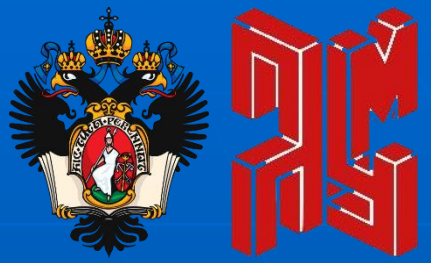
“The Saint-Petersburg state university”
the faculty “Applied mathematics – control processes”
the chair “Information systems”



The theme of dissertation:

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

on the competition of scientific degree of the candidate of technical sciences
on the spec. 05.13.01 – “The system analysis, control and information processing”

The chairman of “The dissertation council”:
the head of the chair “Modeling of electromechanical and computer systems”,
“The honorary professor of "SPbSU"”, d.ph.-m.s., prof. *Egorov Nikolay Vasilyevich*.

The scientific supervisor: the prof. of the chair “Information systems” of “SPbSU”,
the member of “The American mathematical society”,
d.ph.-m.s., prof. *Kvitko Alexander Nikolaevich*.

The applicant: the author of the unique cognitive modeling technology
for the system, financial and complex analysis *Vetrov Anatoly Nikolaevich*.

The Russian Federation, Saint-Petersburg city, 2019 y.

"The Saint-Petersburg state university"
the faculty "Applied mathematics – control processes"
the chair "Information systems"

The plan of the meeting of "The dissertation council":

I. The opening speech of the members of "The dissertation council".
II. The scientific report with multimedia-presentation of the reporter (applicant).
III. The answers the questions of the foreign and national members of "The dissertation council".
IV. The performances of the members of "The dissertation council", the representative of the opposing (leading) organization, the official opponents and the scientific supervisor.
V. The vote of the members of "The dissertation council".
VI. The concluding remarks of the chairman and the members of "The dissertation council".

on the dissertation

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Part I. The opening speech of the members of “The dissertation council”

The chairman of “The dissertation council”:
the head of the chair “Modeling of electromechanical and computer systems”,
“The honorary professor of "SPbSU"”, d.ph.-m.s., prof. *Egorov Nikolay Vasilyevich*.

The scientific secretary of “The dissertation council” :
the prof. of the chair “Modeling of electromechanical and computer systems”,
d.ph.-m.s., prof. *Kurbatova Galina Ibragimovna*.

The secretary of “The dissertation council” :
the associate prof. of the chair “Modeling of electromechanical and computer systems”,
c.ph.-m.s., associate prof. *Varayun Marina Ivanovna*.

The Russian Federation, Saint-Petersburg city, 2019 y.

"The Saint-Petersburg state university"
the faculty "Applied mathematics – control processes"
the chair "Information systems"

Part II. The scientific report with multimedia-presentation of the reporter (applicant) on the dissertation

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

on the competition of scientific degree of the candidate of technical sciences
on the spec. 05.13.01 – "The system analysis, control and information processing"

The reporter (applicant): the author of the unique cognitive modeling technology for the system, financial and complex analysis *Vetrov Anatoly Nikolaevich*.

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The existing contradictions and the priority aspects of informatization

- the technologies, being the basis of the existing means of training and training-methodical complexes practically do not take into account the features of information processing by the trainee as the subject of training;
- the improvement of organization and technology of the process of the automated training causes the need of the analysis of efficiency of functioning of the information-educational environment with taking into account of the individual features of the subjects of training (physiological, psychological, linguistic and etc.);
- the requirements to modern information-educational environments 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 relevance of the theme of dissertation research

is explaining by the evolution of priorities from 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, the need of creation of the universal scientific approach (method and technology) to the assessment of quality of training, and also continuous development and innovations in the field of the information technologies.

The purpose of research is

the increase in the efficiency of functioning of the information-educational environment of the automated (remote) training system due to realization of the 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.

The object of research

the information-educational environment of the automated (remote) training system of educational establishment.

The subject of research

the automated (remote) training system with the properties of adaptation based on the parametrical cognitive models block.

The methods of research

- 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 tasks of research (dissertation research)

The achievement of the purpose of research realizes **the complex of research tasks**

- the analysis of theoretical bases of construction of the automated IEE of the adaptive training with the model of subject of training at the base of the theory of automatic control, organizational models and technologies of interaction of subjects with means of training;
- the development of the structure of IEE of the automated (remote) training system with the properties of adaptation based on the parametrical cognitive models block;
- the creation of the cognitive modeling technology for the system analysis and increase of efficiency of functioning of the automated information-educational environment;
- the synthesis of the parametrical cognitive models block as inf. basis of the system analysis: the formation of the CM of subject of training and the CM of means of training in the basis of the IEE of ART;
- the realization of the complex of programs for the automation of research tasks, including: the adaptive electronic textbook, the basic and applied diagnostic modules.

The main scientific results, submitted on defence:

- the structure of information-educational environment and principles (algorithms) of functioning of components of the automated (remote) training system with the properties of adaptation based on the parametrical CM block **[slides 1.1–1.8.3]**;
- the cognitive modeling technology, including the technique of its use, the recommended innovative bases (models) and the algorithm of formation of the structure of cognitive model, the techniques of research of the parameters of cognitive models and the algorithm of processing of a posteriori data of testing **[slides 2.1.1–2.7.2]**;
- the structures of the cognitive models of subject of training and the means of training **[slides 3.1–3.8]**;
- the complex of programs, including the adaptive electronic textbook (the individually-oriented generation of educational influences by means of the adaptive representation of information fragments processor), the basic diagnostic module (the estimation of the level of residual knowledge of a trainee) and the applied diagnostic module (the diagnostics of parameters of the cognitive model of subject of training) **[slides 4.1.1–4.20.1]**;
- the statistical justification of practical use of the received results (by means of preliminary processing of a posteriori data, the secondary processing of selections of a posteriori data: some results of the regression analysis, the discriminant analysis, multidimensional scaling and the factor analysis) (*) **[slides 5.1-5.6.2]**.

The reliability of the scientific results of dissertation research is confirmed by:

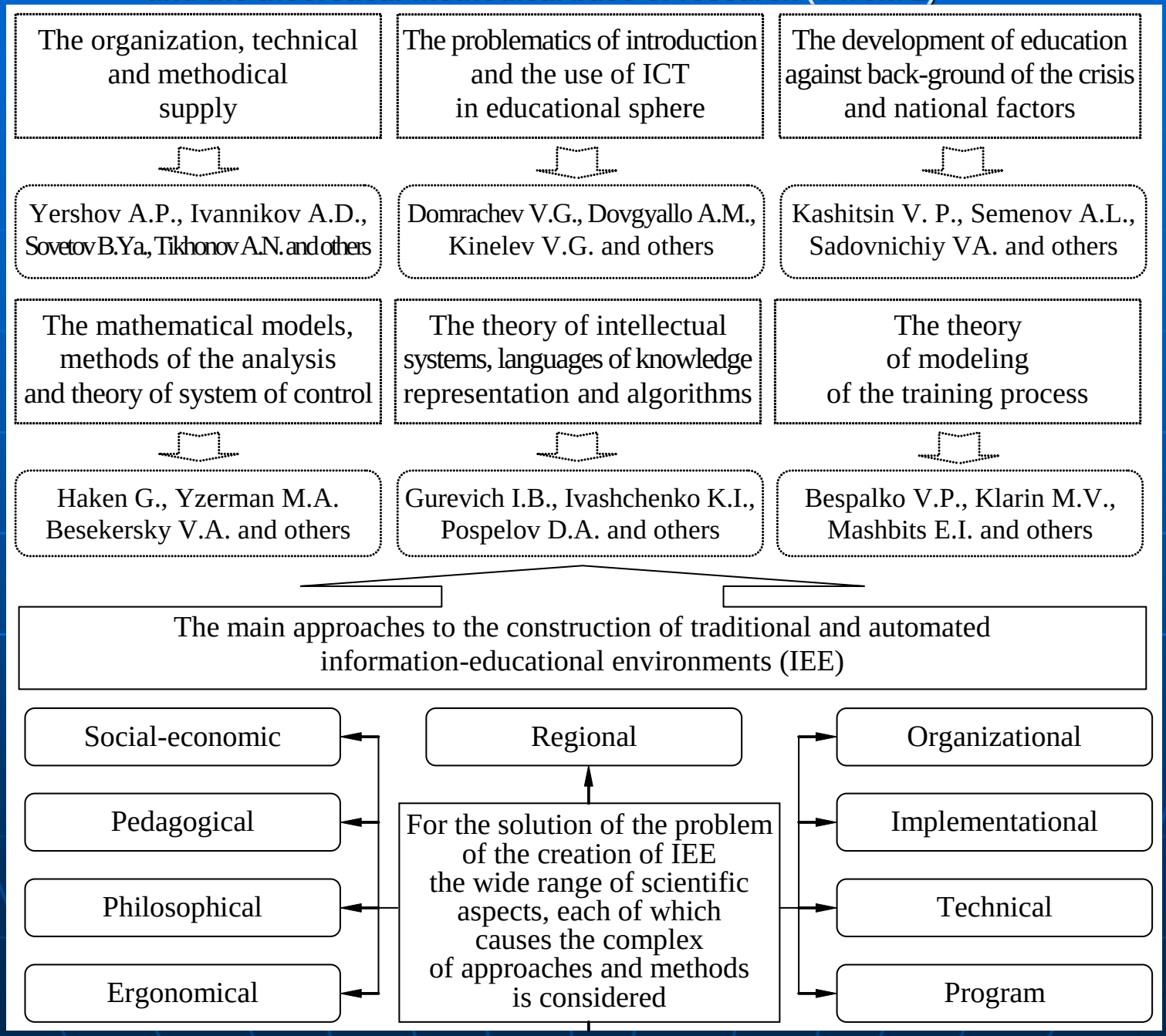
- the system approach to the description of the selected difficult object of research;
- the correct use of fundamental provisions of the theory of information, physiology of sensory systems, cognitive psychology, applied linguistics and ergonomics;
- the approbation of elements of the dissertation on seminars and conferences "IHEAS" and "RAS";
- the introduction of results in learning process of "SPbSETU "LETI"" and "IBI", the reasonable application of experimental methods and the strict logic of carrying out of experiment;
- the results of statistical processing of a posteriori data, training of 10 diploma students.

The basic results of diss. were publ. in 52 on 2007 y. (106 on 2012 y.) [265 on 2018 y.] scientific works:

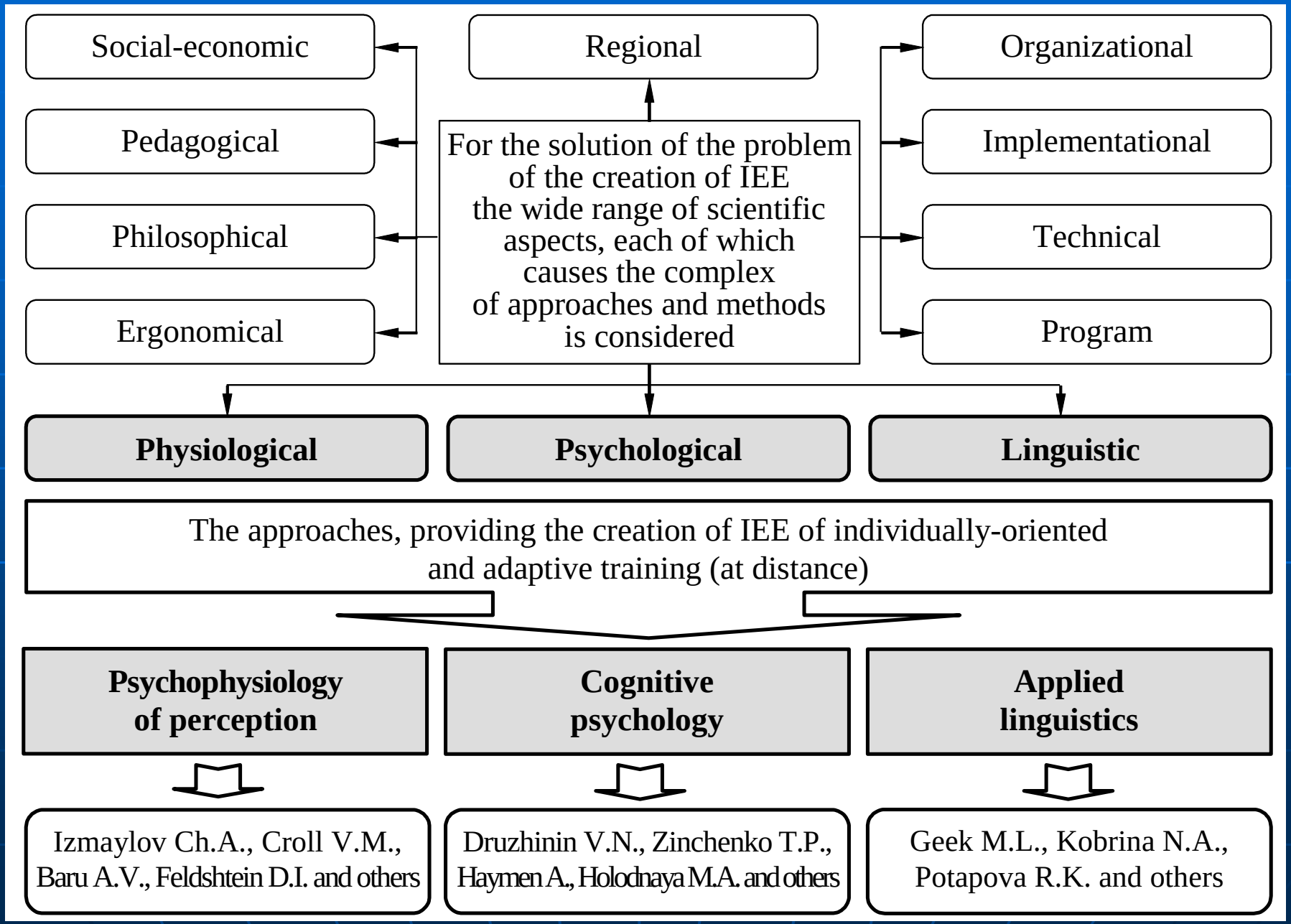
- 01 textbook and 03 methodical instructions to lab. works on the discipline "Computer science";
- 01 textbook (10 volumes) on the discipline "Finance, monetary circulation and credit";
- 02 units in 01 coll. scientific monography of "IHEAS" (with formal coauthors-teachers);
- 04 (10) learning manuals and scientific monographies (with coauthors-diploma-students);
- 12 (29) [49] learning manuals and scientific monographies (without coauthors);
- 01 (02) report(s) on the individual initiative SRW (2003-2005 y. and 2006-2008 y.);
- 01 appendix to the report on the individual initiative SRW (2003-2005 y.);
- 05 (09) [14] scientific articles in scientific journals, recommended by "HSAC of RF", from them 00 (05) scientific articles were deposited in ""VINITI" of "RAS"";
- 22 (48) [182] scientific reports in materials of 11 (24) [39] int. scientific conferences;
- 04 copyright certificates about deposition and registration of works – objects of intellectual property in "RAS" (RF, Moscow city).

In 2005-2007 y. (2012 y.) [2018 y.] the norm for the candidate (doctor) of techn. sciences is executed (it was required 02 (10) scientific articles in scientific journals from the list of "HAC of RF").

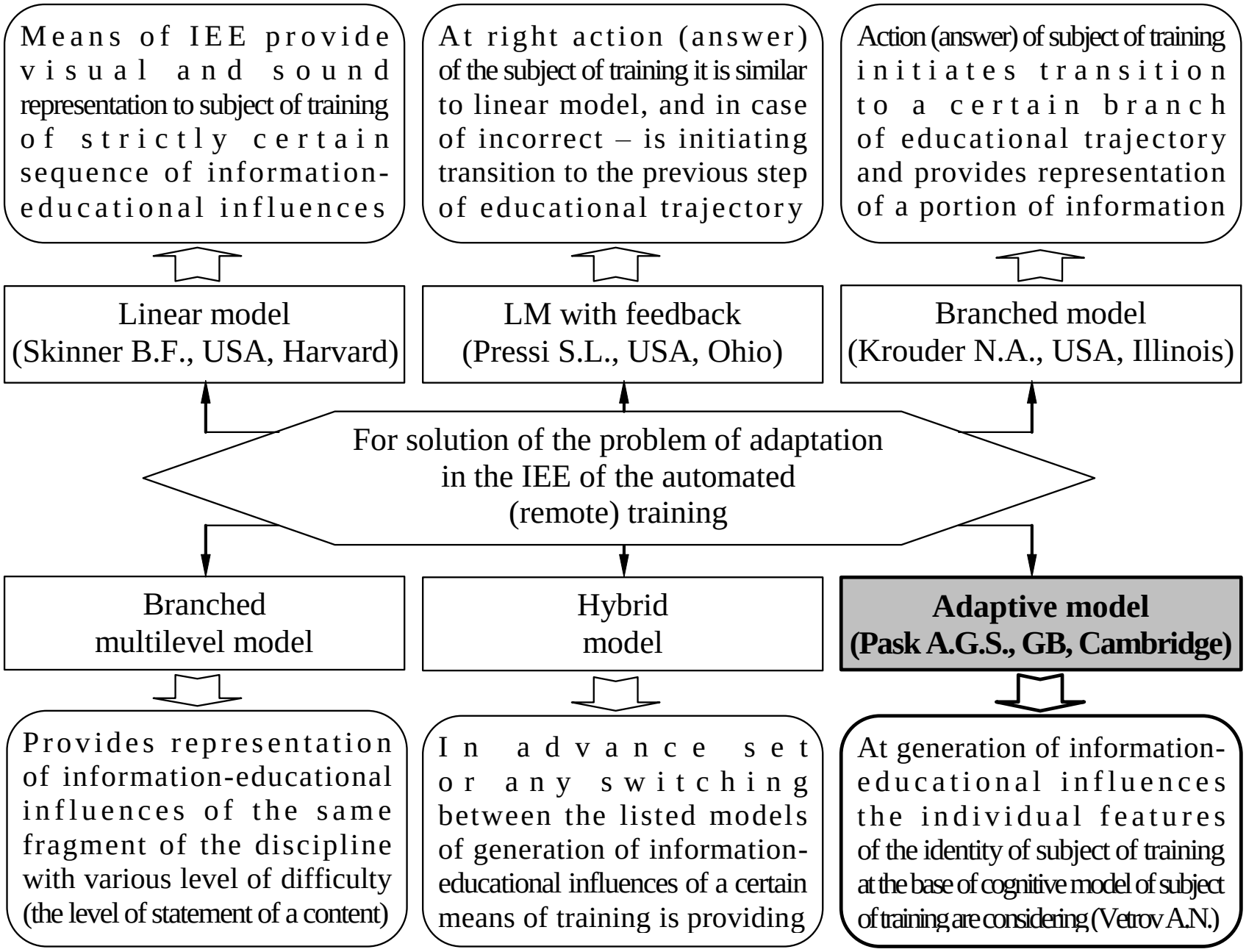
The scientific aspects of informatization of the information-educational environment and the theoretical-methodical base of research (1 from 2)



The scientific aspects of informatization of the information-educational environment and the theoretical-methodical base of research (2 from 2)



The models of organization of interaction of the subjects and means of training for a solution of the problem of adaptation in the information-educational environment



The technologies of organization of interaction of the subjects and means of training for a solution of the problem of adaptation in the information-educational environment

Classical technologies of the organization of ART are not oriented on individualization of training and do not meet modern requirements to IEE of a new generation

- Class-lesson technology
- Design-group technology
- Technology of the correspondence training

Individual orientation of information interaction between the subjects and means of training in IEE is reaching due to the use of a set of technologies

Technology of the individual training	Technology of the individualized training	**Technology of the adaptive training**
Realizes the topological scheme of information interaction "subject – means of training – (teacher)" at studying of educational trajectory in IEE	Allows to take into account individual features of the identity of subjects of training during the educational process, realized in the traditional or IEE of ART	Allows to realize the contour of adaptation in IEE of ART based on parametrical cognitive models block of subject and means of training, offered in this work

The complex approach to the synthesis of the information-educational environment of the automated training with the properties of adaptation based on the parametrical cognitive models block (1 from 2)

The solution of a complex task of the synthesis of the information-educational environment (IEE) of the automated training with the properties of adaptation based on the cognitive models block

The entering of modifications into structure, organization and technology of training

The automated training system with the properties of adaptation based on CM

The entering of new components into the automated training system

Additional actions in the organization and technology of ART

The modifications of the electronic textbook (ET)

The modifications of the diagnostic module (DM)

The parametrical cognitive models block

The modified structure of information environment of the automated training of establishment

The modified principle (algorithm) of functioning of the electronic textbook for the realization of adaptation

The modified principle (algorithm) of functioning of the diagnostic module for the diagnostics of IFPST

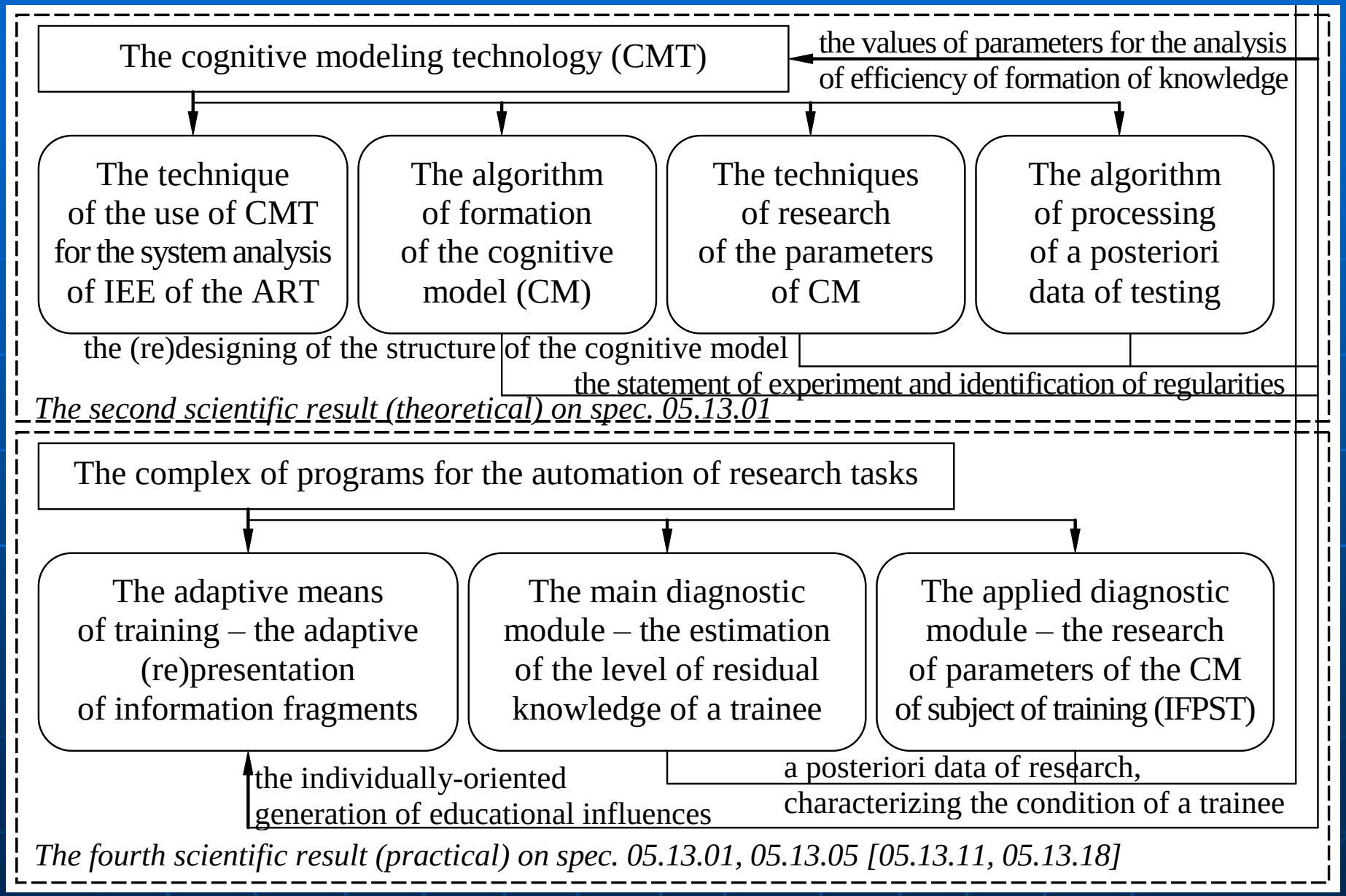
The first scientific result (theoretical) on spec. 05.13.01

The cognitive model of subject of training

The cognitive model of means of training

The third scientific result (theor.) on spec. 05.13.01 and 19.00.02

The complex approach to the synthesis of the information-educational environment of the automated training with the properties of adaptation based on the parametrical cognitive models block (2 from 2)



