}	K_{28}	K_{29}	K_{45}
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 - coefficients	-0,147	0,002	0,182	0,052	0,052	-0,113	-0,226	-0,018	0,172	0,037

The factor (dependent variable) acts as directly the resultativity of technological process of the formation of knowledge of the contingent of trainees Y , and the predictors in the obtained linear model of multiple regression are: Vozr – age, K_7 – protanopia, K_8 – deuteranopia, K_9 – tritanopia, K_{14} – verbal intelligence, K_{15} – generalization, K_{16} – classification, K_{17} – analyticity, K_{18} – arithmetic account, K_{19} – combinatorics, K_{20} – mnemonics and memory, K_{21} – planar thinking, K_{22} – volumetric imagination, K_{23} – verbal associativity, K_{24} – verbal originality, K_{25} – verbal selectivity, K_{27} – figurative associativity, K_{28} – figurative originality, K_{29} – figurative selectivity and K_{45} – the level of proficiency in the language of statement in the subject of studying (discipline).

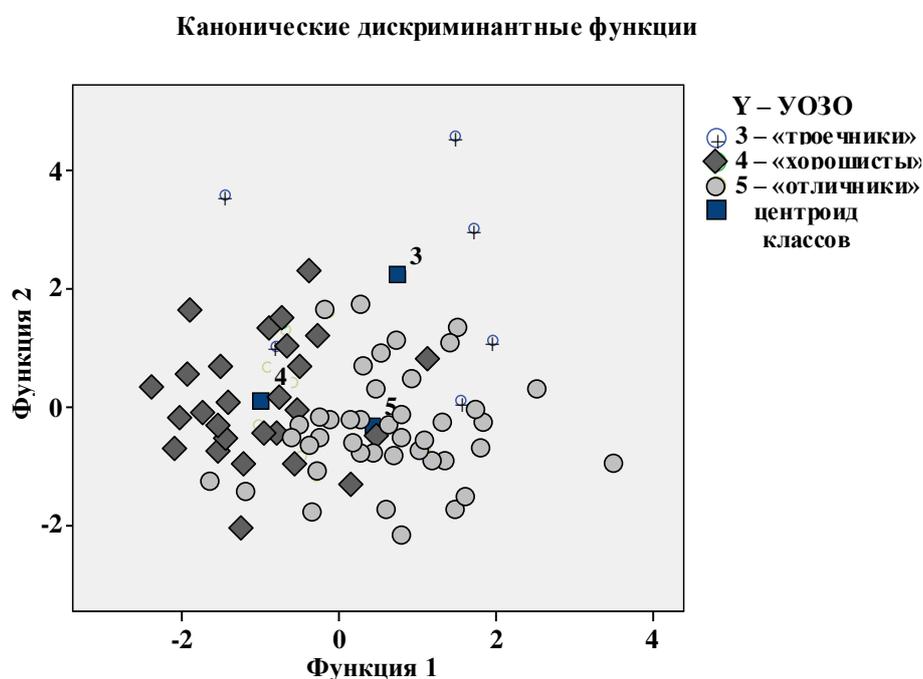
Then the linear equation of multiple regression takes the following view:

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

11. CMT allows to realize the additional contour of adaptation in ATS based on the parametrical CM block, and also quickly carry out the complex system analysis of IEE, directed on the increasing of efficiency of the information interaction between the diverse subjects of training and the means of training and to provide the increasing of resultativity of the controlled technological process of the formation of knowledge of the trainees in the process of functioning of ART system.

12. In the course of the discriminant analysis the several groups of trainees were allocated in dependence from the dynamics of the nominal value of the indicator of resultativity 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".

Pic. 10 reflects the geometrical interpretation of the mutual relative arrangement of the centroids of classes corresponding to the selected groups of trainees in the given space of coordinate of the two canonical discriminant functions.



Pic. 10. The centroids of the three classes of trainees in the space of two canonical discriminant functions

The informativity of both canonical discriminant functions is approximately the same, and their resolution is significantly differentiated in relation to the centroids of classes: the first canonical discriminant function allows to distinguish the centroids of the classes of "mediocre-students" and "good-students" relative to the centroid of the class "excellent-students", but poorly distinguishes between the centroids of the classes of "mediocre-students" and "good-students"; the second canonical discriminant function allows to distinguish the centroids of the classes "good-students" and "excellent-students" relative to the centroid of the class "mediocre-students", but poorly distinguishes between the centroids of the classes "good-students" and "excellent-students".

The complex of programs directly allows to realize the automation of the tasks of research and the system analysis of IEE, the information interaction between the subjects of training and the means of training, and also to significantly to increase the efficiency of functioning of ATS with the properties of adaptation based on the parametrical CM block.

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**ПРОГРАММНЫЙ КОМПЛЕКС ДЛЯ ЗАДАЧ ИССЛЕДОВАНИЯ
АДАПТИВНОЙ СРЕДЫ АВТОМАТИЗИРОВАННОГО ОБУЧЕНИЯ
НА ОСНОВЕ КОГНИТИВНЫХ МОДЕЛЕЙ**

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Программный комплекс предназначен для автоматизации системного анализа информационной среды автоматизированного обучения со свойствами адаптации на основе параметрических когнитивных моделей и включает: электронный учебник на основе процессора адаптивной репрезентации информационных фрагментов, учитывающий индивидуальные особенности субъектов обучения и потенциальные технические возможности средств обучения; основной диагностический модуль для тестирования уровня остаточных знаний обучаемых и прикладной диагностический модуль для обеспечения автоматизации процесса исследования параметров когнитивных моделей субъектов обучения

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