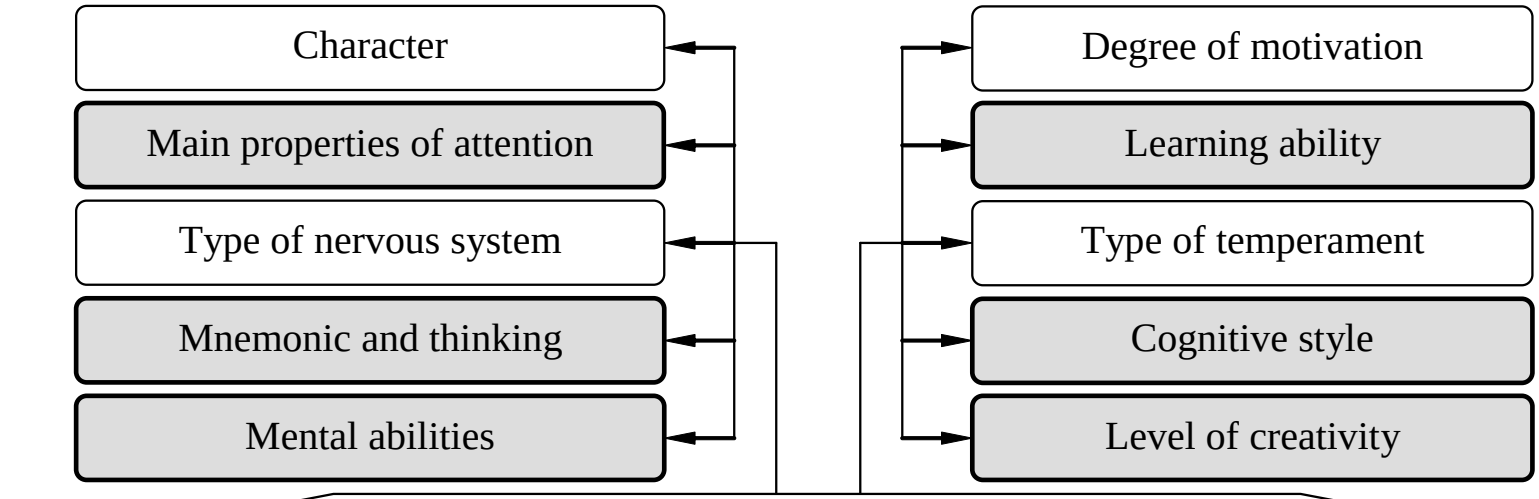
The main requirements presented to the structure of the cognitive modeling technology and the cognitive models

The synthesis of the automated training system with the properties of adaptation based on the parametrical cognitive models block demands the elaboration of complex approach

The modification of structure and principles (algorithms) of functioning of the components of automated training system for the realization of adaptation based on the cognitive models block

The cognitive modeling technology (CMT)	The technique of use of CMT and the algorithm of formation of the cognitive model	The cognitive models of subject of training and means of training
Is universal in relation to the object of research, represents the iterative cycle, including a set of stages and allowing not only to receive the primary representations, but also to carry out the structural analysis	Are developed for the formalization of the sequence of the use of the cognitive modeling technology with the purpose of construction the structure of cognitive model for the tasks of the system analysis of information-educational environment	Concentrates in the own basis a set of the parameters, characterizing the IFPST (the CM of subject of training) and the technical capabilities of means of training, on the basis of which the generation of information-educational influences (the CM of means of training) is realized

The main requirements presented to the structure of the cognitive models of subject of training and means of training

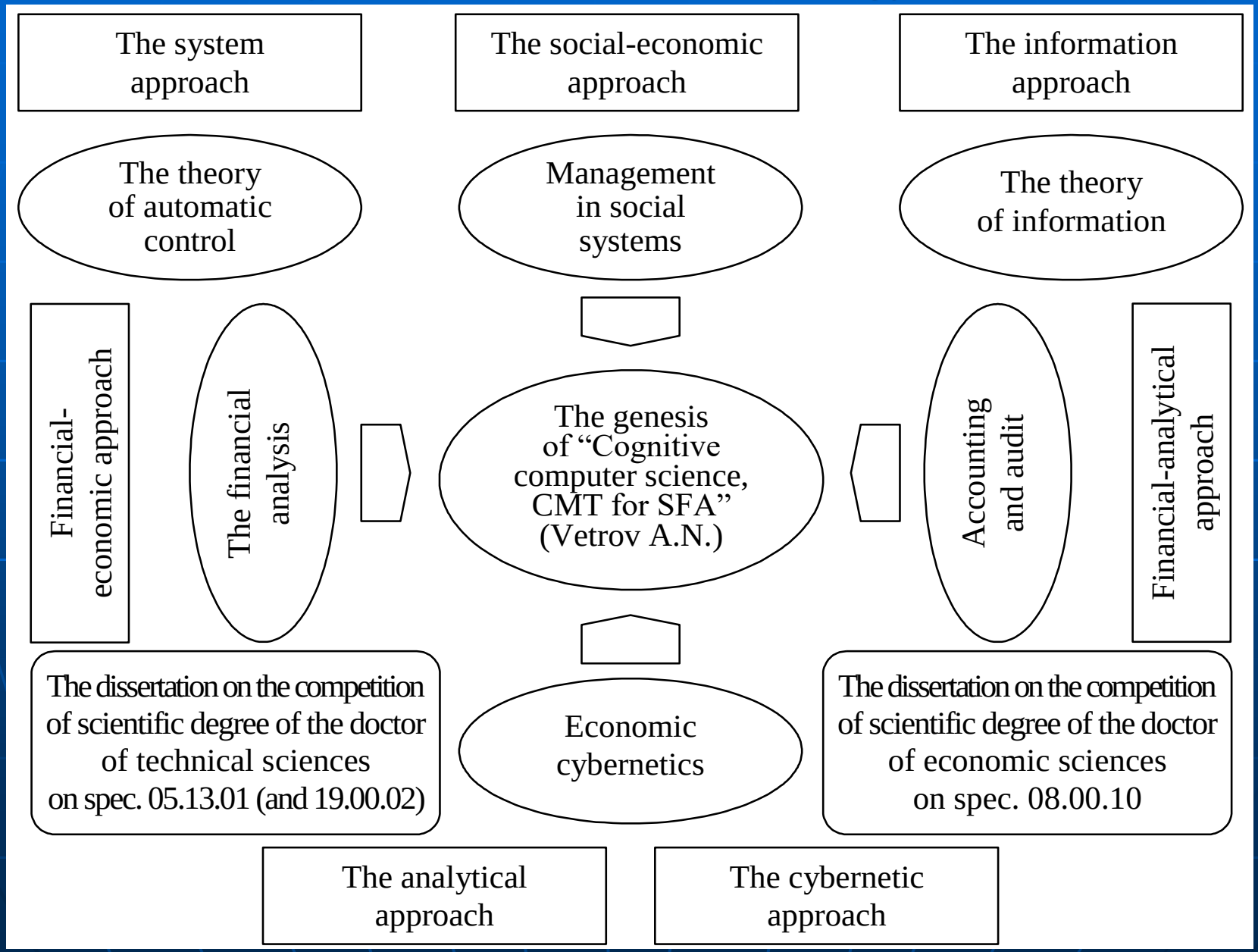


Realization of technology of the adaptive training initiates accounting of specific features

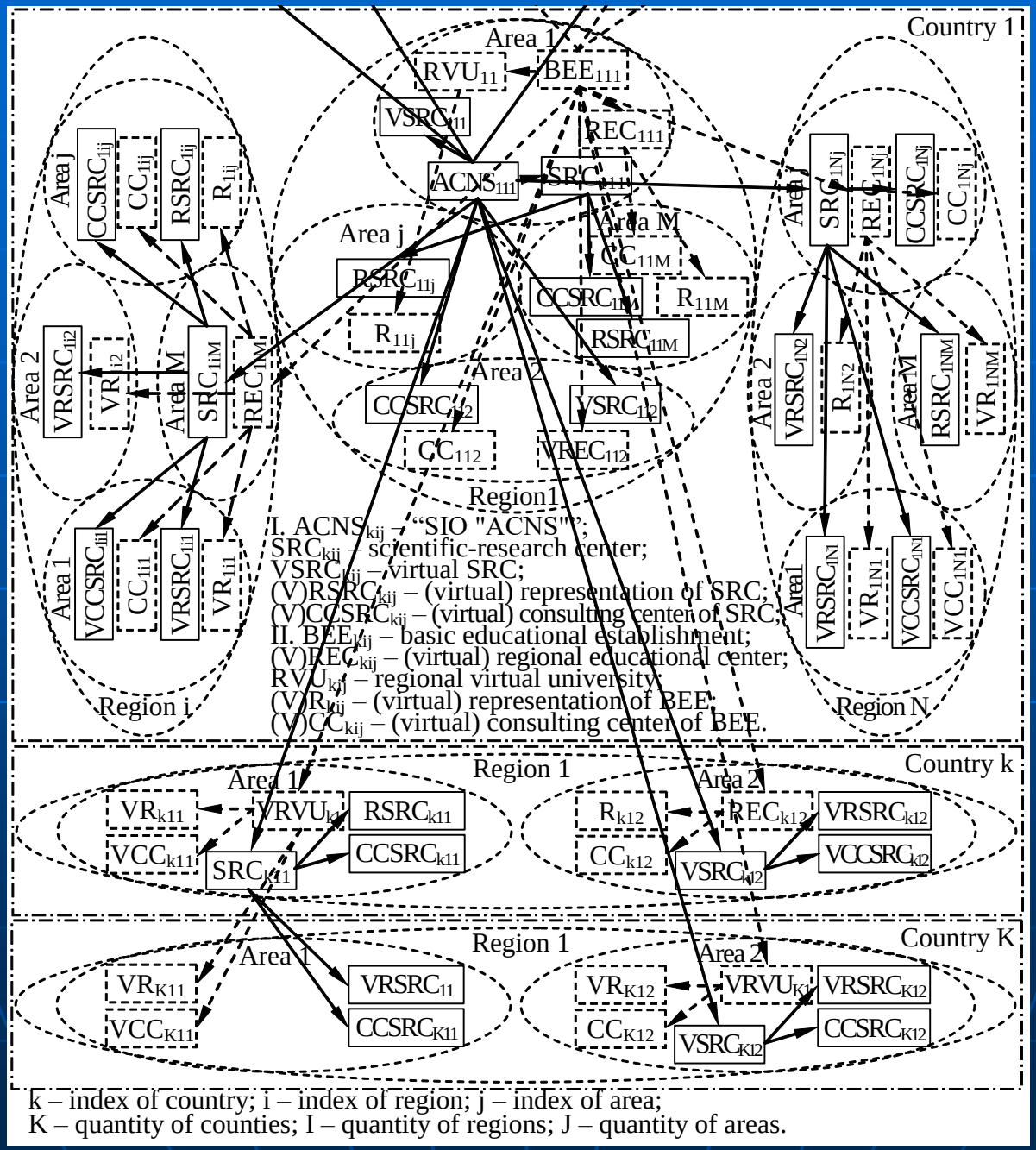
At developing of the structure of the cognitive model it is necessary to take into account a set of specific requirements

Relevance	Adequacy	Solvency
IEE must consider only those individual features of the subject, which are essential for achievement of the planned purposes of the training process with taking into account IFPST	IEE must provide the compliance of model of subject to its original, is extremely important division of steady and situational individual features of subjects and means	IEE must support the quasidynamic updating of model of the subject of training due to systematic updating and accumulation of data about his condition

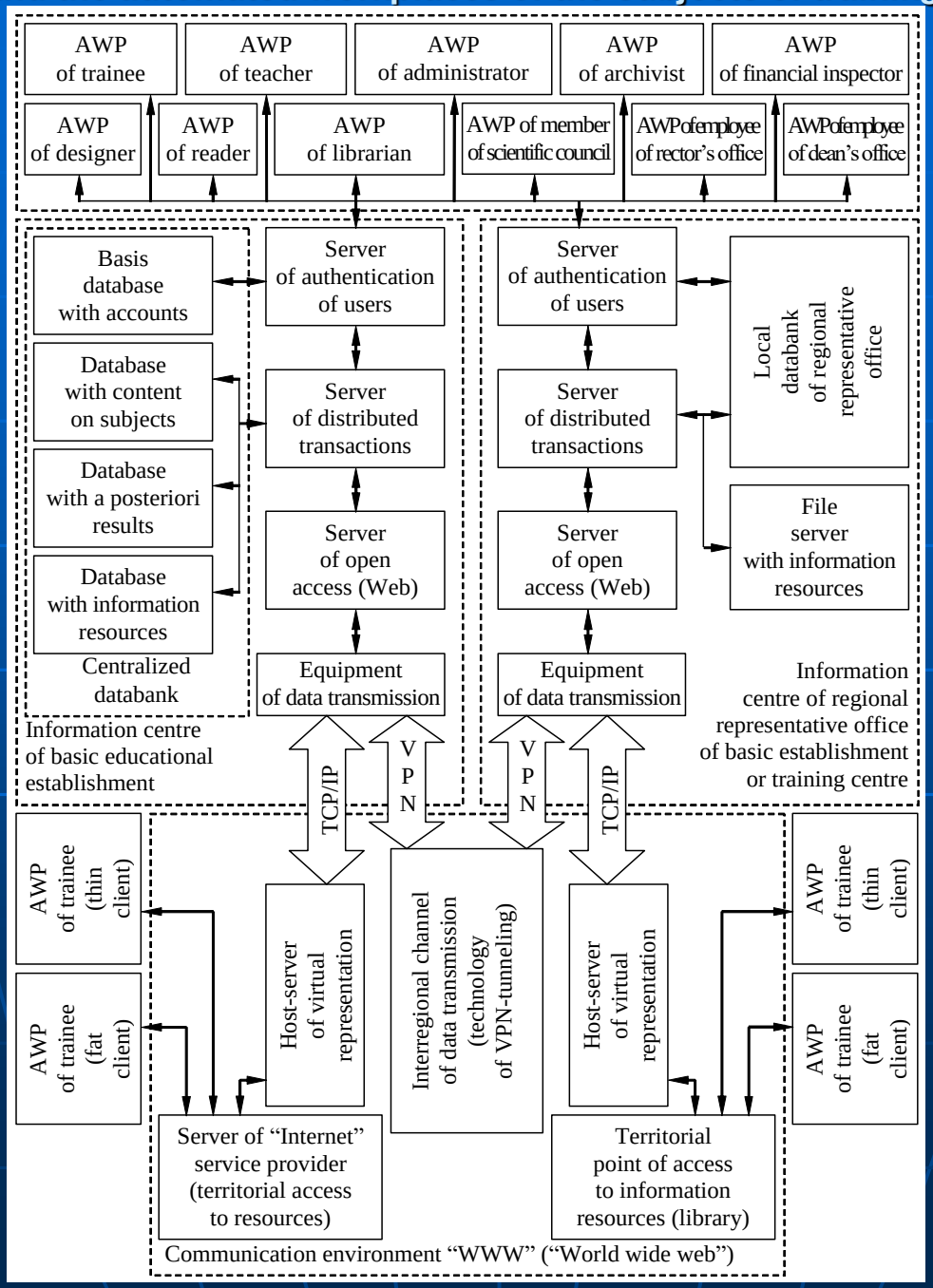
The genesis of "Cognitive computer science, the cognitive modeling technology for the system and financial analysis" as new (academic) scientific direction (according to the decision of "The Presidium of "The Russian academy of natural science"", the protocol №699 from the 08th of June 2018 y.)



The structure of the territorially distributed information-educational environment: as the example of the geographically distributed (countries), regions and areas

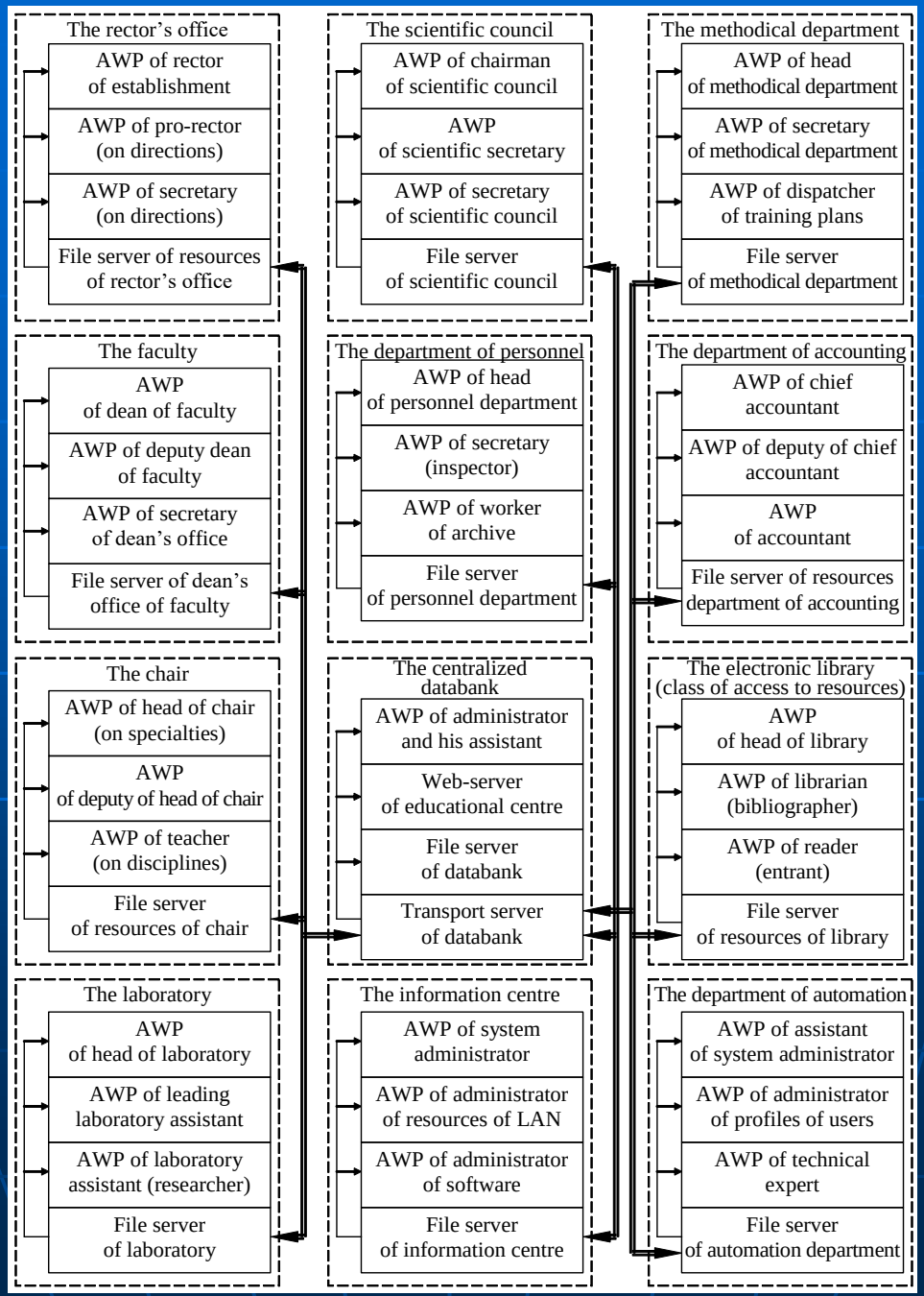


The standard scheme of interaction of the information centre of educational establishment and the automated workplaces of the subjects of training

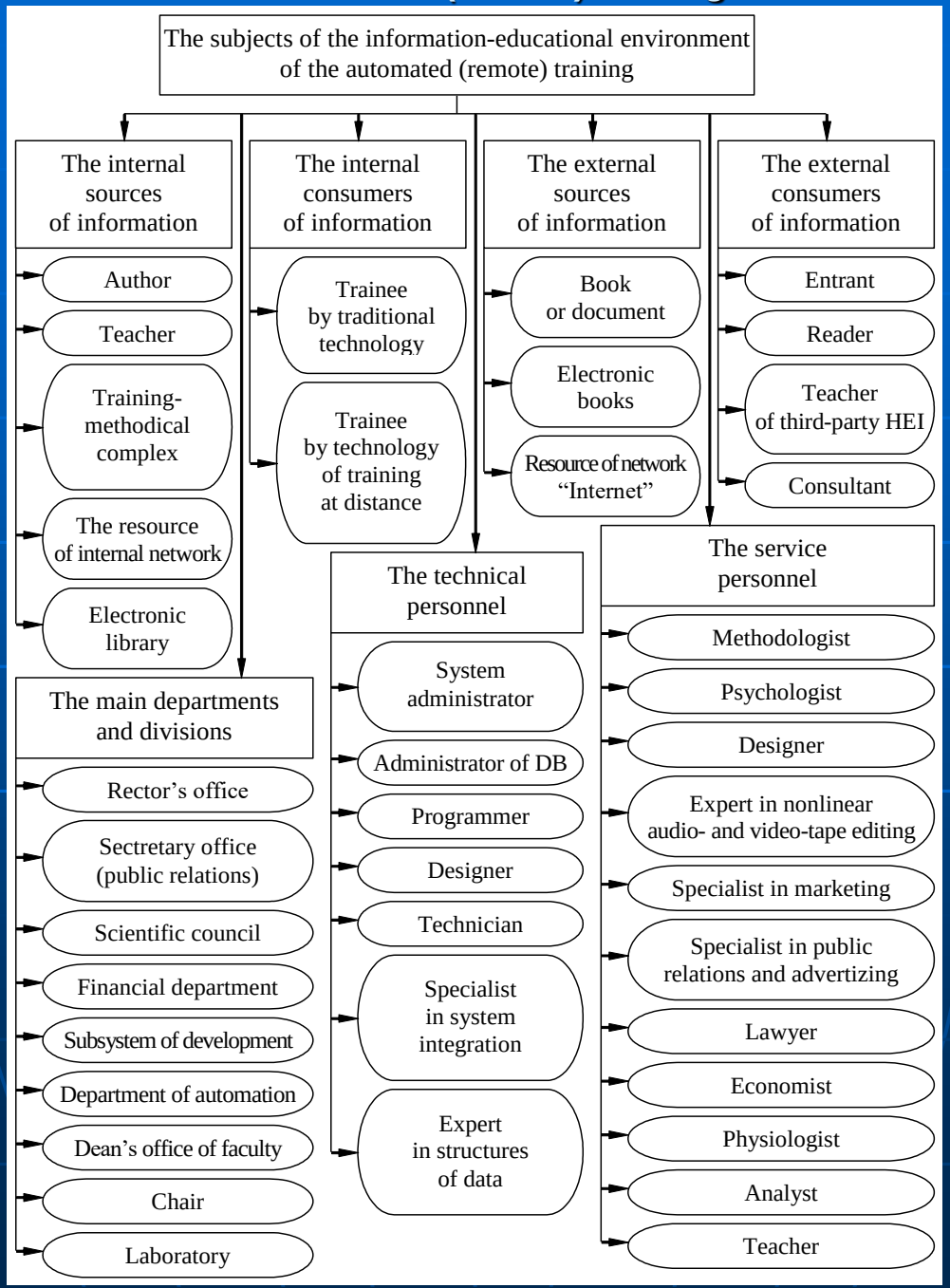


The standard scheme of interaction of the automated workplaces of the subjects of the information environment of educational establishment

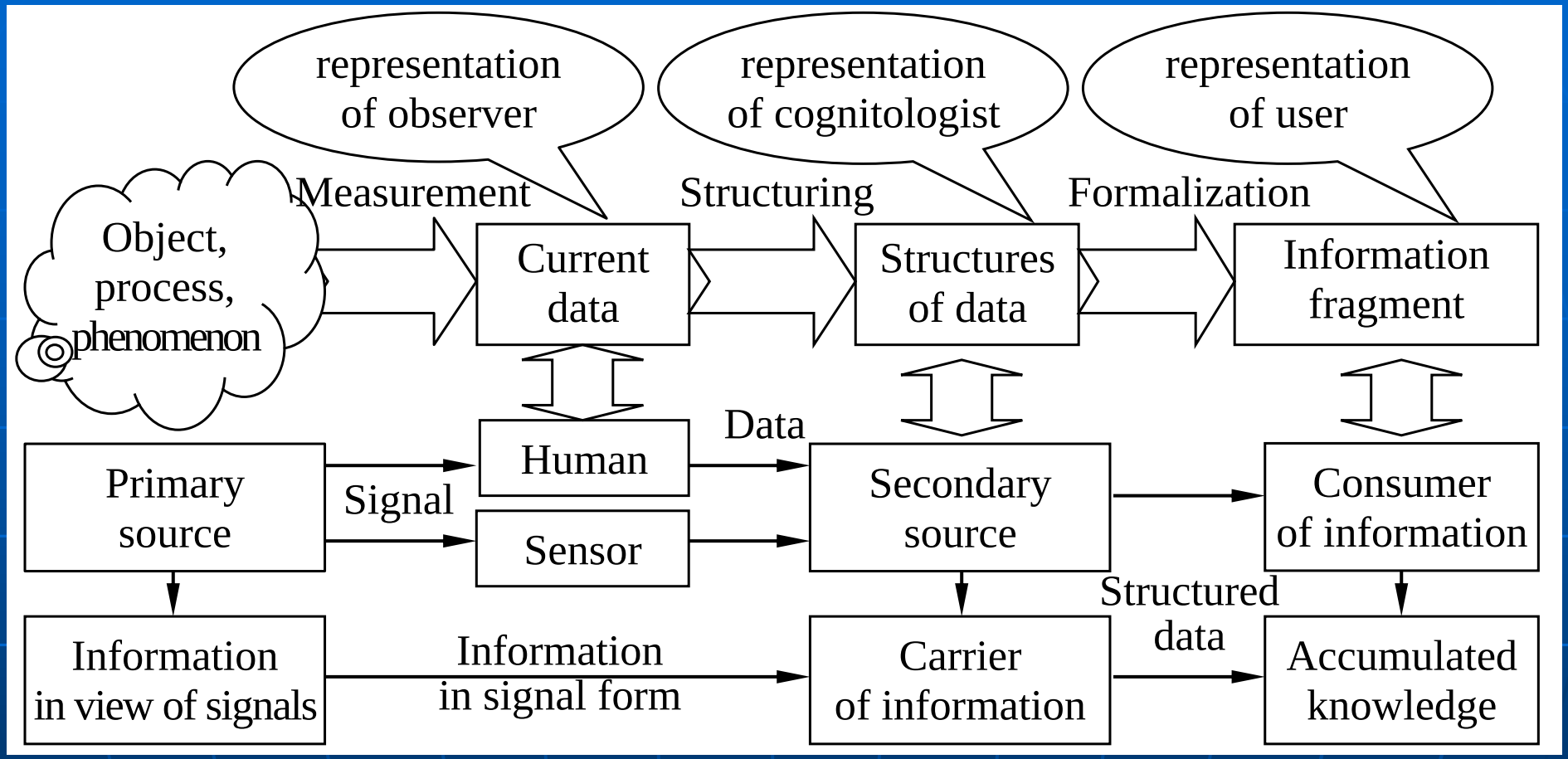
1.2.2



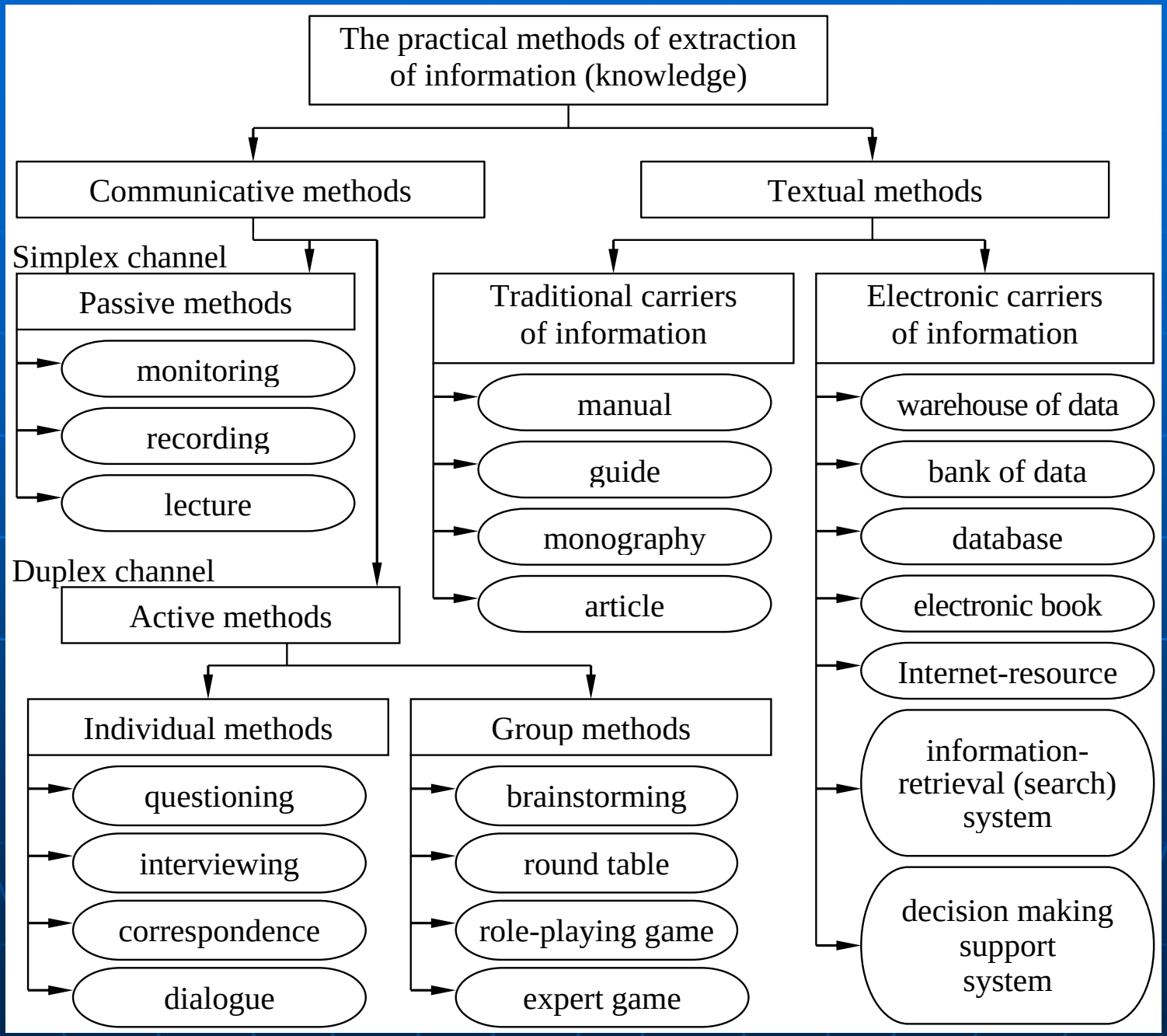
The classification of the subjects of the information-educational environment of the automated (remote) training



The transformation of information in the technological process of formation of knowledge

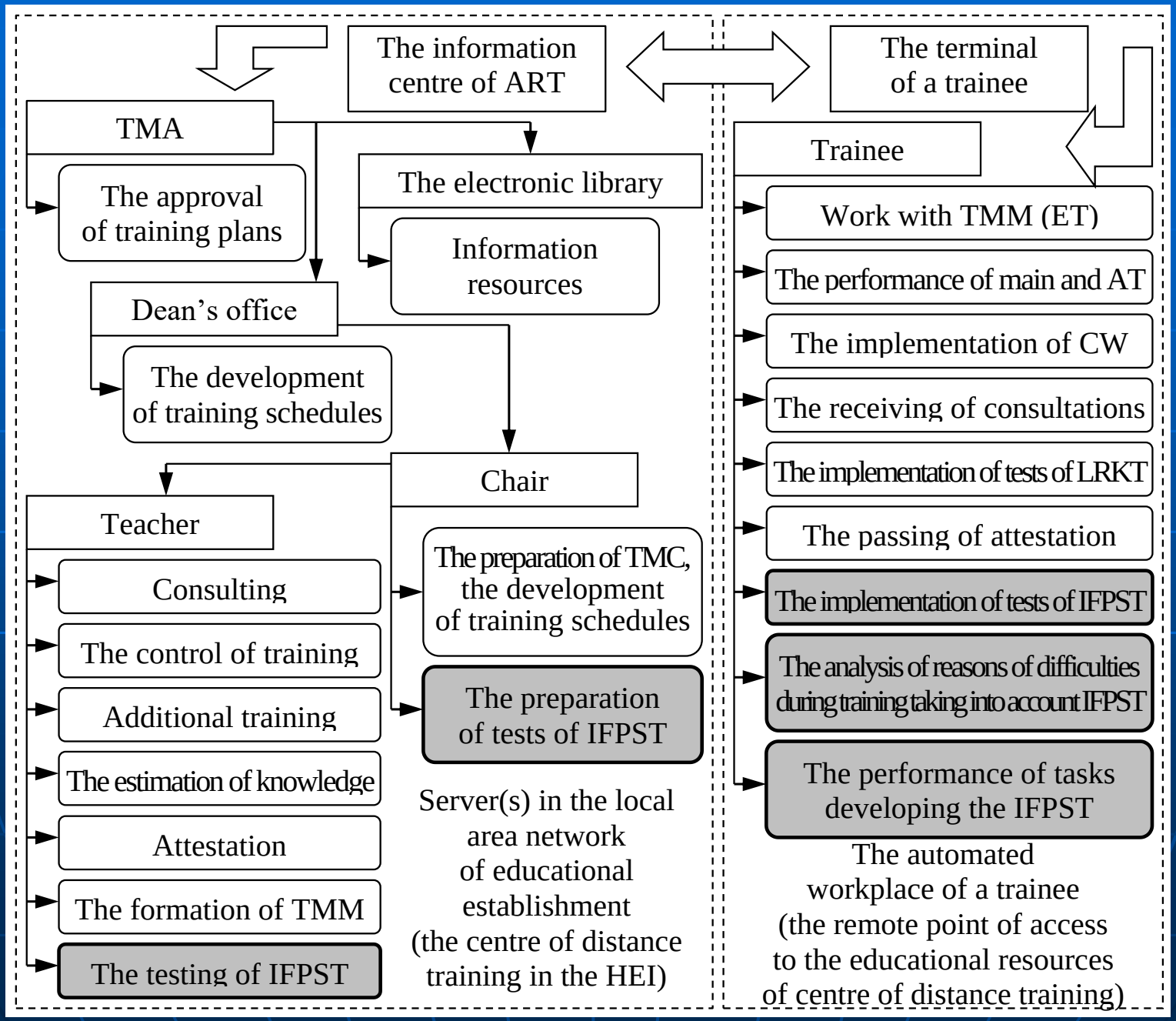


The classification of the practical methods of extraction and transmission of information (as the aggregate of knowledge) on the subjects of studying

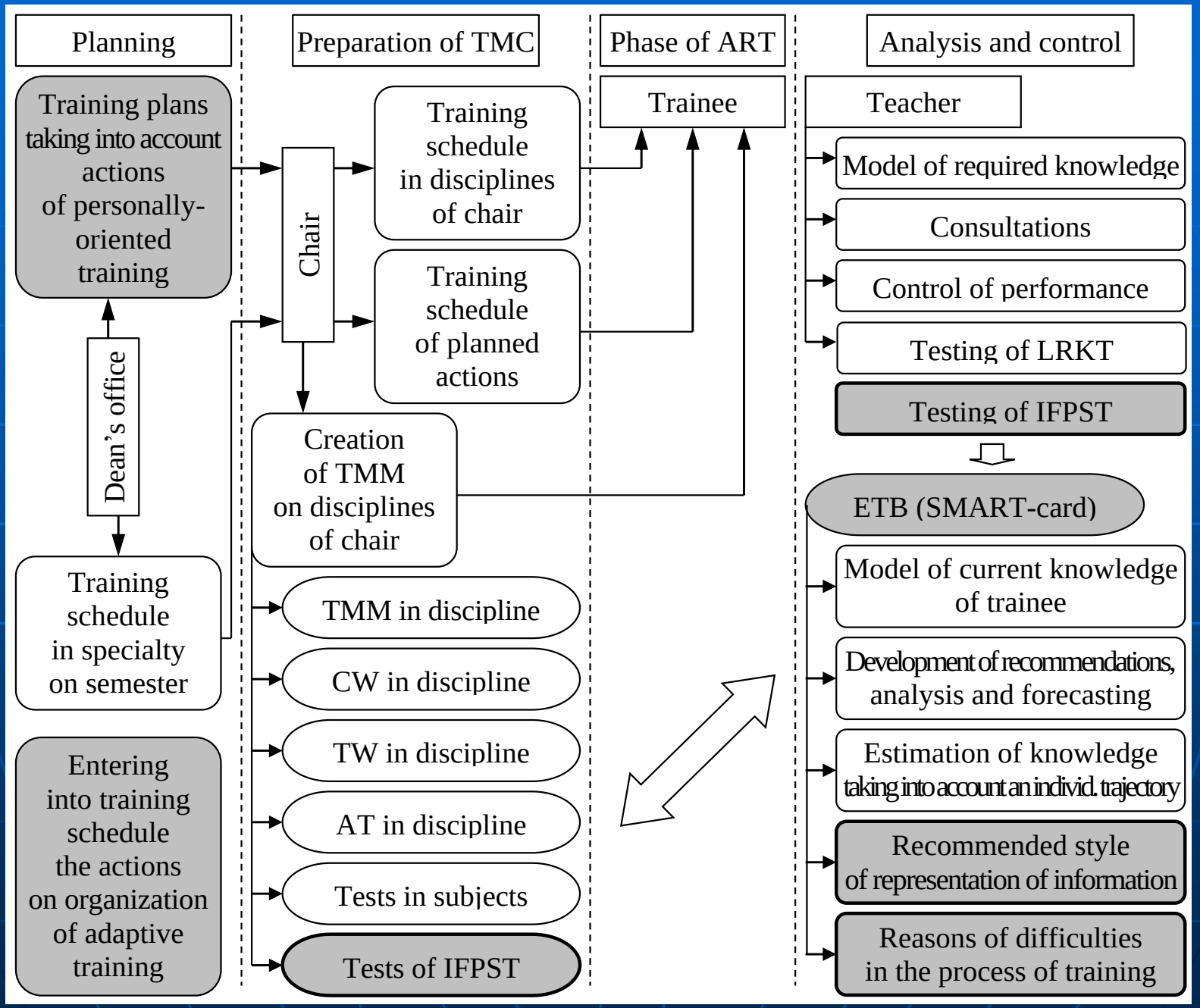


Modifications in the organization of the information environment of educational establishment for the support of accounting of the individual features of personality of the subjects of training

1.3.1

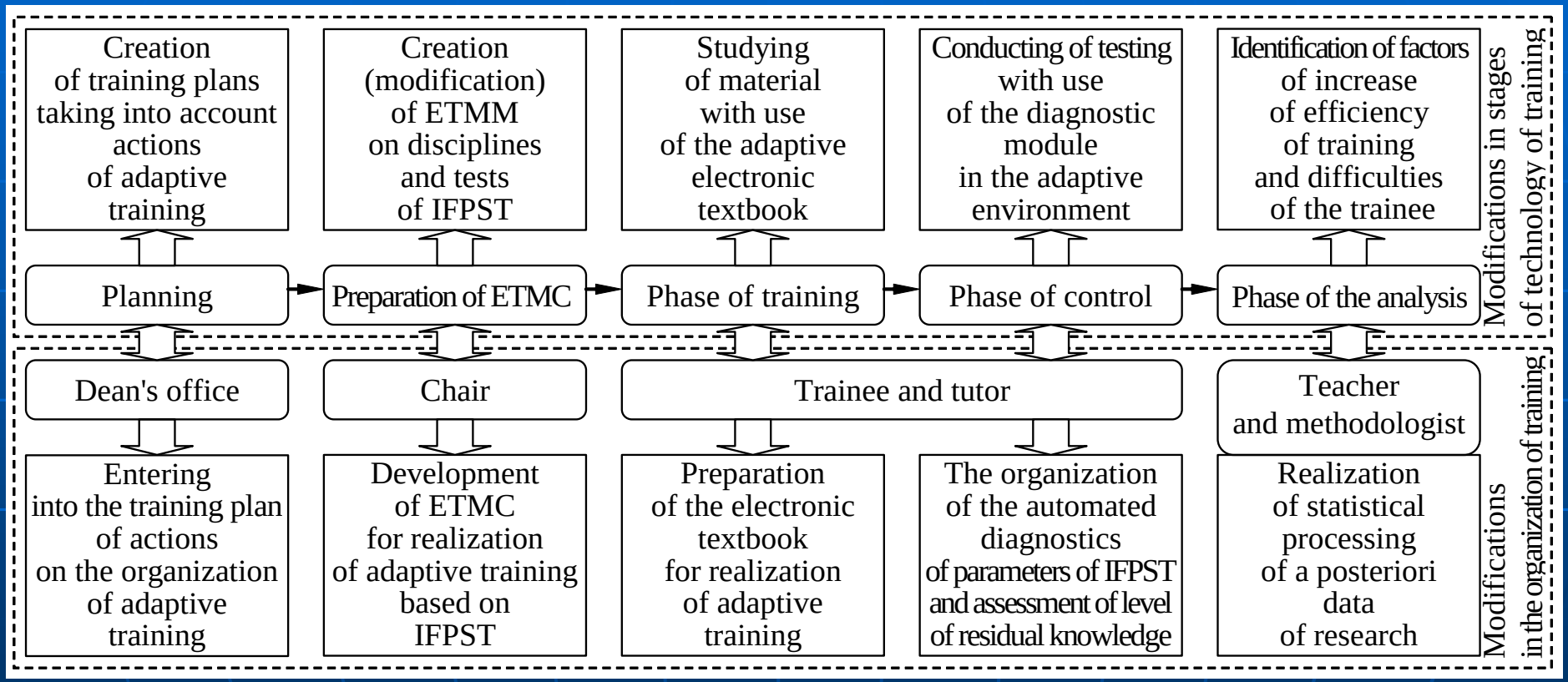


Modifications in the technological process of formation of knowledge at the realization of the automated personally-oriented training

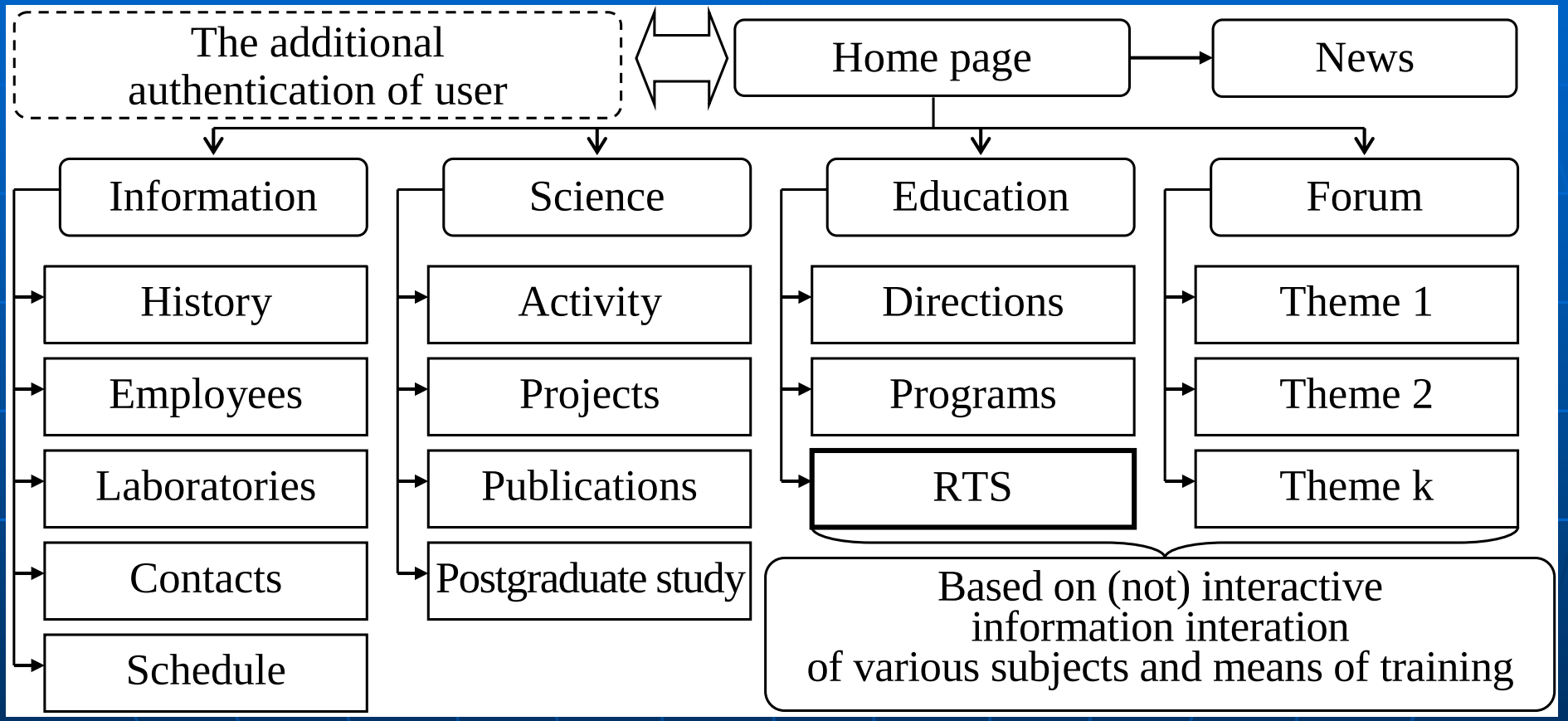


The comparison of modifications in the organization and technology of automated training for the realization of the contour of adaptation based on the parametrical cognitive models

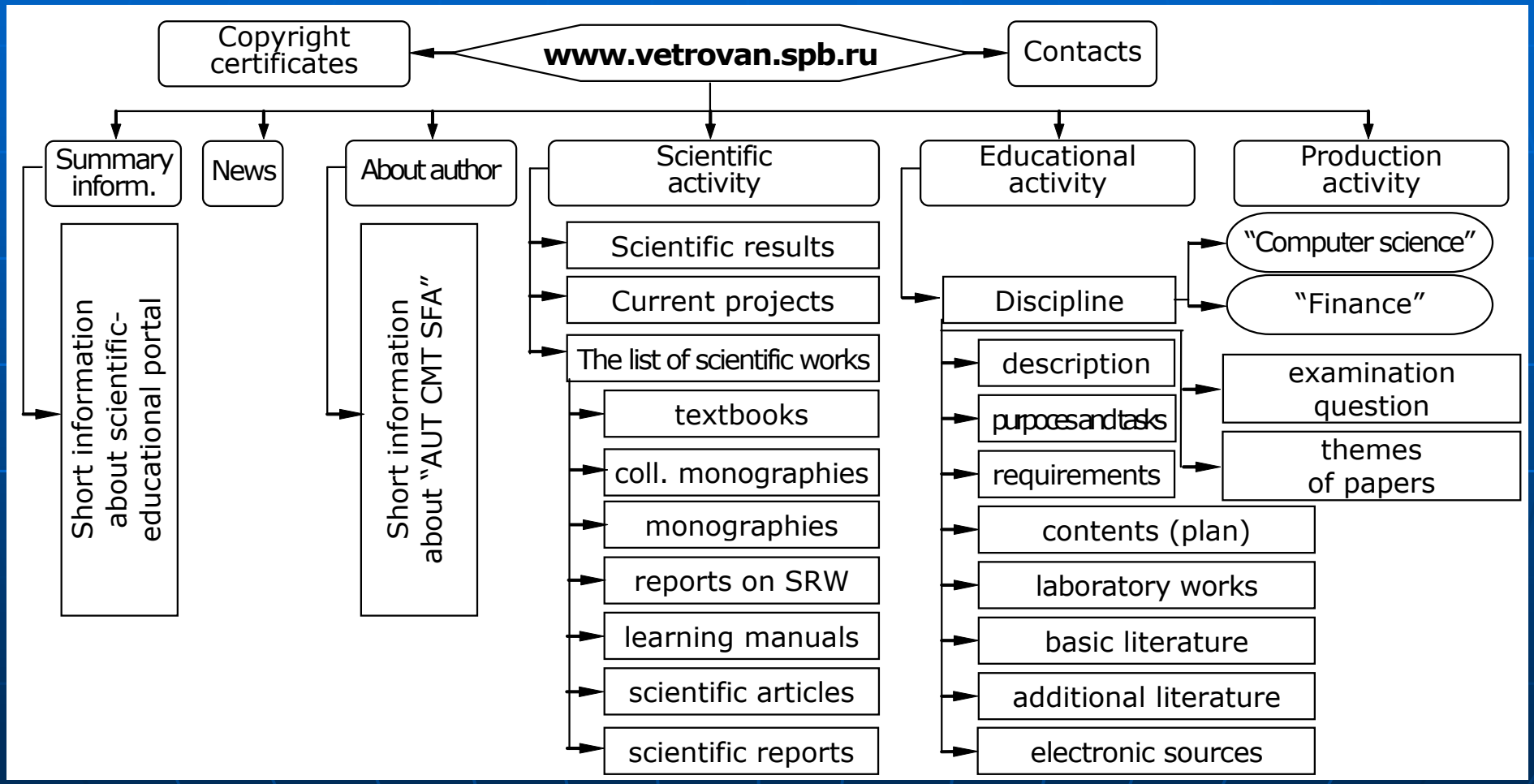
1.3.3



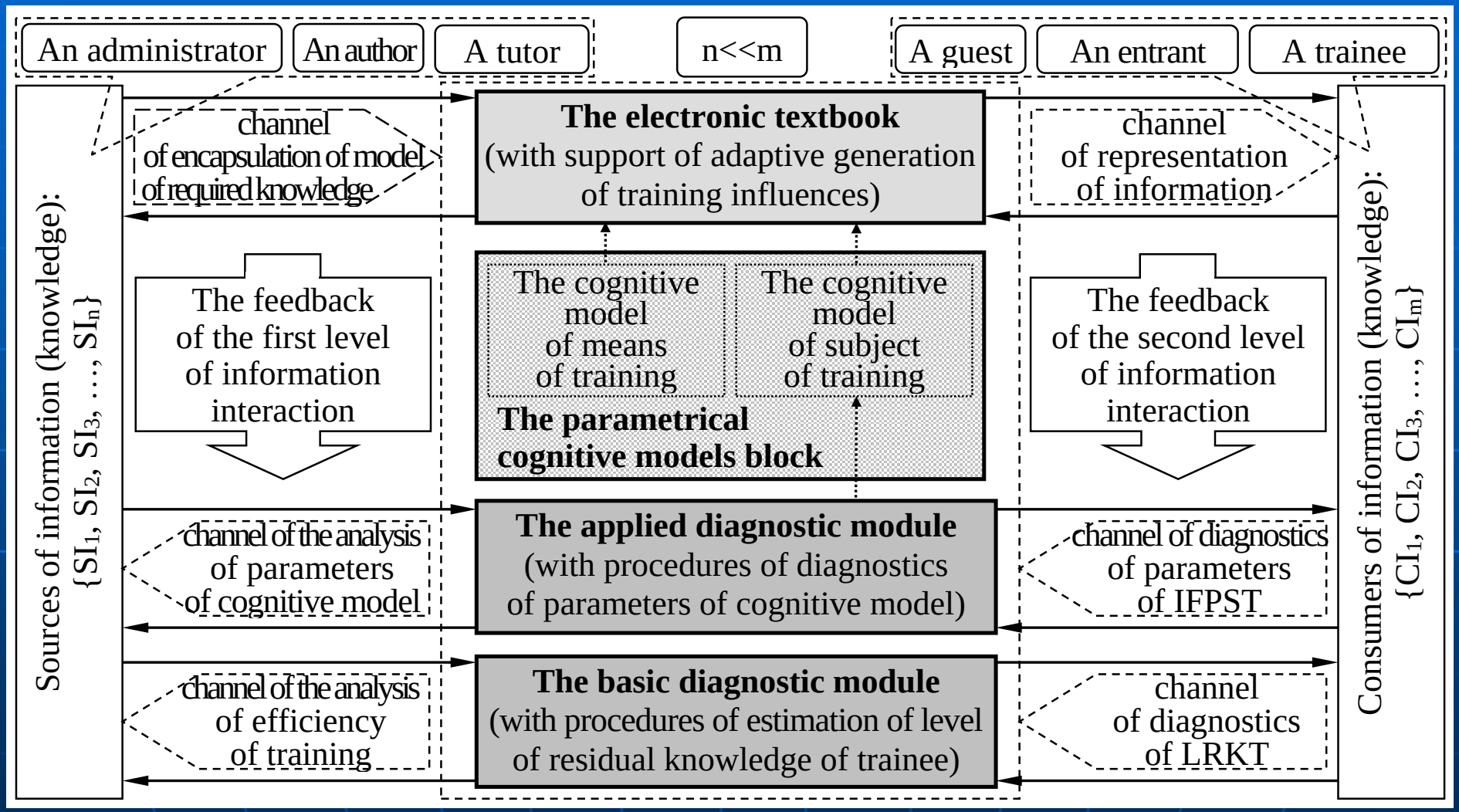
The structure of the information-educational portal of educational (scientific) centre



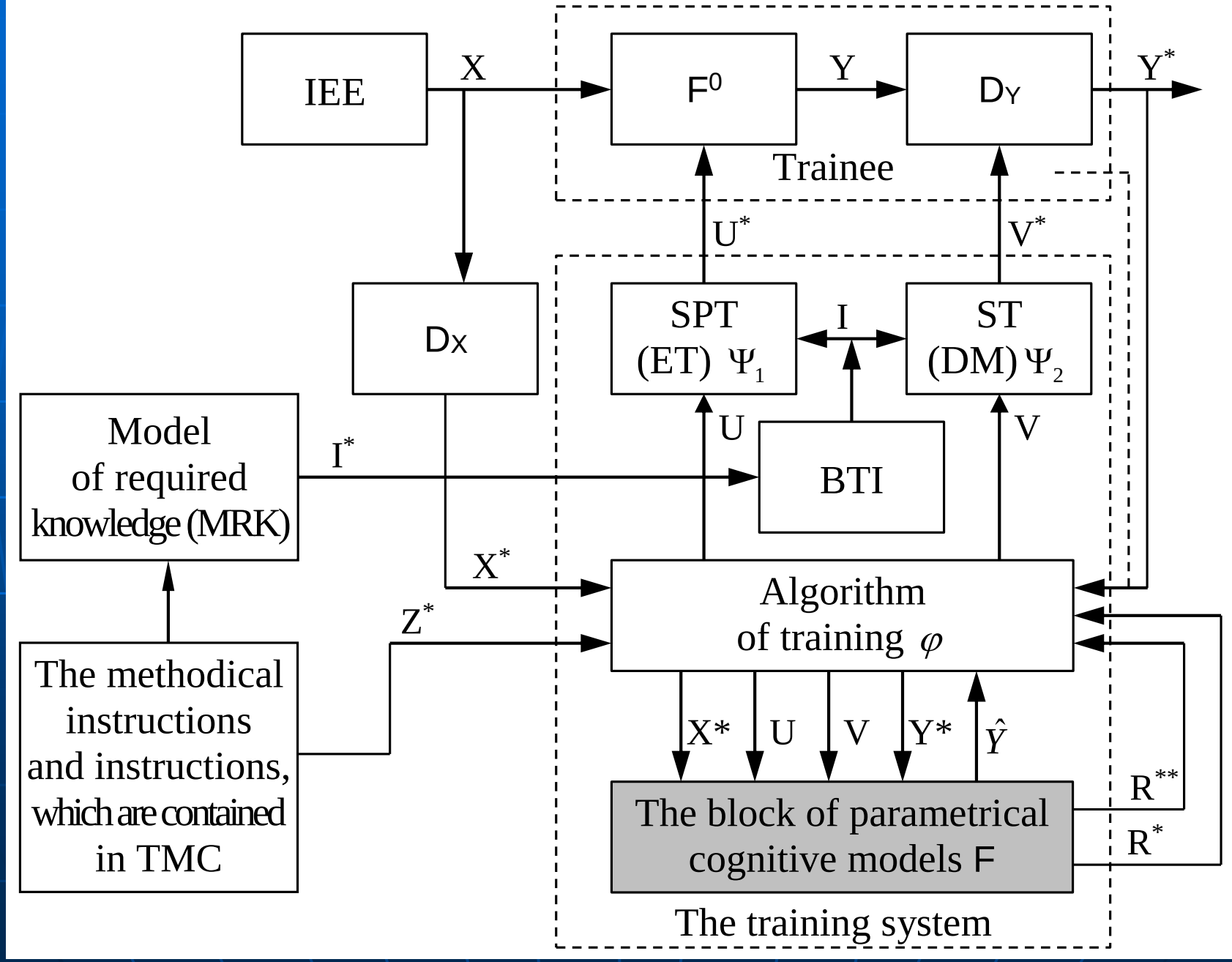
The structure of the information-educational portal of teacher (scientist): on the example of the scientific-educational portal of "AUT CMT SFA" Vetrov A.N. (in the international foreign English language and the national Russian language)



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



The formal description of the structure of the automated training system with the properties of adaptation based on the cognitive models (1 from 3)



The formal description of the structure of the automated training system with the properties of adaptation based on the cognitive models (2 from 3)

1. The condition of trainee and its estimation:

$$\begin{cases} Y = F^0(X, U^*) \\ \hat{Y}_n = F(X_n^*, U_{n-1}, V_n, Y_n^*) \end{cases}$$

2. The algorithm of training φ forms addresses and parameters of TI and control questions:

$$\begin{cases} U_{in} = \varphi(X_n^*, \hat{Y}_{n-1}, Z_n^*, C_{n-1}); \\ V_{in} = \varphi(X_n^*, \hat{Y}_{n-1}, Z_n^*, R_{n-1}) \end{cases}$$

n∈[1,k]- number of step, i∈[1,N]- number of information fragment;
C=[C*, C**], C*- potential possibilities of means of training (the CM of means of training), C**- IFPST (the CM of subject of training)

3. The databank of training information:

$$I^* \to I = < I_{1n}, I_{2n}, \ldots I_{in}, I_{Nn} > \qquad I_{in} = \{I_{in}^U, I_{in}^V\}$$

$$\begin{cases} I_{in}^U = \{I_{1n}^U, \ldots, I_{Nn}^U\} \\ I_{in}^V = \{I_{1n}^V, \ldots, I_{Nn}^V\} \end{cases}$$

4. The shaper of a portion of training (SPT) and the shaper of tests (ST):

$$\begin{cases} U_{in}^* = \Psi_1(U_{in}, I_{in}^U) \quad U_{in}^*(t_{n-1}) \Rightarrow Y_i^*(t_n) \\ V_{in}^* = \Psi_2(V_{in}, I_{in}^V) \quad (i \in [1, N], n \in [1, k]) \end{cases}$$

provides the adaptive generation of TI U^* and control questions V^* with the use of addresses in DB and parameters of display U_i and V_i on the basis I

5. The resultativity of performance of test tasks:

$$Y^* = D_Y(Y, V^*)$$

calculation with the operator D_Y (sensor) on the basis of the condition of trainee Y and a set of questions V^*

6. The task and the purpose of training is represented in the view:

$$Z^* = \begin{cases} Q(Y^*) \to \delta, \\ T(Y^*) \to \min, \end{cases}$$

δ- the required LRKT

$Y_0 \to Y^{**}$ – *CAP(cond._abs._proficiency)*

$Q_n \approx \delta (\delta \approx Q^*)$

7. The condition of the trainee on the n-th step:

$$Y_n \Leftrightarrow P_n \quad P_n = \{p_1^n, p_2^n, \ldots, p_i^n, p_N^n\} \quad p_i^n\big|_{t_n} \in [0,1]$$

probability of ignorance of the i-th element TI at the n-th moment of time t_n

$p^{**} = 0$

8. The condition (the probability of ignorance of contents) of j-th trainee changes by means of a set of TI:

$$P_n^j = F_n^j(P_{n-1}^j, U_n^j, C_{n-1}^j) \quad P_{n-1}^j\Big|_{C_{n-1}} \xrightarrow{U_n} P_n^j$$

9. As the condition of the trainee directly is not observed $Y_n \Leftrightarrow P_n$, therefore testing is necessary. At the same time reaction (answer) of the trainee:

$$\begin{cases} R_n = F^0(P_n, U_n, V_n) \\ R_n = (r_{u_1}^n, r_{u_2}^n, ..., r_{u_i}^n, ..., r_{u_{M_n}}^n) \end{cases} \quad r_{u_i}^n = \begin{cases} 0 \\ 1 \end{cases}$$

U_n – educational influence of the set level of difficulty (on the basis of the level of required knowledge)

10. The task and algorithm of adaptation of the parameters of cognitive models in the process of training:

$$C_n = \chi(C_{n-1}, R_n) \quad Y_n \Leftrightarrow P_n = \chi(P_{n-1}, U_n, R_n)$$

11. The algorithm of training allows to define the optimum portion of TI at each step:

$$Q(P_{n+1}) = Q(F(P_n, U_{n+1}, C_n)) \to \min_{U_i, R_j} \Rightarrow U_{n+1}^*,$$

12. The probability of ignorance of the elements of TI:

$$p_i^n = p_i(t_i^n) = 1 - e^{-\alpha_i^n t_i^n} \quad (i \in \{1,...,N\}, n \in \{1,...,\infty\})$$

$$\alpha_i^{n+1} = \begin{cases} \alpha_i^n (i \notin U_n) \\ \gamma' \alpha_i^n (i \in U_n; r_i^n = 0) \\ \gamma'' \alpha_i^n (i \in U_n; r_i^n = 1; n = 1,2,...) \end{cases}$$

13. The criterion of quality of training:

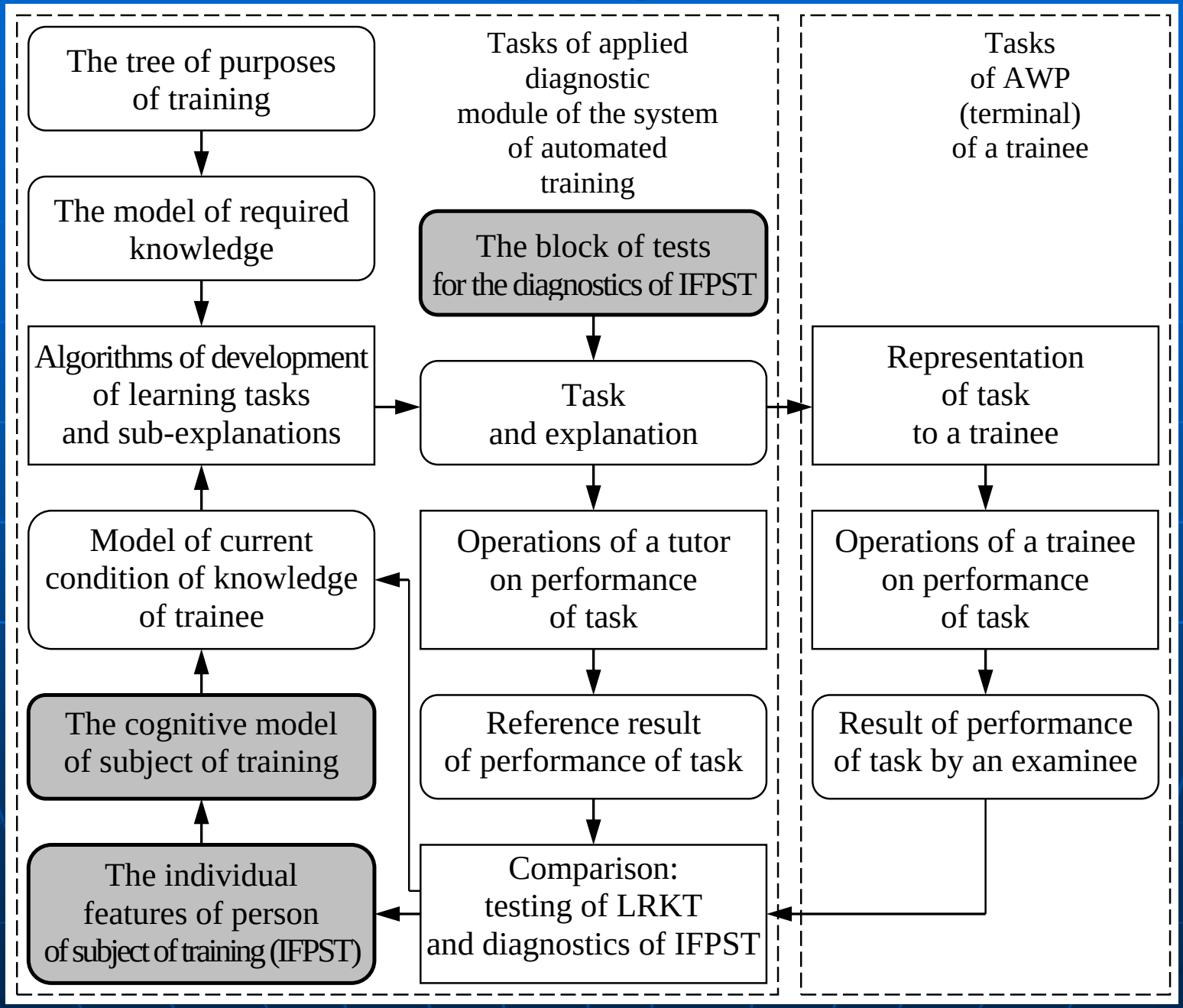
$$Q_n = \sum_{i=1}^{N} p_i(t_i^n) q_i \quad Q_n = \sum_{i=1}^{N} p_i(t_i^n) q_i \to \min_{U_n \in \Phi(L_n)} \Rightarrow U_n^*$$

$$t_i^{n+1} = \begin{cases} \Delta t_i^n (i \in U_n) \\ t_i^{n+1} + \Delta t_i^n (i \notin U_n); n = 0,1,... \end{cases}$$

14. The algorithm of selection of information fragments

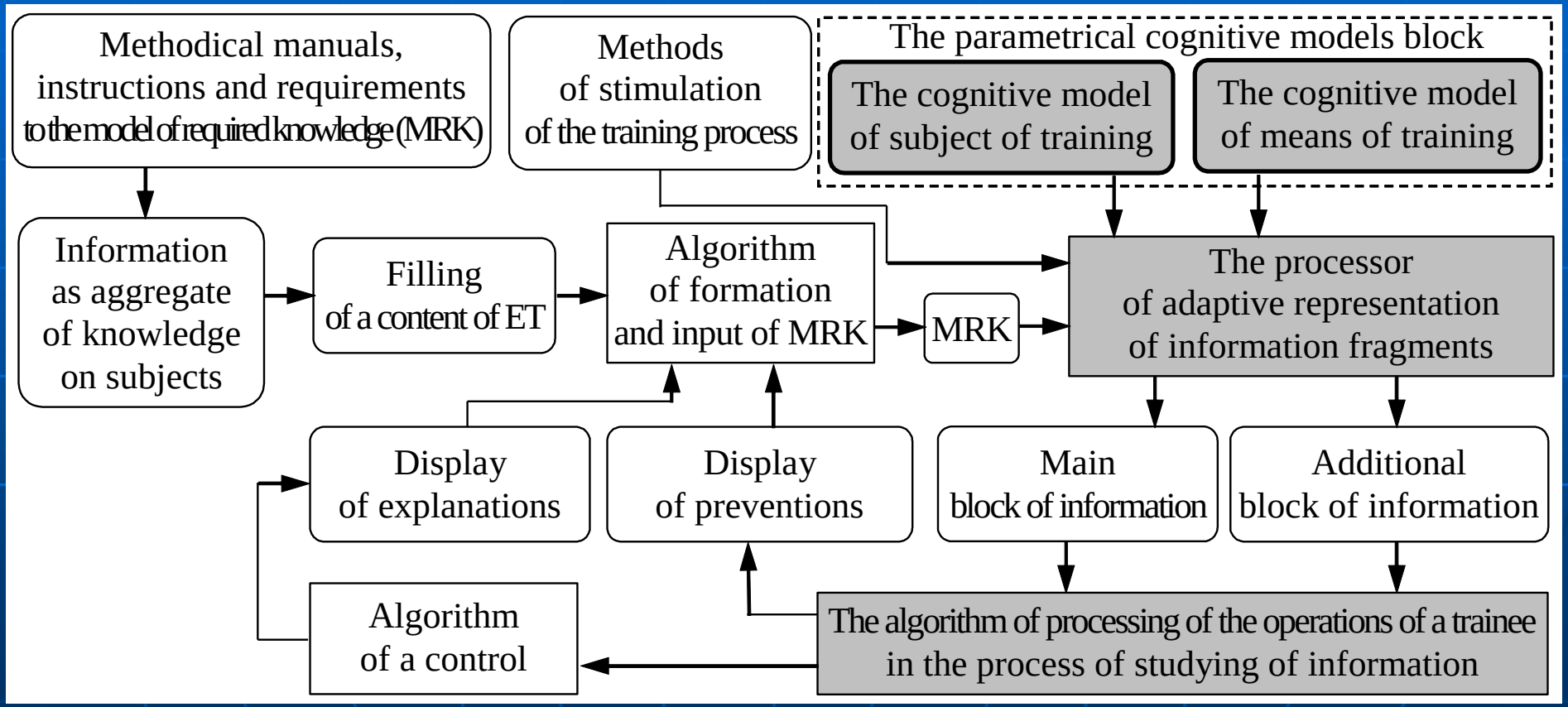
$$\begin{cases} u_1 = \max\limits_{i \in [1,N]} p_i(t_i'') q_i \\ u_i = \max\limits_{i \in [1,N](i \neq u_1)} p_i(t_i^n) q_i \\ u_{M_n} = \max\limits_{i \in [1,N](i = u_j, j = [1,M_n])} p_i(t_i^n) q_i \end{cases}$$

The scheme, reflecting the principle (algorithm) of functioning of the basic and applied diagnostic modules

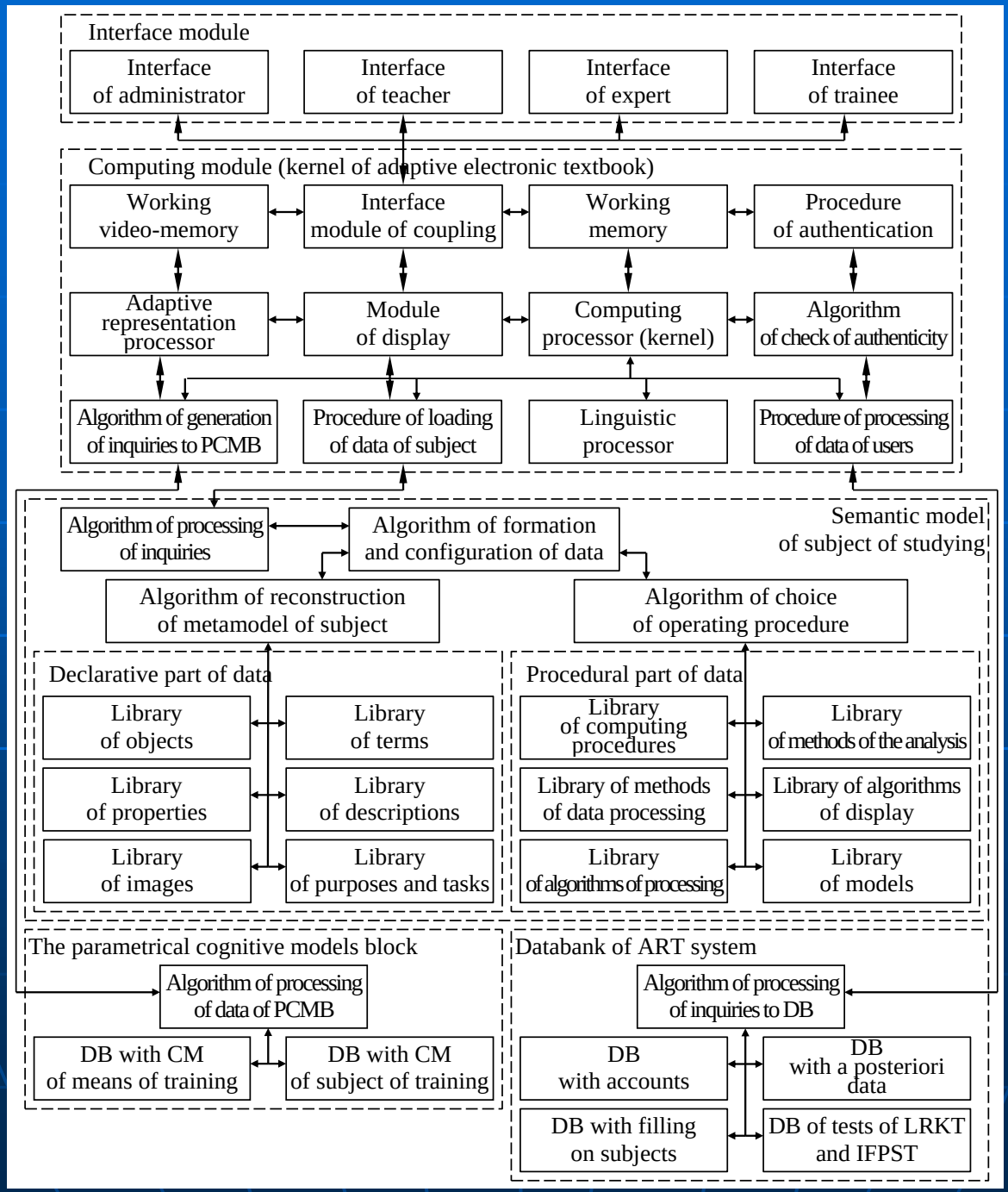


The scheme, reflecting the principle (algorithm) of functioning of the electronic textbook with adaptation based on the parametrical cognitive models block

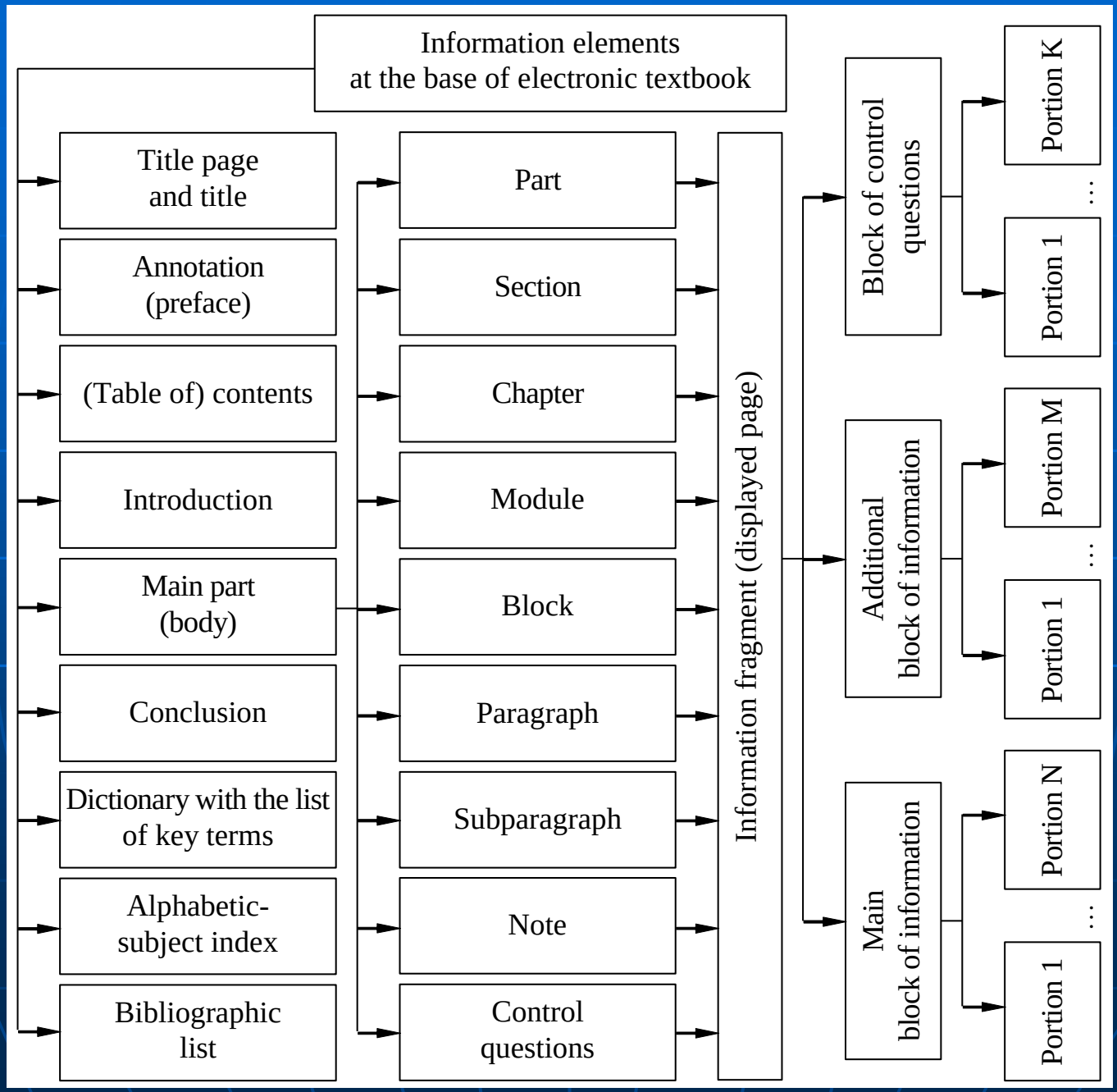
1.7.2



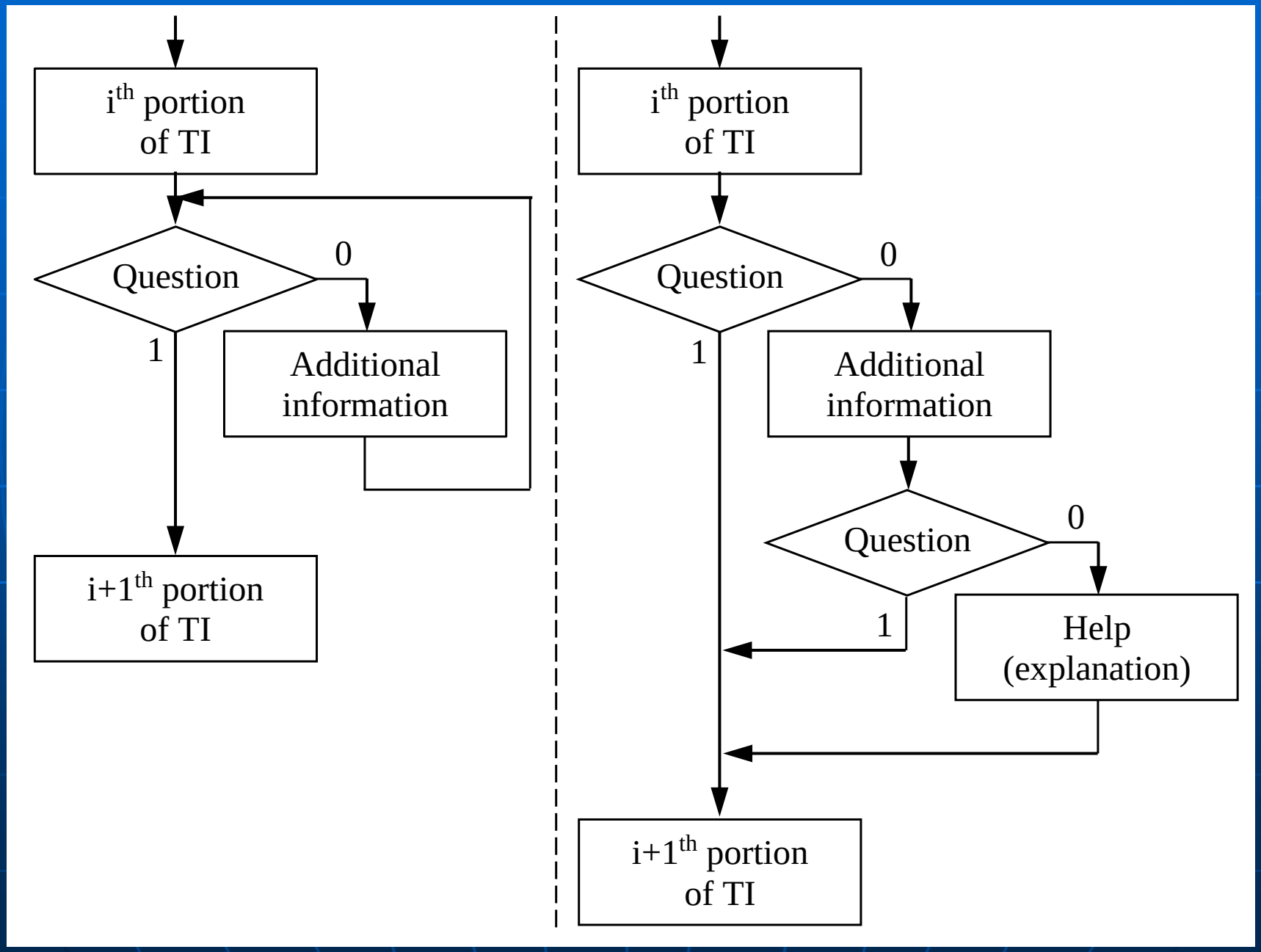
The features of architecture of the adaptive electronic textbook



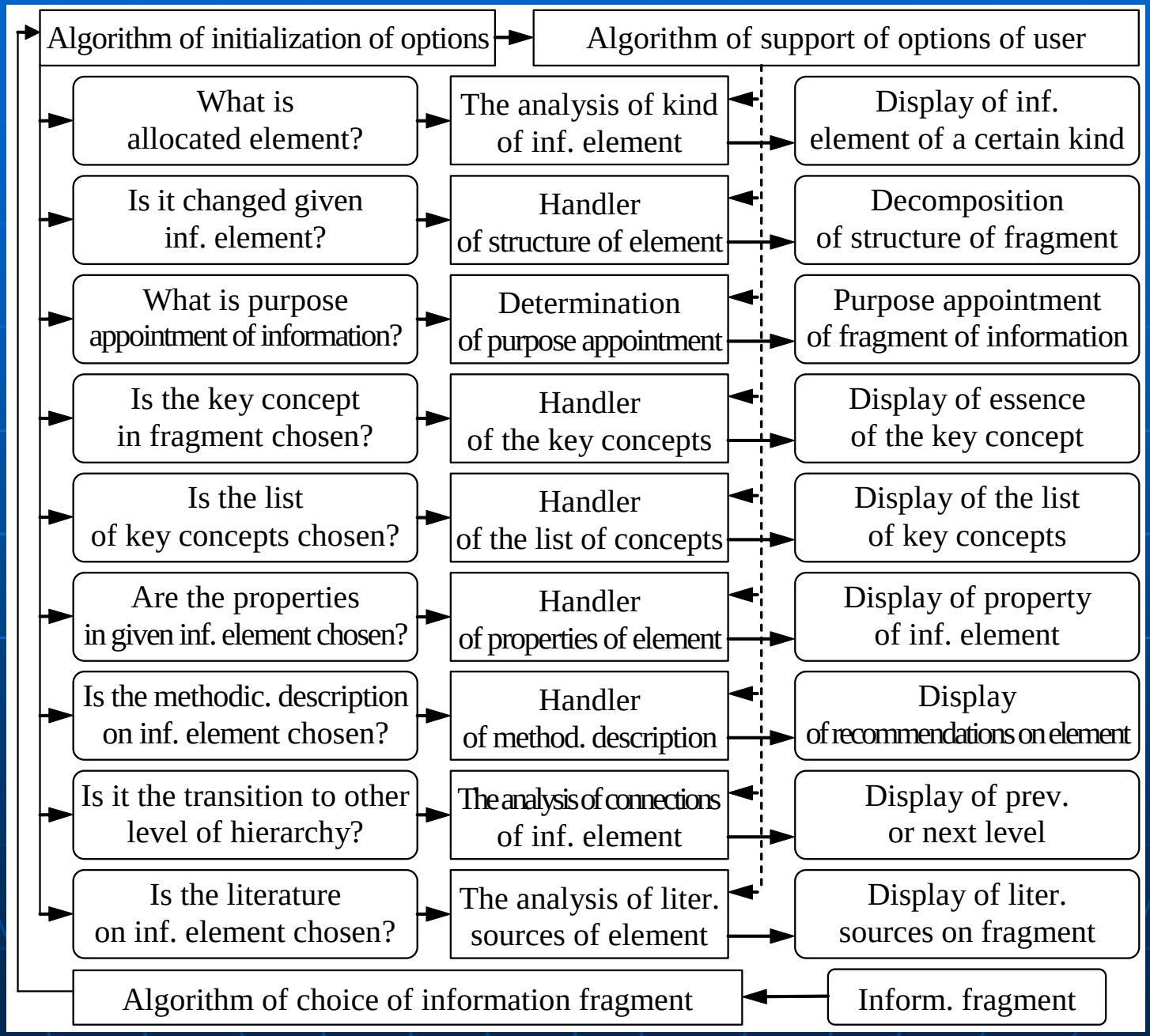
The information structure of the subject of studying, displayed at the level of representation of data by means of the electronic textbook

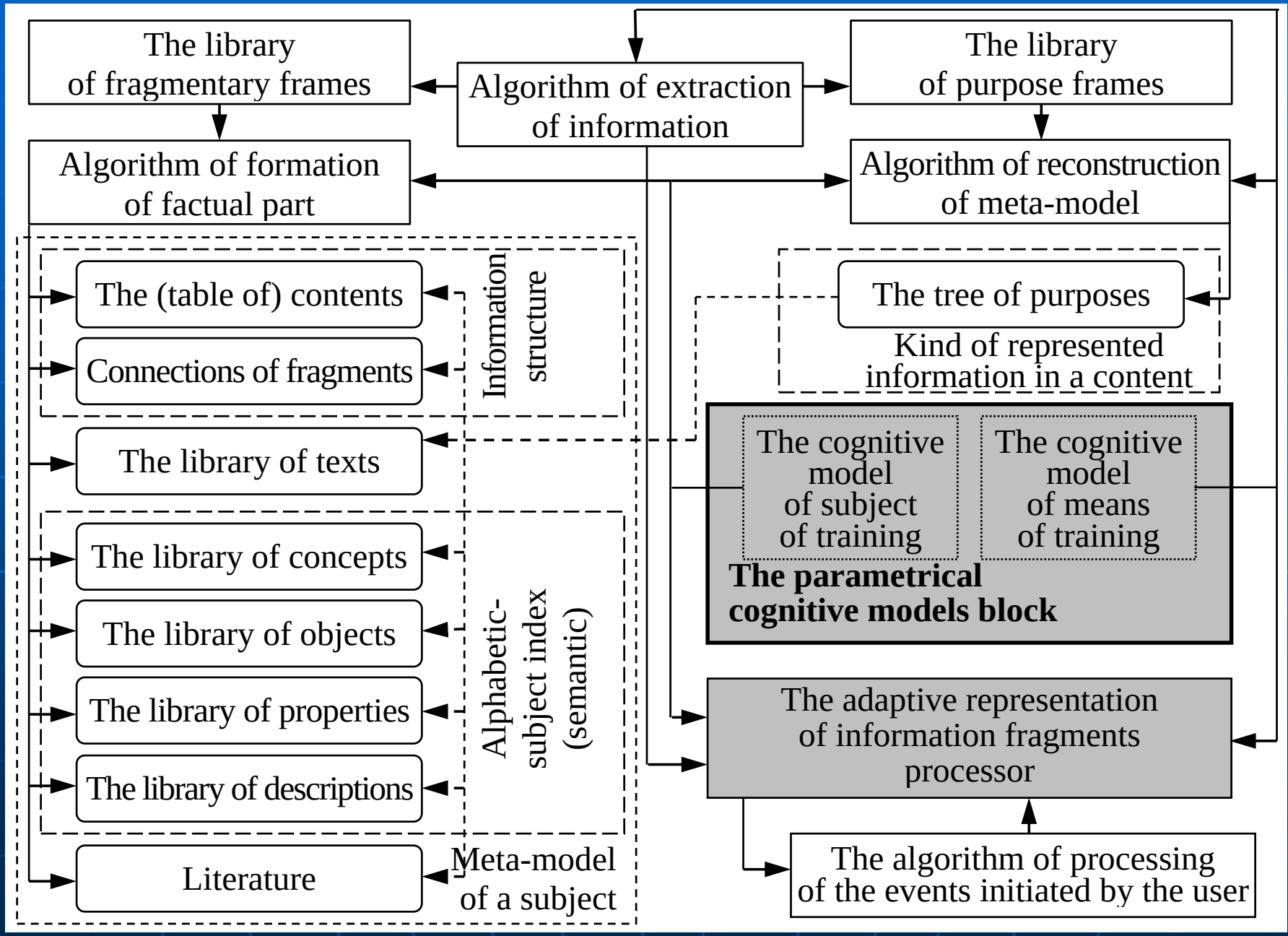


The schemes of realization of branching (1 – correct answer, 0 – wrong answer): at the left – linear model and at the right – branched model

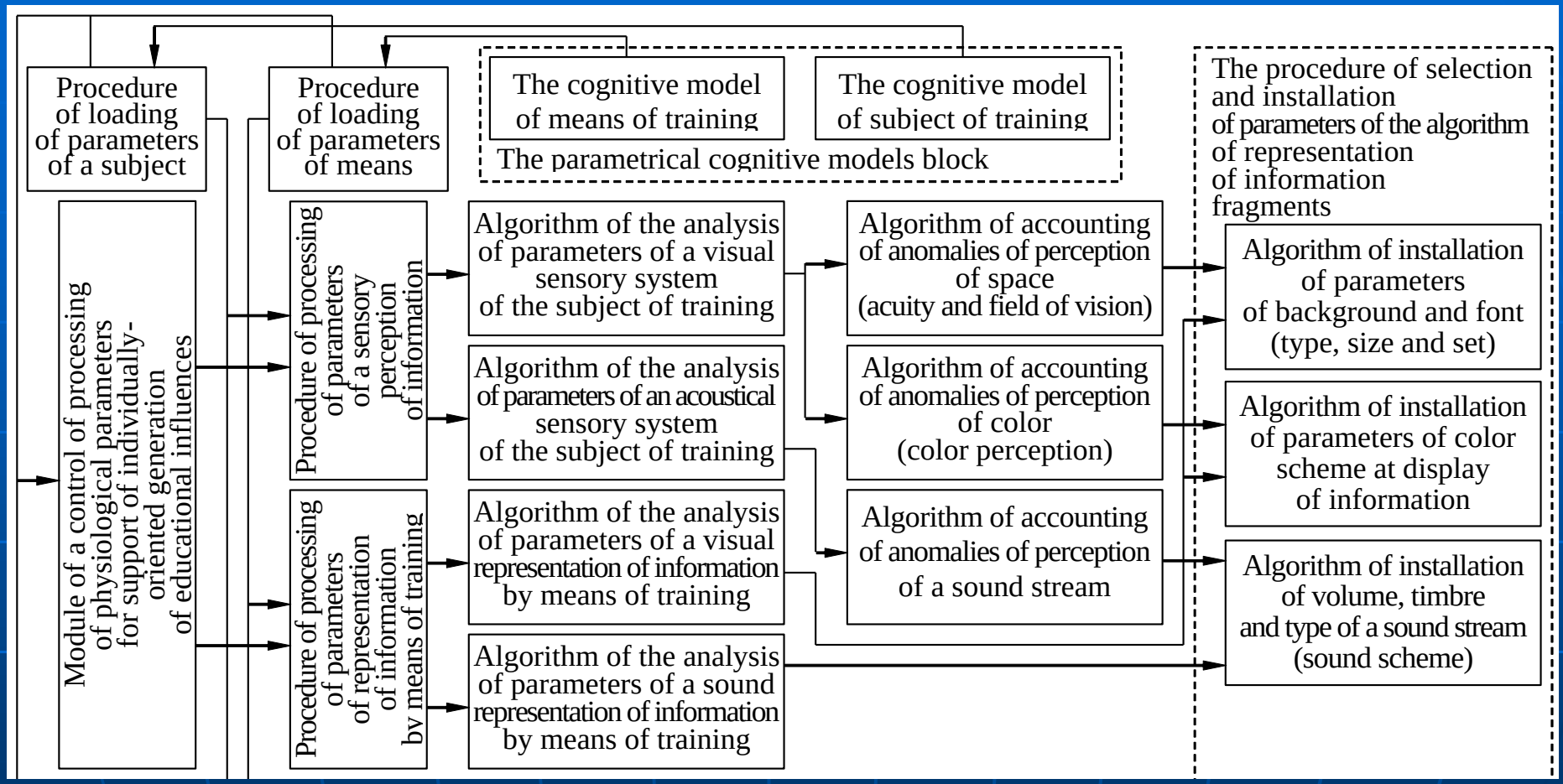


The algorithm of processing of events initiated by the user in the adaptive means of training (electronic textbook)

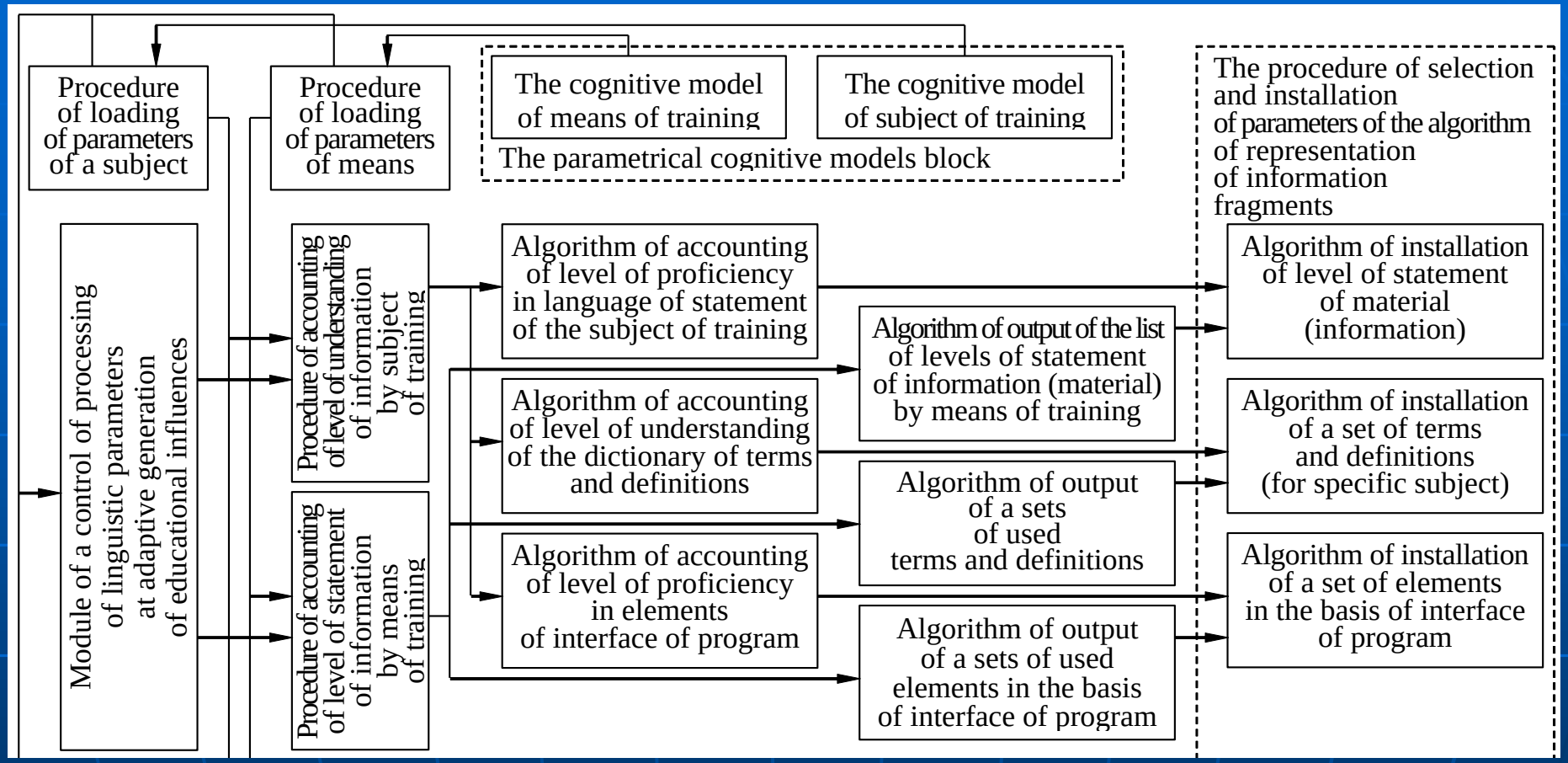



The library of fragmentary frames
Algorithm of extraction of information
The library of purpose frames
Algorithm of formation of factual part
Algorithm of reconstruction of meta-model
The (table of) contents
Connections of fragments
Information structure
The tree of purposes
Kind of represented information in a content
The library of texts
The cognitive model of subject of training
The cognitive model of means of training
The parametrical cognitive models block
The library of concepts
The library of objects
The library of properties
The library of descriptions
Alphabetic-subject index (semantic)
The adaptive representation of information fragments processor
Literature
Meta-model of a subject
The algorithm of processing of the events initiated by the user

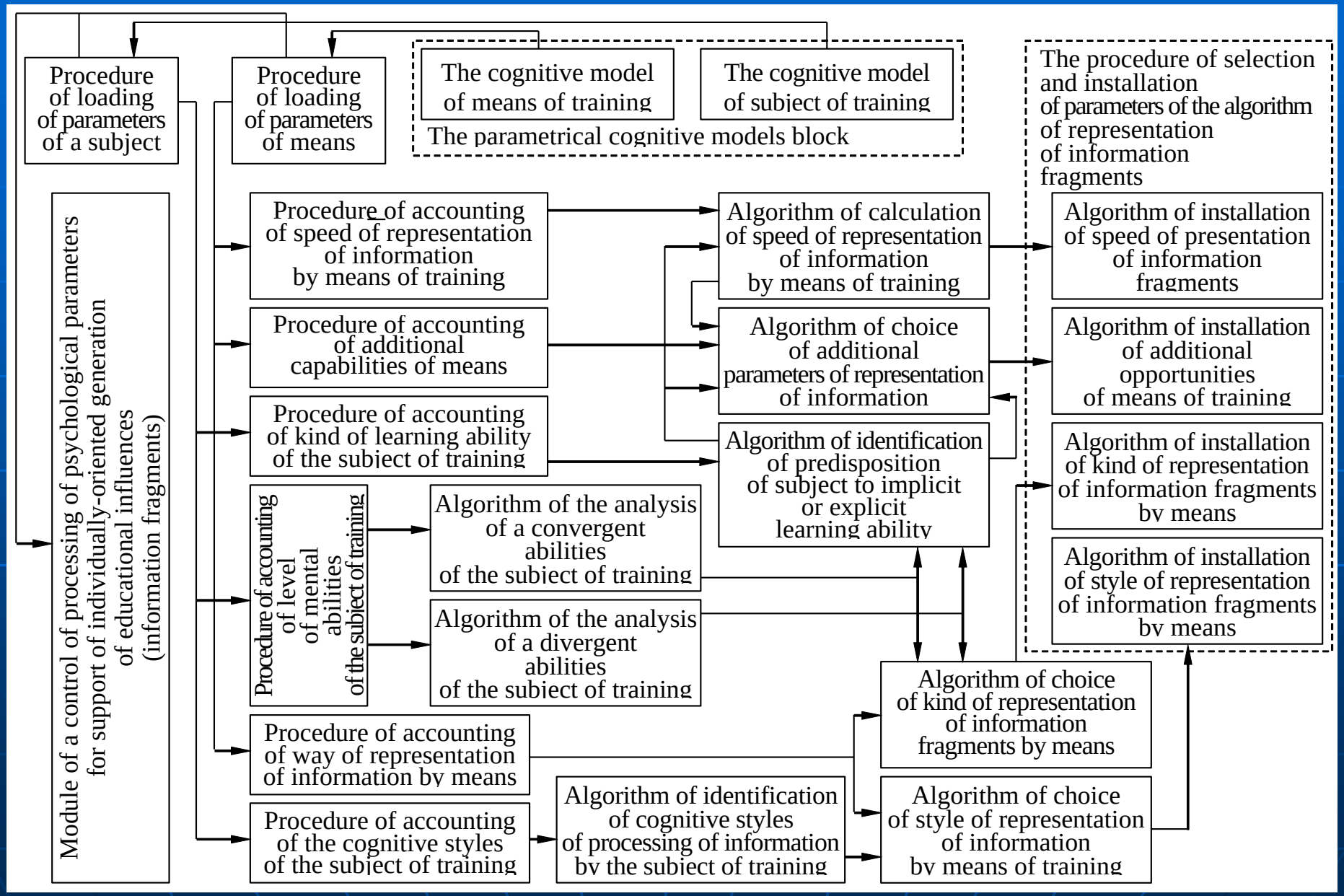
The structurally-functional scheme of the adaptive representation of information fragments processor (1 from 3)



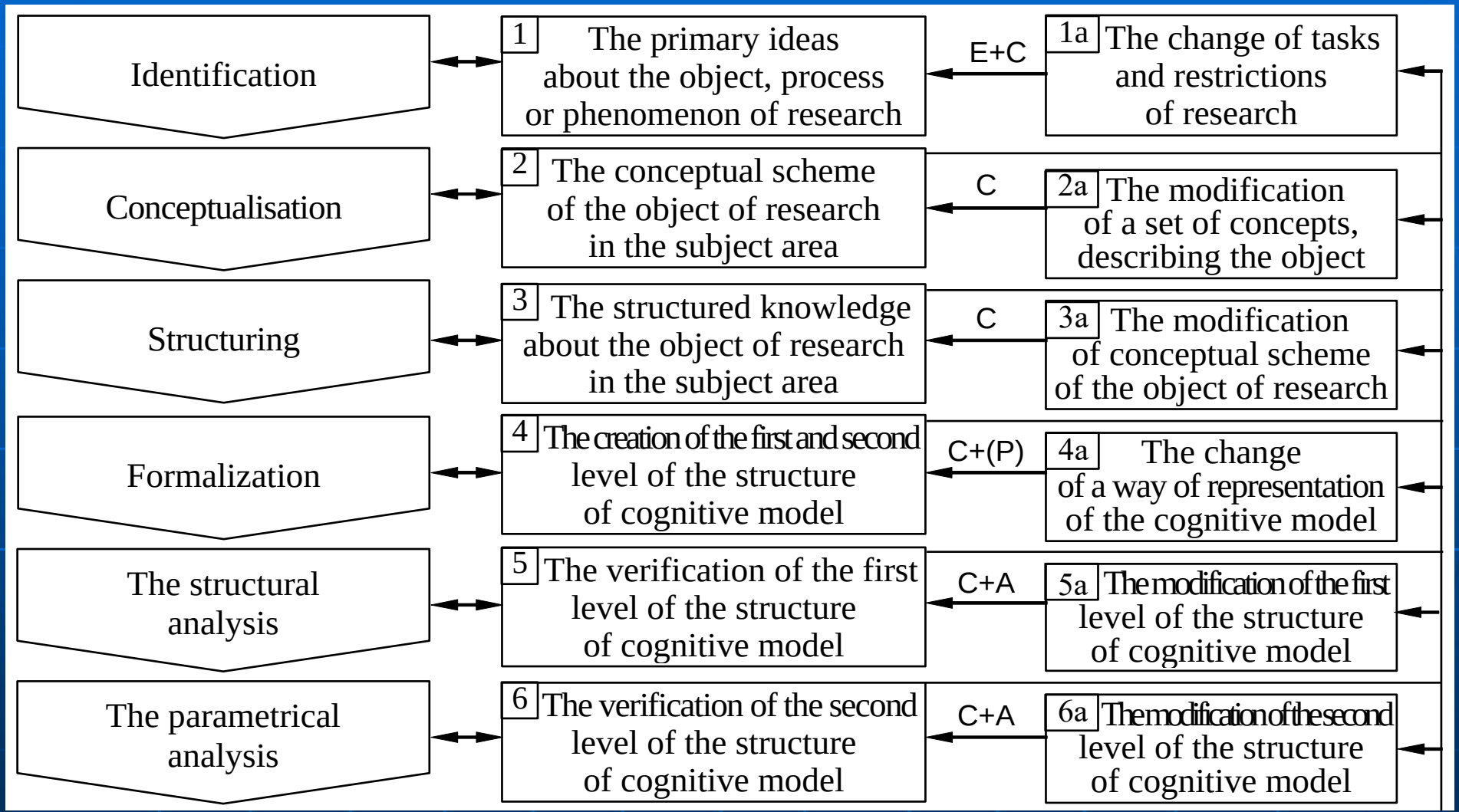
The structurally-functional scheme of the adaptive representation of information fragments processor (2 from 3)



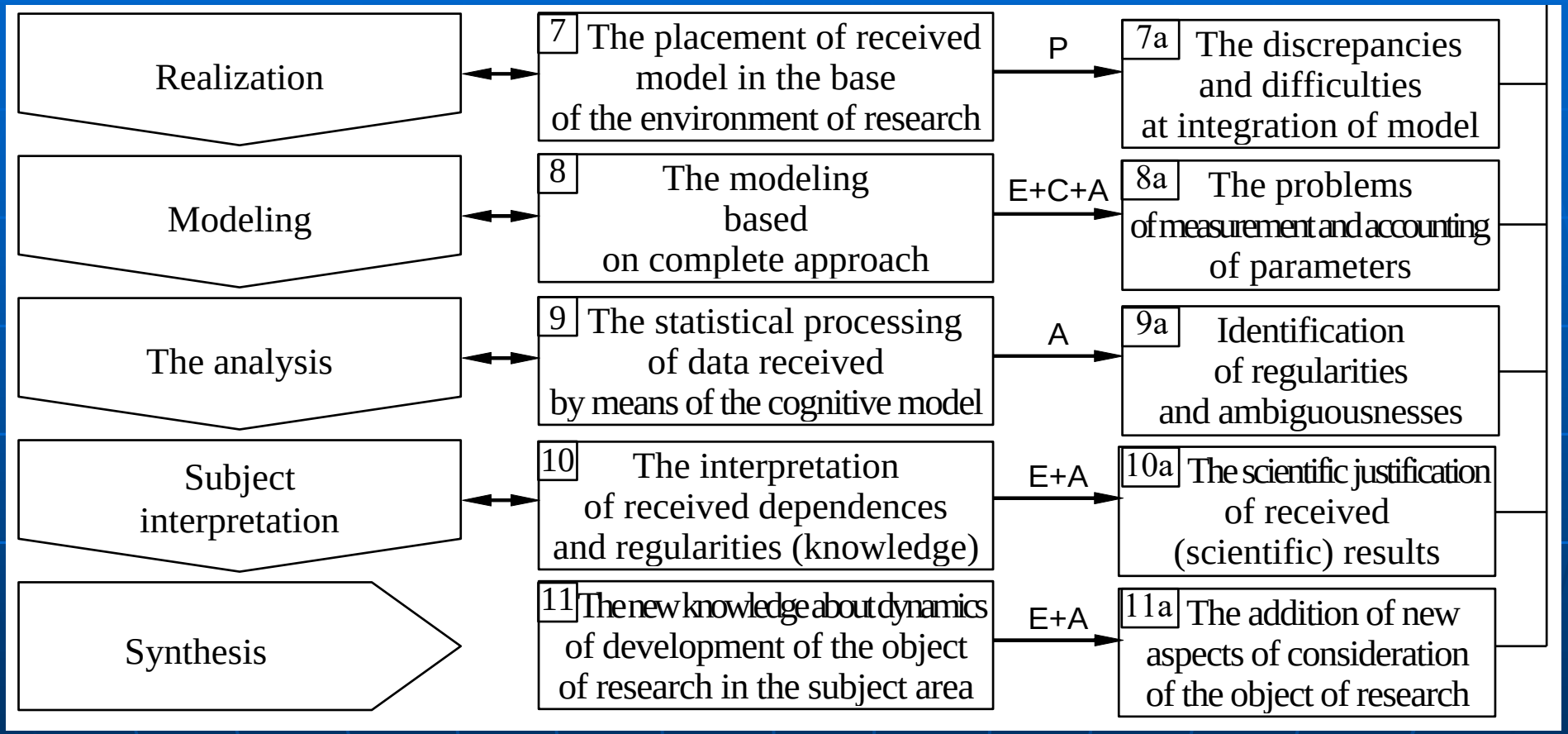
The structurally-functional scheme of the adaptive representation of information fragments processor (3 from 3)



The iterative cycle of the cognitive modeling technology (1 from 2)



The iterative cycle of the cognitive modeling technology (2 from 2)



The technique of use of the cognitive modeling technology (for the tasks of the analysis of the inf.-educational environment of automated training) (1 from 2)

For the use of the cognitive modeling technology in relation to the object of research in the subject area it is necessary to satisfy a set of conditions at each stage

The analysis of an object of research and choice of a way of representation of CM

- **At the stage of identification** → 1 There is provided the collecting of data (purposes, tasks and restrictions to the IEE) necessary and sufficient for the formation of the structure of cognitive model (is provided the involvement of experts at necessary), is defined a set of portraits PR_i of model
- **At the stage of conceptualization** → 2 There are allocated the key concepts (properties Pr_k and parameters P_m), relating to the features of the object of research in the subject area, are defined the classes of concepts (portraits PR_i and kinds of properties KP_j) and groups of parameters (vectors of parameters VP_l), are set up the AAV
- **At the stage of structuring** → 3 There are defined the relations and connections between the allocated key concepts (properties and parameters), their classes (portraits and kinds of properties), and also groups of parameters (vectors of parameters), characterizing the object of research in the subject area

The algorithm of formation of the structure of cognitive model

- **At the stage of formalization** → 4 There is provided the creation (addition) of the structure of cognitive model by means of the use of one of the formal (informal) models of representation of data and knowledge from the field of the theory of intellectual systems
- **At the stage of the structural analysis** → 5 It is necessary to carry out of the analysis of connections and correlation dependences between the allocated concepts (parameters): each portrait (PR_i) in the structure of cognitive model must include a set of vectors of parameters (VP_l)
- **At the stage of the parametrical analysis** → 6 Sets of parameters in the context of various portraits should not be crossed and be contradictory, and the received structure of cognitive model must meet the purposes, requirements and restrictions, developed on the relation to the object of research

The technique of use of the cognitive modeling technology (for the tasks of the analysis of the inf.-educational environment of automated training) (2 from 2)

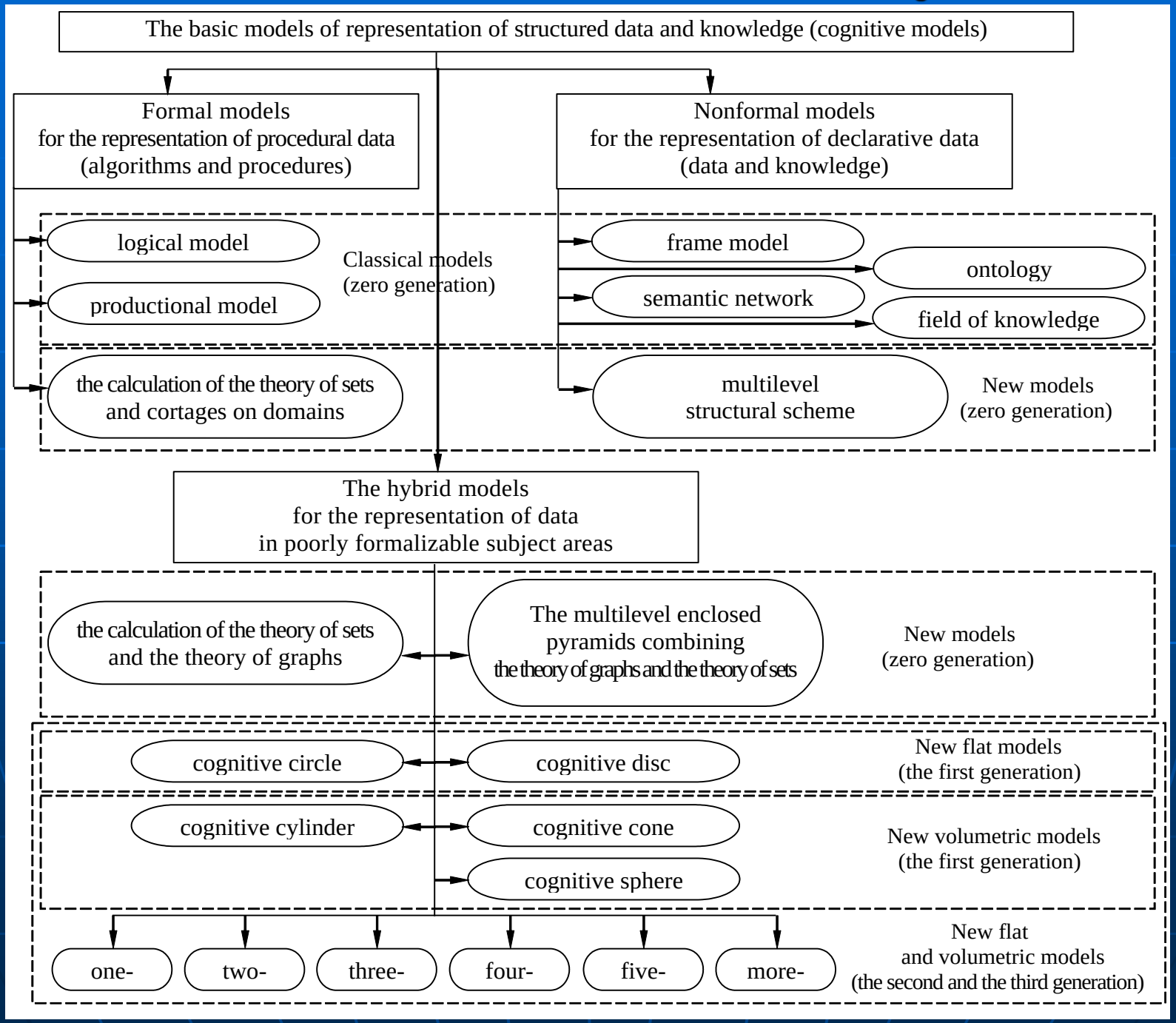
The technique of research of the parameters of CM

- At the stage of realization → 7 There is carried out the practical use of the cognitive model in the base of IEE, the received structure is filled by the values of parameters, which are considered at the generation of information-educational influences by the means of training
- At the stage of modeling → 8 There is carried out the accumulation of information about the condition of the object of research as the complete system and its elements in particular, and also the analysis of adequacy and mutual influence of parameters, characterizing the dynamics of its functioning

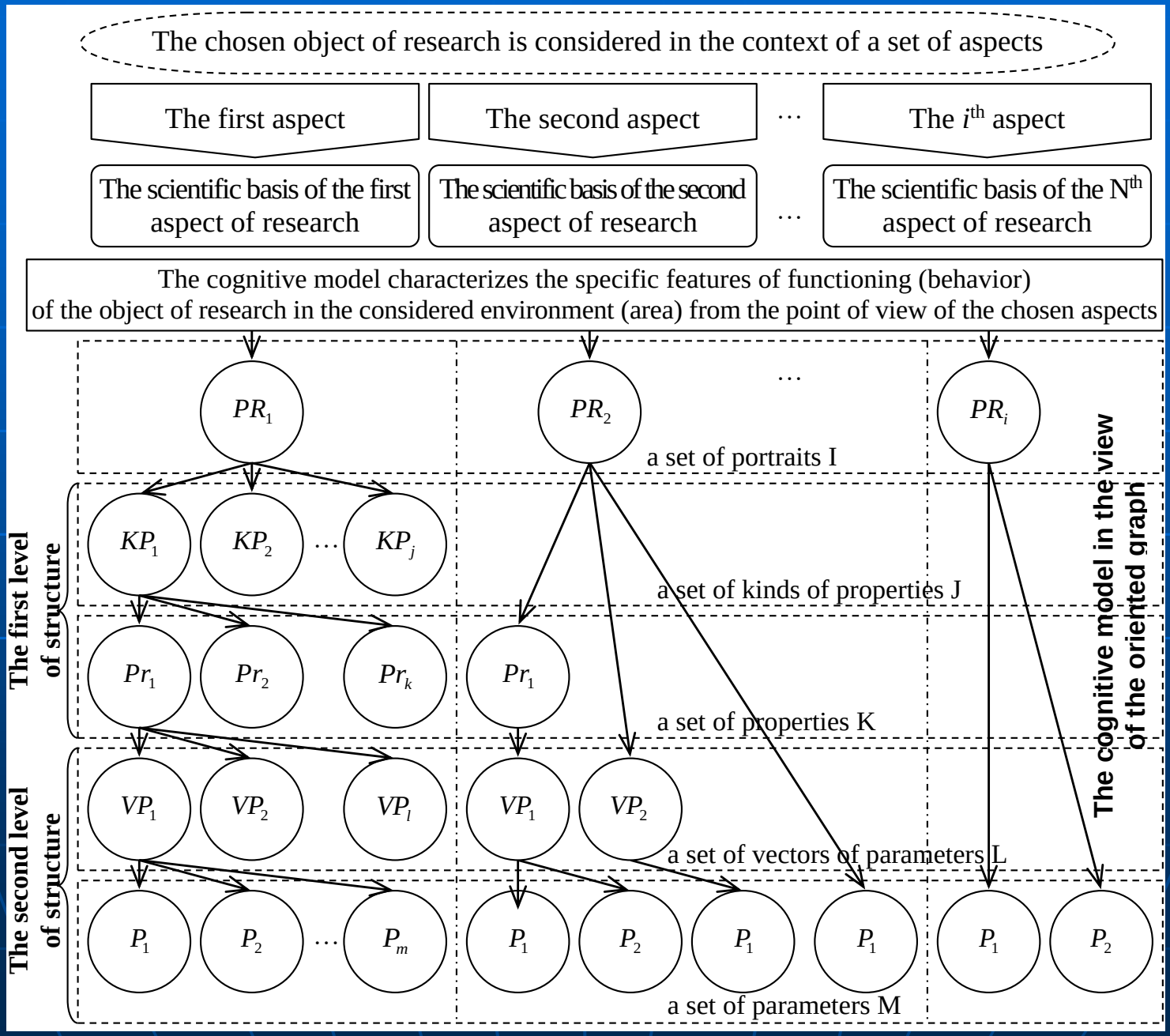
The algorithm of processing of a posteriori data

- At the stage of the analysis → 9 There is carried out the statistical processing of a posteriori data of modeling and are formulated the conclusions about efficiency of functioning of the object, process or phenomenon of research in general and its elements in particular
- At the stage of subject interpretation → 10 There are formulated the objective conclusions on the basis of the received data from the point of view of various subject areas (according to the chosen range of scientific aspects of consideration of the object, process or phenomenon of research)
- At the stage of synthesis → 11 There are formulated the tasks on improvement of the structure of cognitive model in width and depth with taking into account results of subject interpretation and dynamics (progressive and regressive) of development of the object, process or phenomenon of research

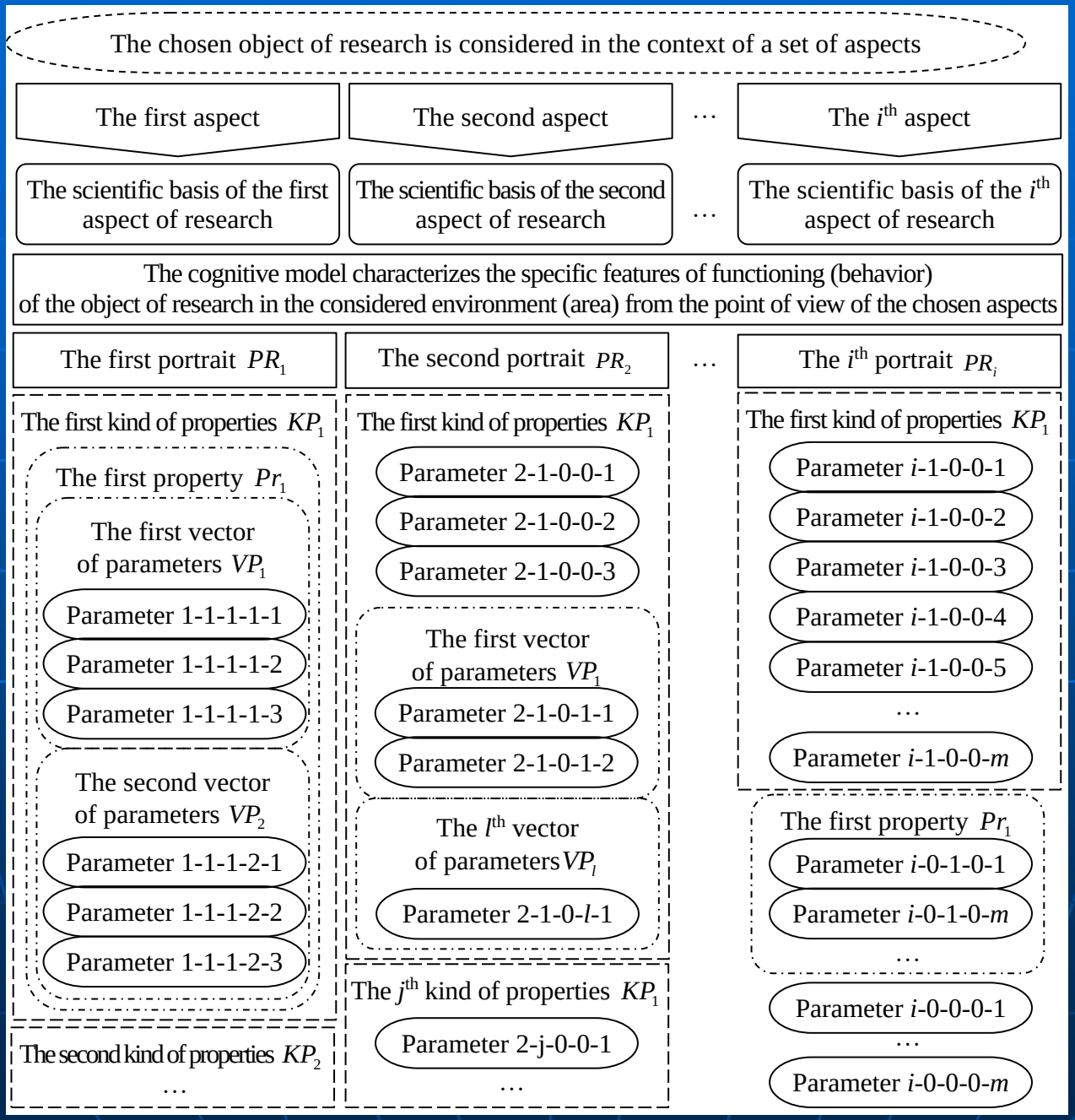
The recommended bases for the construction of the structure of cognitive model



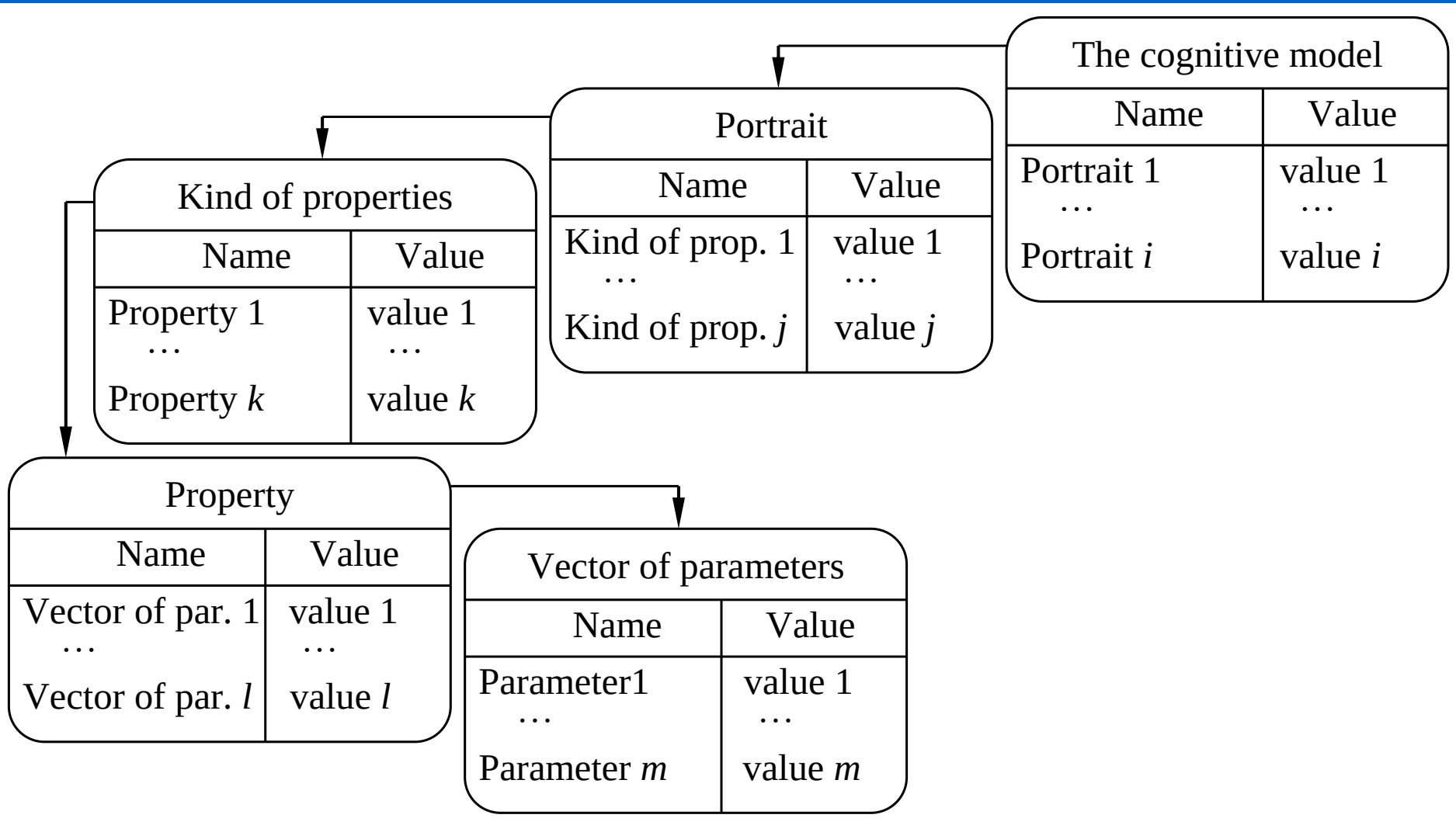
The recommended basis for the construction of the structure of cognitive model in the view of the oriented graph combining the theory of sets



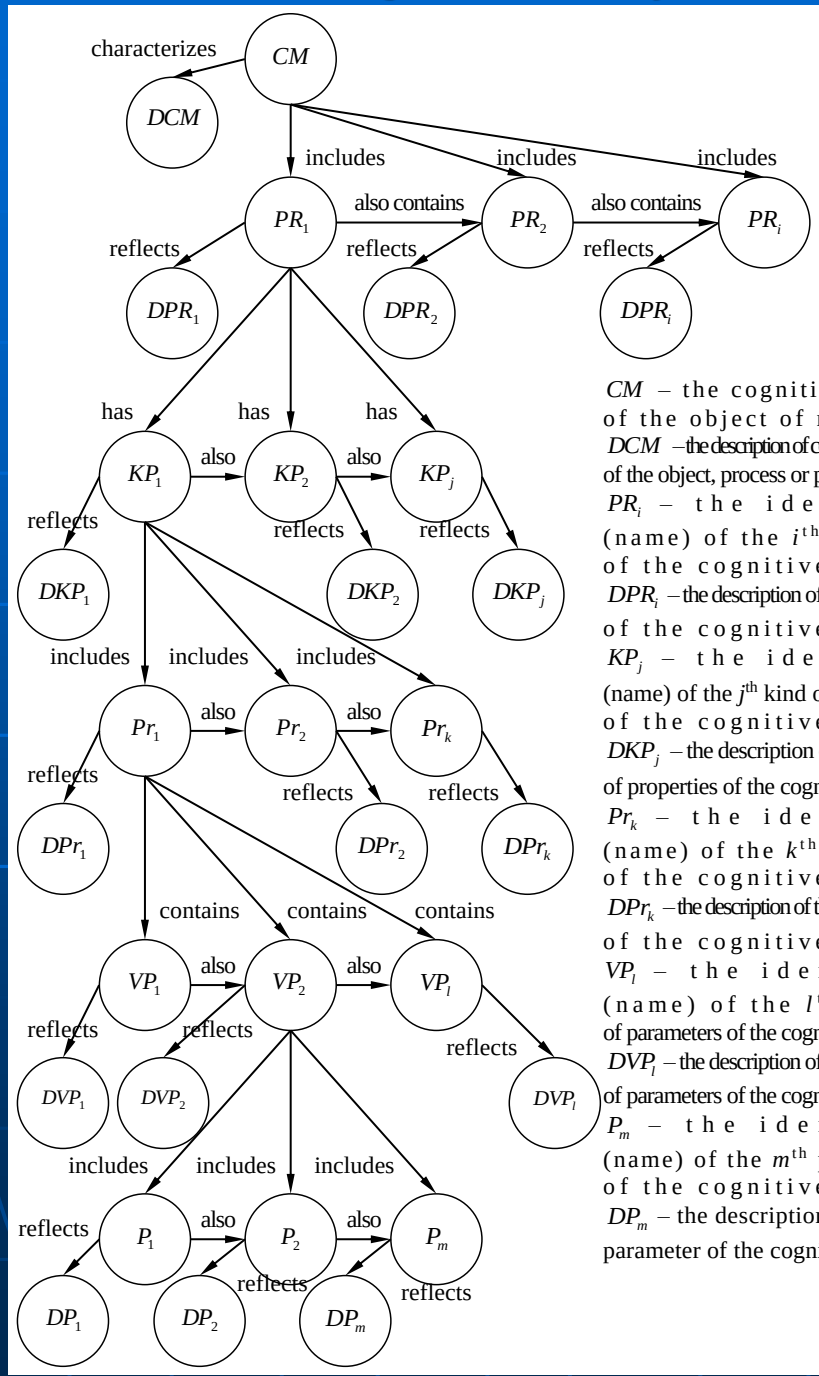
The recommended basis for the construction of the structure of cognitive model in the view of the structural scheme (without connections between information elements)



The representation of the structure of cognitive model by means of the frame model

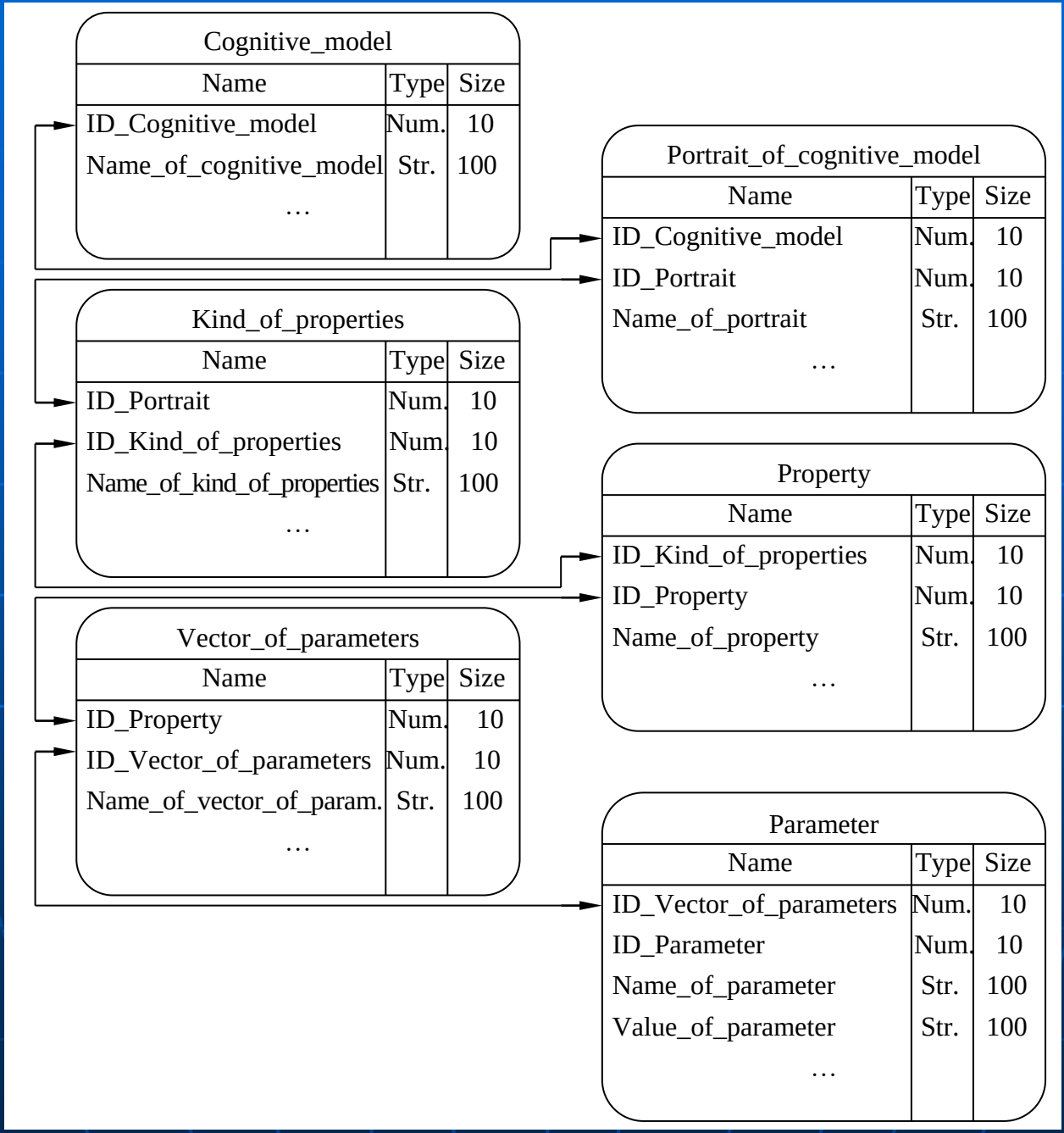


The representation of the structure of cognitive model by means of the semantic network



CM – the cognitive model of the object of research;
DCM – the description of cognitive model of the object, process or phenomenon;
PR_i – the identifier (name) of the i^{th} portrait of the cognitive model;
DPR_i – the description of the i^{th} portrait of the cognitive model;
KP_j – the identifier (name) of the j^{th} kind of properties of the cognitive model;
DKP_j – the description of the j^{th} kind of properties of the cognitive model;
Pr_k – the identifier (name) of the k^{th} property of the cognitive model;
DPr_k – the description of the k^{th} property of the cognitive model;
VP_l – the identifier (name) of the l^{th} vector of parameters of the cognitive model;
DVP_l – the description of the l^{th} vector of parameters of the cognitive model;
P_m – the identifier (name) of the m^{th} parameter of the cognitive model;
DP_m – the description of the m^{th} parameter of the cognitive model.

The infological scheme of database for the representation of the structure of cognitive model



The algorithm of formation of the structure of cognitive model for the analysis of the information-educational environment of the automated training (1 from 2)

At the stage of identification

1 Proceeding from the received primary representations, it is required to define the necessary quantity of portraits (PR_i) in the base of structure of cognitive model sufficient for the carrying out of the analysis of the object of research, considered in the context of a set of scientific aspects

At the stage of conceptualization

2 It is necessary to allocate (to add) a set of kinds of properties (KP_j), which characterize the object of research from the point of view of a certain scientific aspect and to bring them in the corresponding portrait (PR_i) of cognitive model

On the first step

2.1 It is required to characterize each kind of properties (KP_j) of the object of research by a set of elementary properties (Pr_k): if in the kind of properties it is impossible to mark out the elementary properties, then it is elementary property

On the second step

2.2 Each elementary property (Pr_k) of the object of research needs to be characterized by the vector of parameters (VP_l): if in the elementary property it is impossible to allocate the vector of parameters, then it is the vector of parameters

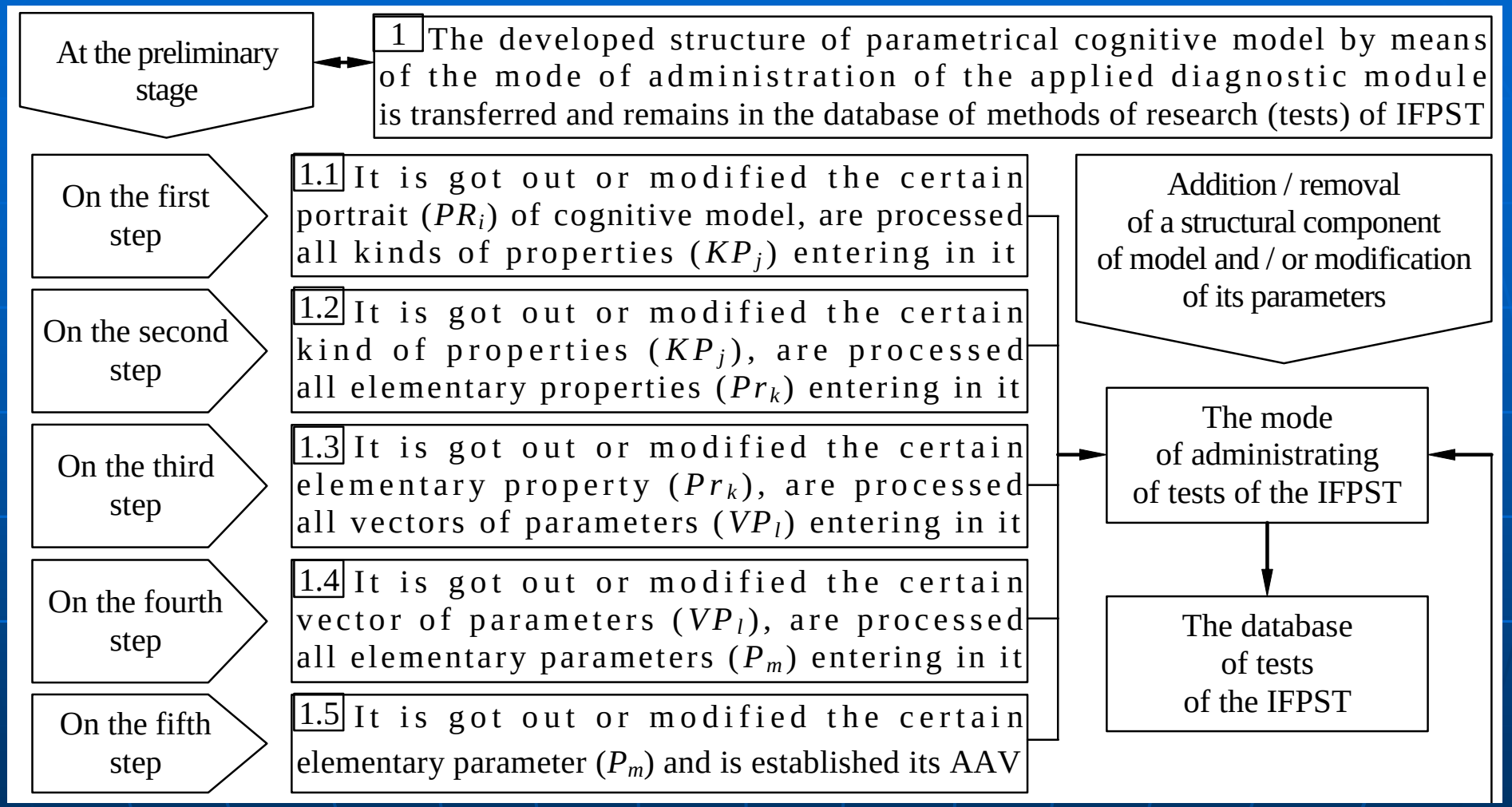
On the third step

2.3 It is required to determine the elementary parameters (P_m) entering into the basis of each vector of parameters (VP_l): if in the vector of parameters it is impossible to allocate the elementary parameters, then it is elementary parameter

The algorithm of formation of the structure of cognitive model for the analysis of the information-educational environment of the automated training (2 from 2)

At the stage of structuring	3 It is necessary to unite the received results of previous technological stage and to form the structure of cognitive model (newly created or to decompose the existing with taking into account the new components and possible restrictions)
At the stage of formalization	4 It is necessary to choose one of the formal (logical, graph, theory of sets and etc.) or informal (conceptual model, ontology of the object of research and etc.) models of representation of structural components of cognitive model
On the first step	4.1 It is necessary to create the first level of cognitive model: according to the chosen aspects of research and received earlier results it is necessary to form a set of portraits of CM (I), then to set up a set of kinds of properties (J) and a set of properties (K)
On the second step	4.2 It is required to create the second level of cognitive model: it is necessary to add the received structure of cognitive model (the first level), having formed a set of vectors of parameters (L) and having given a set of parameters (M)
At the stage of the structural analysis	5 It is carried out the system analysis of structure of received cognitive model at the first level – a set of kinds of properties (J) and properties (K): components in a corresponding sets qualitatively characterize the object of research
At the stage of the parametrical analysis	6 It is realized the analysis of structure of received cognitive model at the second level – a sets of vectors of parameters (L) and parameters (M): values of parameters of the second level of structure of cognitive model characterize the IFPST and should not be contradictory
At the stage of realization and subsequents	7 It is carried out the encapsulation of received structure of cognitive model in the basis of information-educational environment, the filling of parameters of model by a posteriori data of modeling, their statistical analysis and subject interpretation

The technique of research of parameters of the cognitive model of subject of training (1 from 2)



The technique of research of parameters of the cognitive model of subject of training (2 from 2)

At the preparatory stage

2 It is made the selection of methods of research (tests) of the IFPST for the automated diagnostics of parameters of cognitive model, and also statement, organization and conducting of experimental researches (pilot studies)

On the first step

2.1 It is carried out the selection and addition in the database of tests of the IFPST of a new method of research of parameter(s)

On the second step

2.2 It is provided the program realization of a method of research (test) of the IFPST in the base of the applied diagnostical module

On the third step

2.3 It is carried out the integration of program realization of a new method of research (test) of the IFPST into the structure of applied diagnostical module

New procedure of diagnostics of parameters

The applied diagnostic module

At the stage of testing

3 It is realized the automated diagnostics of nominal values of parameters of the cognitive model of subject of training by means of the applied diagnostical module, which is in the structure of complex of programs

On the first step

3.1 The diagnostics of parameters of the first portrait of cognitive model (PR_1) by means of a set of applied methods of research, which are contained in the database of tests of the IFPST

On the i^{th} step

3.i The diagnostics of parameters of the i^{th} portrait of cognitive model (PR_i) by means of a set of applied methods of research, which are contained in the base of tests of the IFPST

The mode of diagnostics of parameters of cognitive model

The database of a posteriori results of research

At the stage of the analysis

4 The automated (manual) calculation of recommended values of parameters of the cognitive model of means of training (types, kinds and ways of display of information) on the basis of the analysis of values of parameters of the cognitive model of subject of training (parameters, characterizing the IFPST)

At the stage of adaptive training

5 It is realized the automated individually-oriented representation of information fragments by means of the adaptive electronic textbook, functioning on the basis of the parametrical cognitive models block

The technique of research of parameters of the cognitive model of means of training (1 from 2)

At the preliminary stage

1 The developed structure of cognitive model of means of training by means of the mode of administrating of the applied diagnostic module is transferred and remains in the settings of adaptive means of training (electronic textbook)

On the first step

1.1 It is got out or modified the certain portrait (PR_i) of cognitive model, are processed all kinds of properties (KP_j) entering in it

On the second step

1.2 It is got out or modified the certain kind of properties (KP_j), are processed all elementary properties (Pr_k) entering in it

On the third step

1.3 It is got out or modified the certain elementary property (Pr_k), are processed all vectors of parameters (VP_l) entering in it

On the fourth step

1.4 It is got out or modified the certain vector of parameters (VP_l), are processed all elementary parameters (P_m) entering in it

On the fifth step

1.5 It is got out or modified the certain elementary parameter (P_m) and is established its AAV

Addition / removal of a structural component of model and / or modification of its parameters

The mode of administrating of the means of training

The saving of parameters of configuration

The technique of research of parameters of the cognitive model of means of training (2 from 2)

At the preparatory stage

2 It is carried out the analysis of life cycle of program realization of the adaptive means of training and comes to light the functional possibilities of display of information on the basis of technical specification for the modification of a set of parameters of the CM of means of training

On the first step

2.1 The analysis of a possibility of technical realization of representation of diverse information, considering the new parameter of display

On the second step

2.2 It is provided the program realization of procedure (algorithm) in the base of the adaptive representation of information fragments processor of the means of training

On the third step

2.3 It is carried out the integration of program realization of the new procedure (algorithm) of display into the structure of adaptive representation of information processor

The new procedure in the base of the adaptive representation of information processor

The adaptive means of training (electronic textbook)

At the stage of debugging

3 It is realized the check of nominal values of parameters of the cognitive model of means of training used by the adaptive means of training, in order to avoid the incorrect display of information in the process of automated training

On the first step

3.1 The verification of values of parameters of the first portrait of cognitive model (PR_1) set up manually or by means of the procedure of automatic calculation

⋮

On the i^{th} step

3.i The verification of values of parameters of the i^{th} portrait of cognitive model (PR_i) set up manually or by means of the procedure of automatic calculation

The procedure of automatic calculation of values of parameters of display

Form for the installation of values of parameters manually

At the stage of the analysis

4 It is realized the automated (manual) calculation of recommended values of parameters of the cognitive model of means of training (types, kinds and ways of display of information) on the basis of the analysis of values of parameters of the cognitive model of subject of training (characterize the IFPST)

At the stage of adaptive training

5 It is realized the automated individually-oriented representation of information fragments by means of the adaptive electronic textbook, functioning based on the parametrical cognitive models block

The algorithm of processing of a posteriori results of testing (1 from 2)

At the preliminary stage

1 In the result of the analysis of question-answers structures of test is reached the calculation of indicators necessary for the conducting of testing: it is formed the interval scale and function of estimation

$$\begin{cases} b_0 = 0; \\ b_{\max} = n \end{cases}$$

On the first step

1.1 It is defined the maximally and minimally possible number of correct answers for the procedure of estimation and formation of function of estimation

On the second step

1.2 There are set up the lower and top threshold values of sums of correct answers (points) for the exposure of corresponding nominal values of estimates

$$\begin{cases} [b_0 = 0] - mark(nominal)=1; \\ [b_1, b_2] - mark(nominal)=2; \\ [b_2, b_3] - mark(nominal)=3; \\ [b_3, b_4] - mark(nominal)=4; \\ [b_4, b_5 = n] - mark(nominal)=5; \\ b_0 < b_1 < b_2 < b_3 < b_4 < b_5 \end{cases}$$

On the third step

1.3 There are formed the intermediate borders of intervals on the basis of sums of correct answers (points) for the set up of intermediate nominal values of estimates (is formed the interval scale of estimation)

$$\mu(x) = \begin{cases} 1, b_0 < x < b_1; \\ 2, b_1 < x < b_2; \\ 3, b_2 < x < b_3; \\ 4, b_3 < x < b_4; \\ 5, b_4 < x < b_5 = n; \end{cases}$$

On the fourth step

1.4 On the basis of interval scale the function of estimation of the diagnostical module is set up

At the stage of testing

2 There is carried out the preparation of software to the testing of target indicators: the interval scale and function of estimation in the mode of administrating is brought for the support of functioning of algorithmic structure

The algorithm of processing of a posteriori results of testing (2 from 2)

At the stage of the analysis of results

3 The saved-up a posteriori data are exposed to the statistical processing, allowing to carry out the analysis and to formulate the conclusions about current condition (level of residual knowledge of examinee and his personal characteristics)

3.1 The coefficient of difficulty of task, proceeding from which value is defined: at K>0,9 – the task is difficult, at K<0,2 – the task is easy

$$K_j = \frac{N_j}{N}$$

3.2 Total result of performance of all tasks by the i^{th} examinee

$$y_j = \sum_{j=1}^{M} x_{ij}$$

3.3 Total result of performance of the j^{th} task by all examinees

$$x_j = \sum_{i=1}^{N} x_{ij}$$

3.4 Average level of testing on results of performance of all tasks

$$\bar{Y} = \frac{\sum_{i=1}^{N} y_i}{N}$$

3.5 Average level of performance of j^{th} task by all examinees

$$p_j = \frac{x_j}{N}$$

3.6 Dispersion of total points of all examinees (subjects of training)

$$\delta_y^2 = \frac{\sum_{i=1}^{N} (y_i - \bar{Y})^2}{N-1}$$

3.7 Standard deviation of total points of examinees

$$\delta_y = \sqrt{\delta_y^2}$$

3.8 Dispersion of results of testing on the j^{th} task

$$\delta_j^2 = \frac{\sum_{i=1}^{N} (x_i - p_j)^2}{N-1}$$

3.9 Standard deviation of results of testing on j^{th} task

$$\delta_j = \sqrt{\delta_j^2}$$

3.10 Estim. of conn. of the each j^{th} task with the sum of points on all test

$$r_j = \frac{\frac{\sum_{i=1}^{N} (x_{ij} y_i)^2}{N} - p_j \bar{Y}}{\delta_j^2 \delta_y} \cdot \frac{N}{N-1}$$

3.11 Average arithmetical of independent expert estimates

$$\bar{Z} = \frac{\sum_{i=1}^{N} Z_i}{N}$$

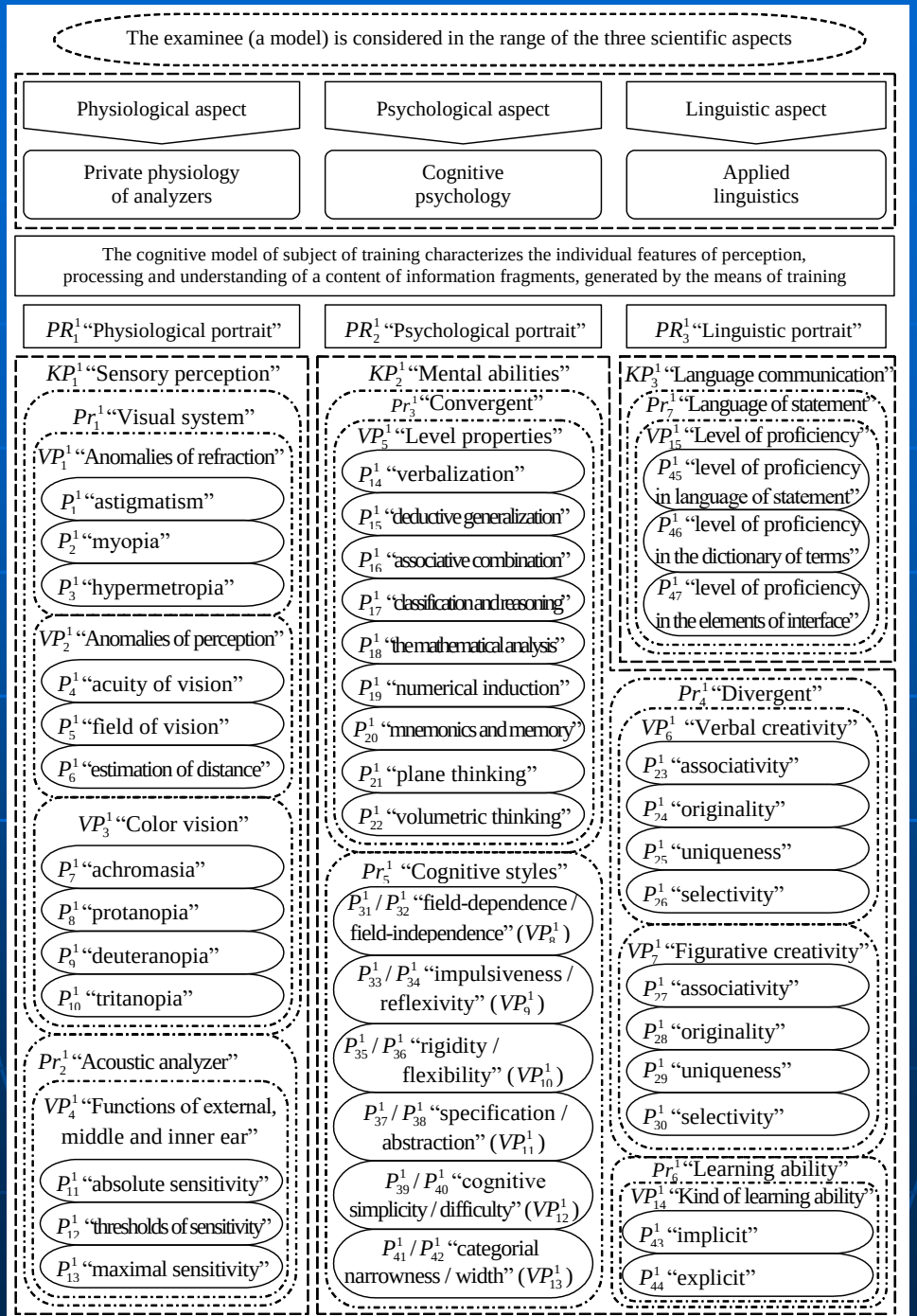
3.12 Standard deviation of expert estimates

$$\delta_Z = \sqrt{\frac{\sum_{i=1}^{N} (Z_i - \bar{Z})^2}{N-1}}$$

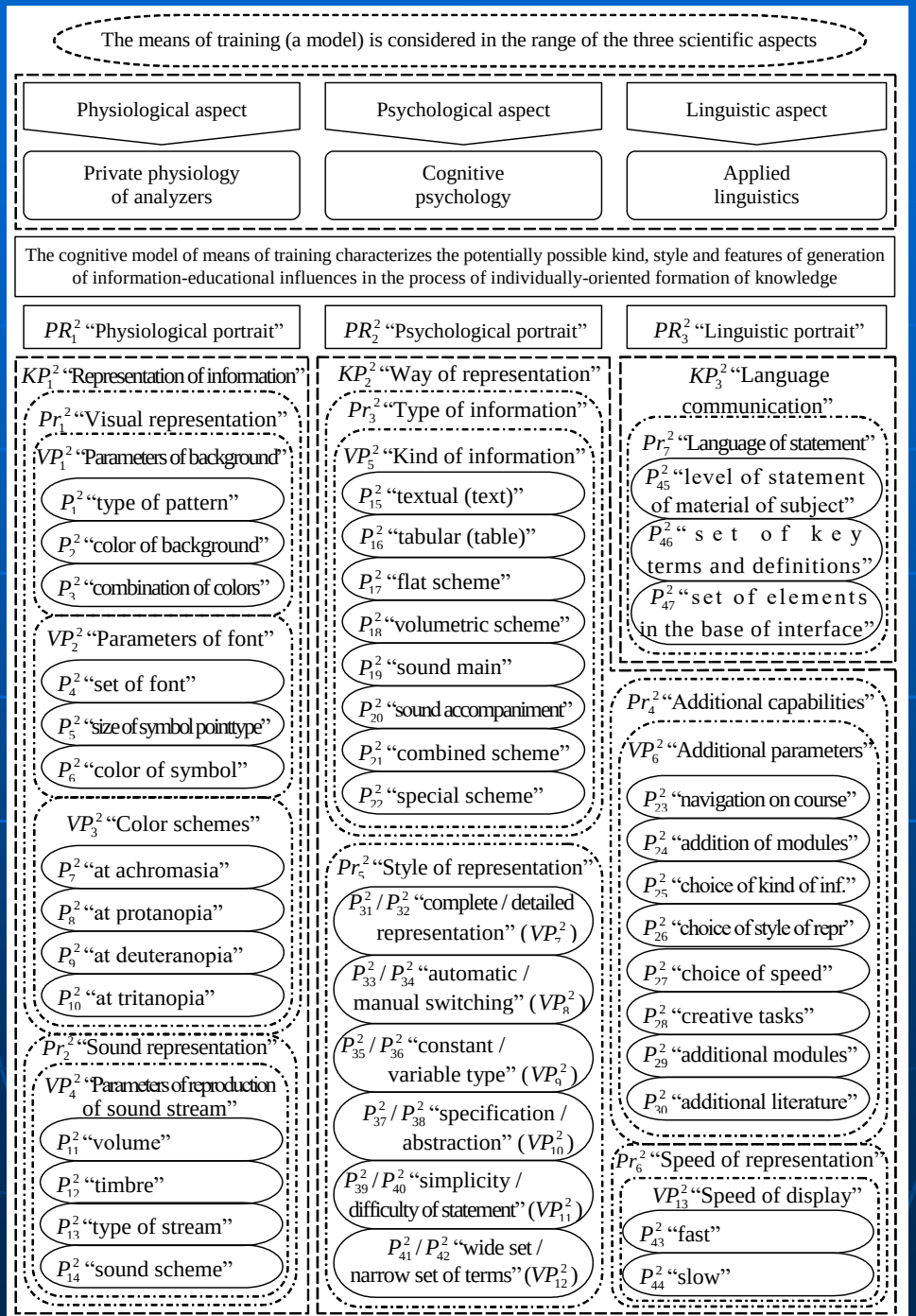
3.13 Coefficient of correlation of results of testing and independent expert estimates (validity of test)

$$V = \frac{\frac{\sum_{i=1}^{N} (Z_i y_i)}{N} - \bar{Z}\bar{Y}}{\delta_Z \delta_y} \cdot \frac{N}{N-1}$$

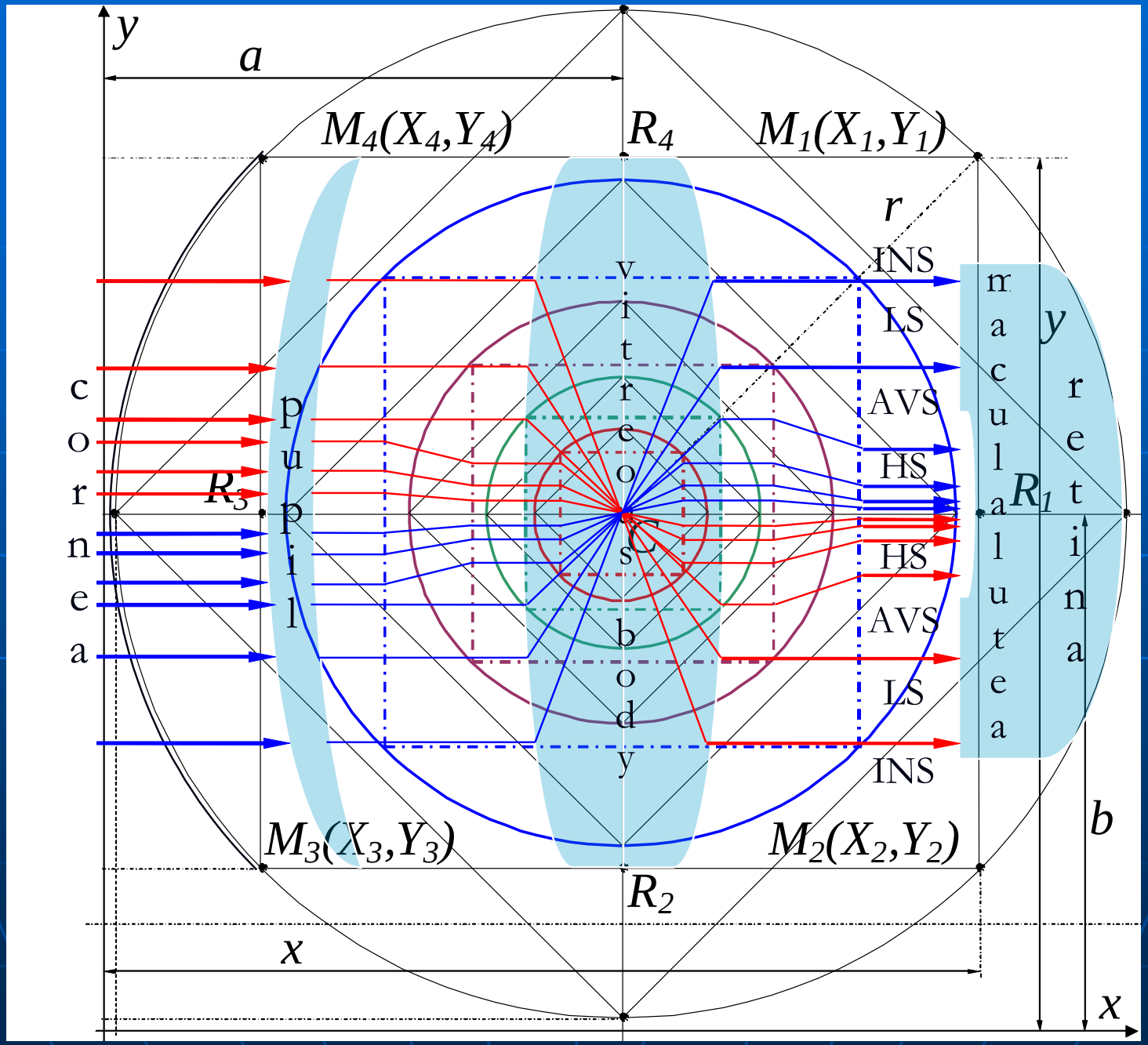
The structure of the parametrical cognitive model of subject of training



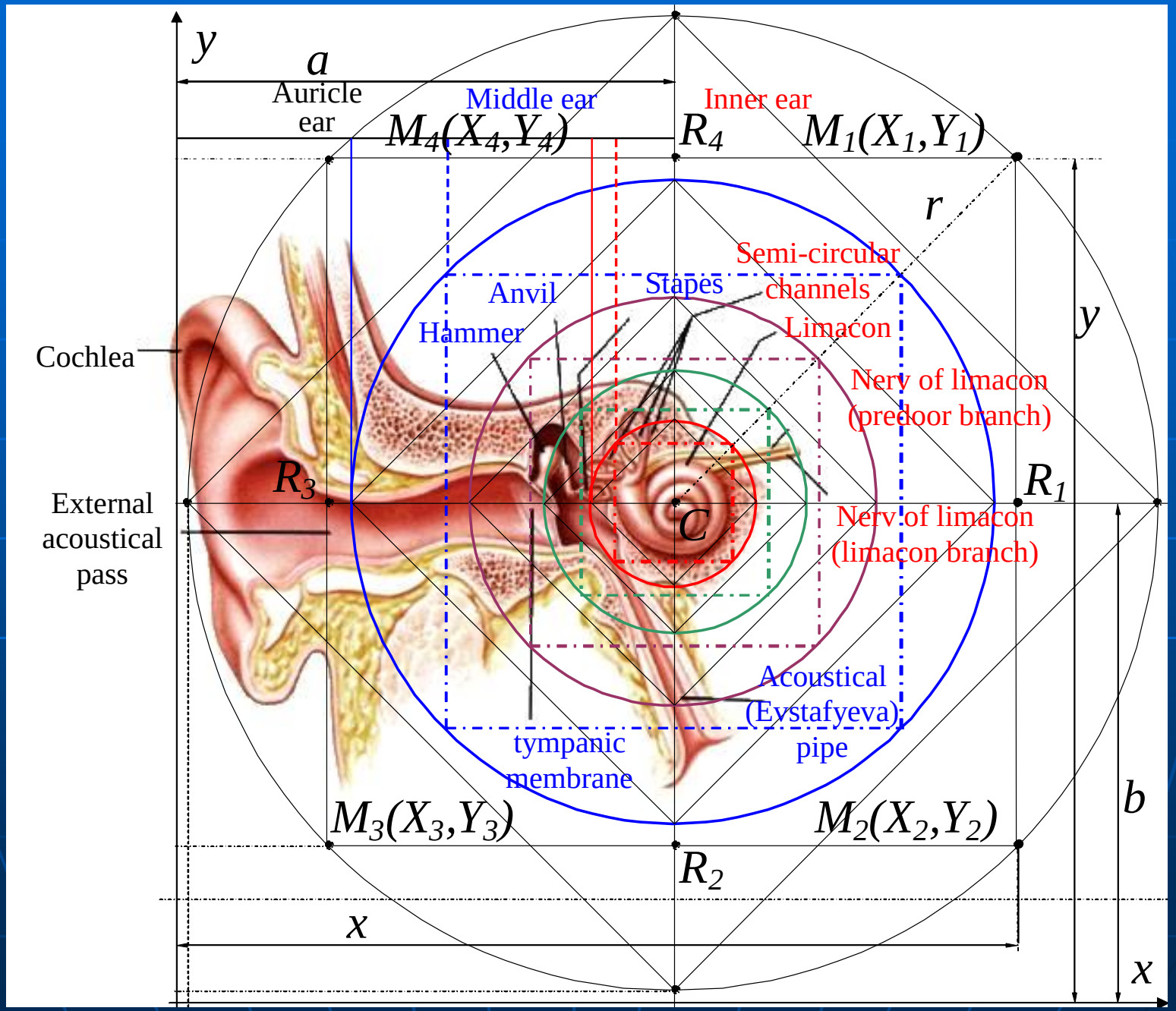
The structure of the parametrical cognitive model of means of training



The structure of the modified model of reduced eye of human

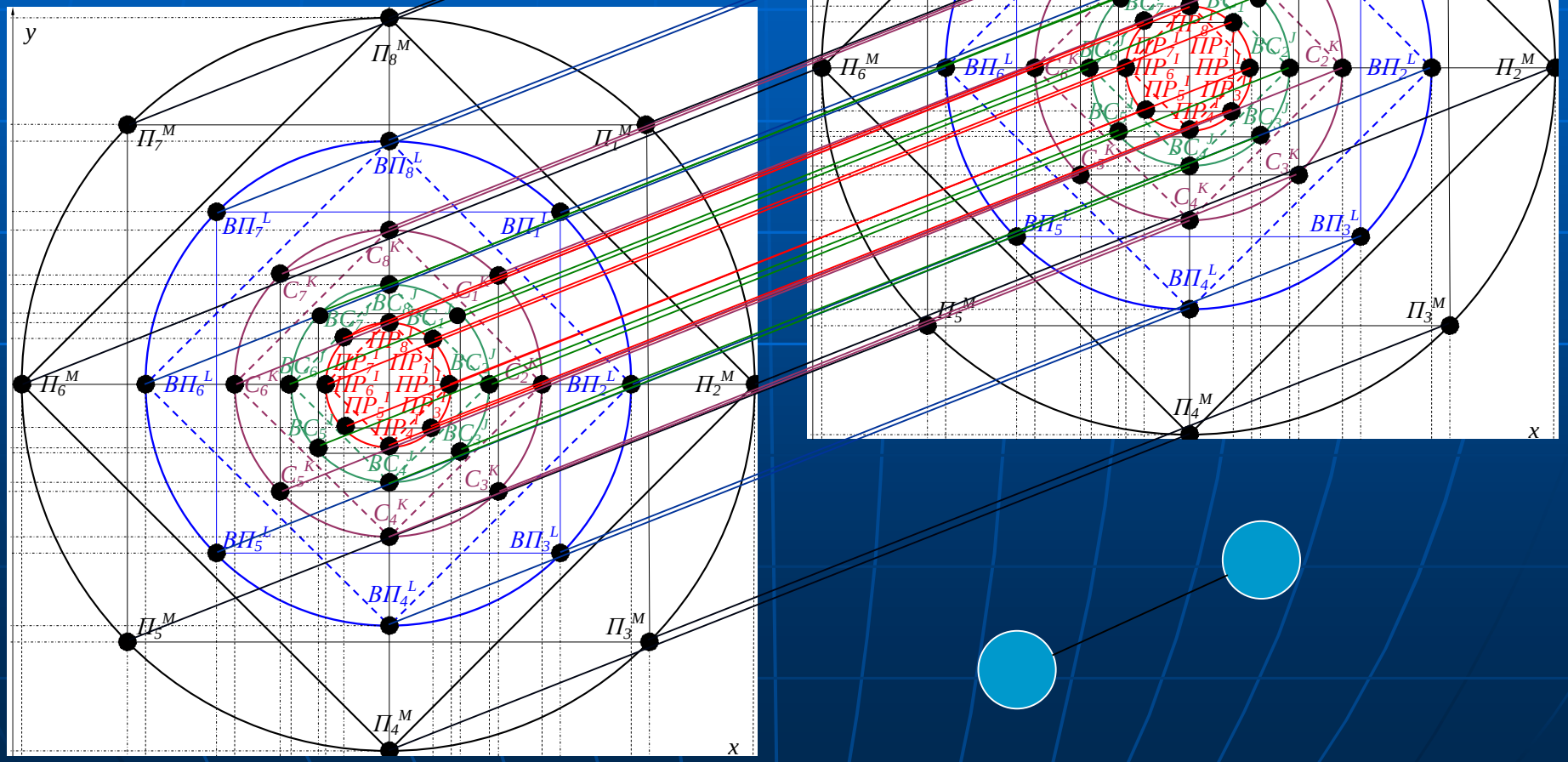


The structure of the modified model of reduced ear of human



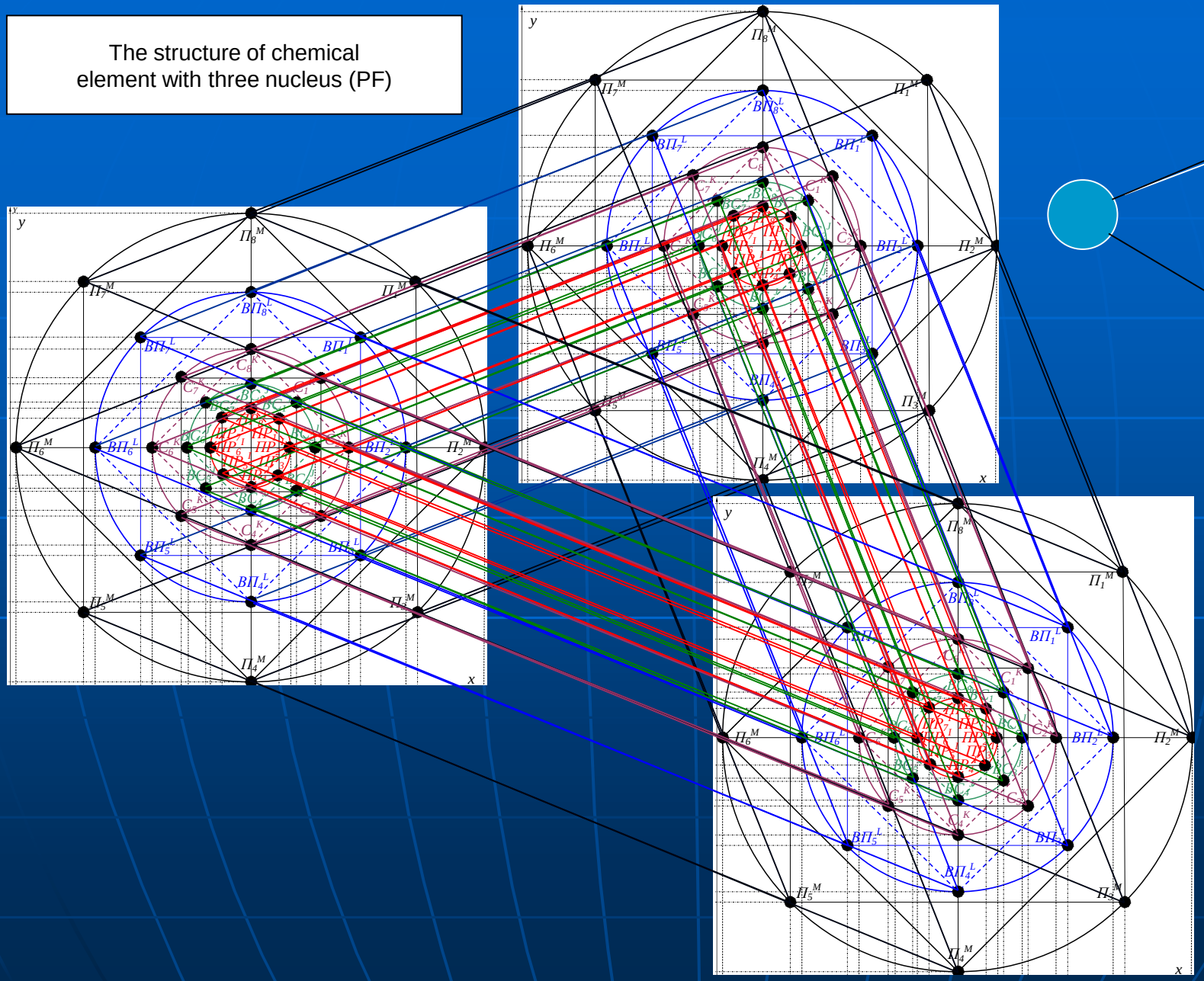
The structure of the cognitive model of chemical element (nuclear polymer) with two nucleus (plasmatic formations) in the view of the two-cognitive sphere

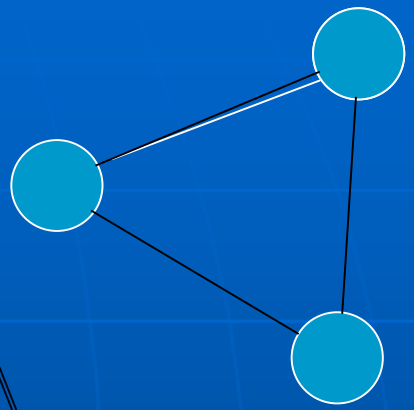
The structure of chemical element with two nucleus (PF)



The structure of the cognitive model of chemical element (nuclear polymer) with three nucleus (plasmatic formations) in the view of the three-cognitive sphere

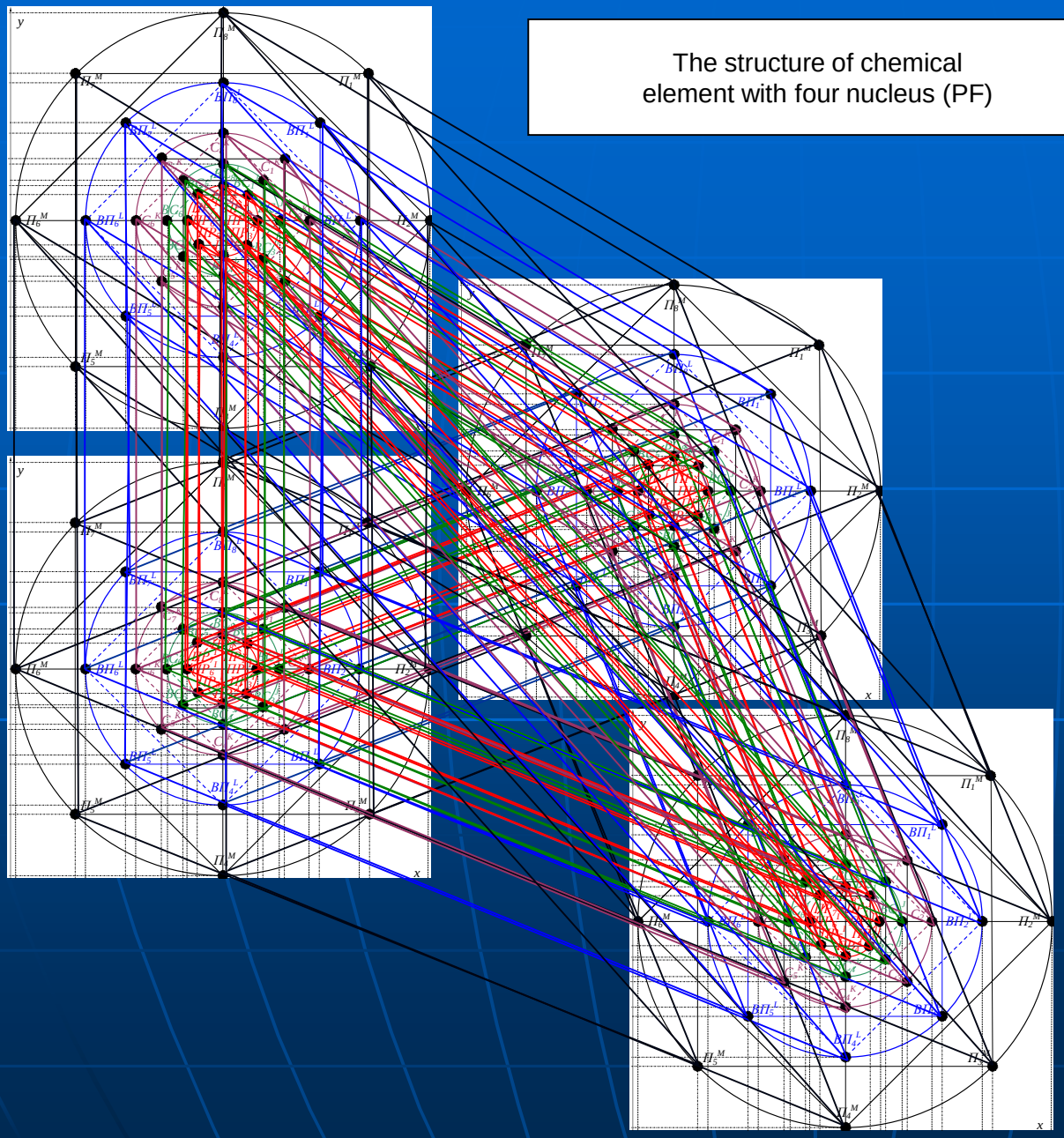
The structure of chemical element with three nucleus (PF)

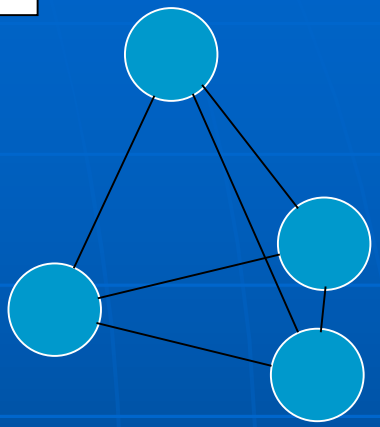




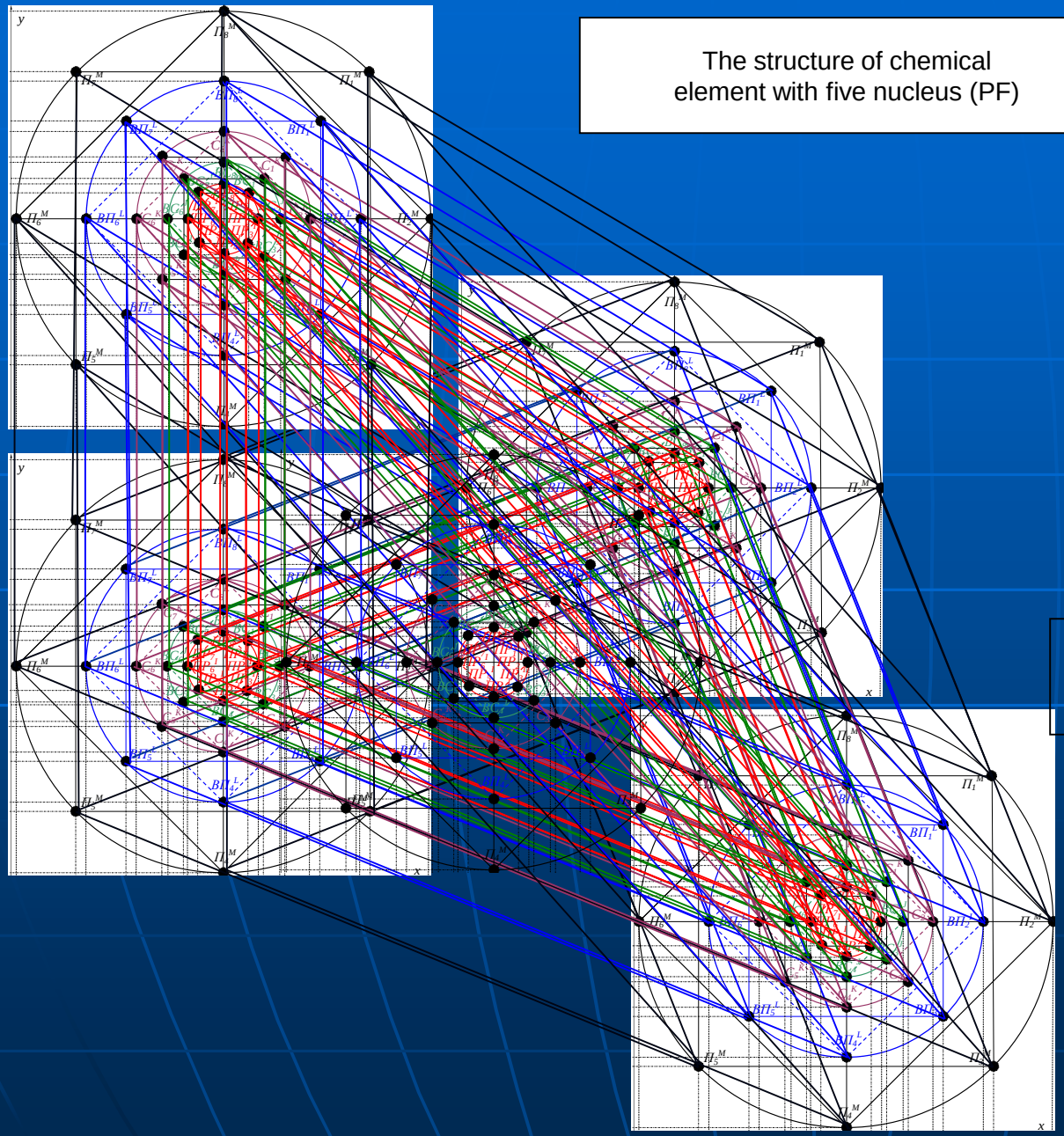
The structure of the cognitive model of chemical element (nuclear polymer) with four nucleus (plasmatic formations) in the view of the four-cognitive sphere

The structure of chemical element with four nucleus (PF)

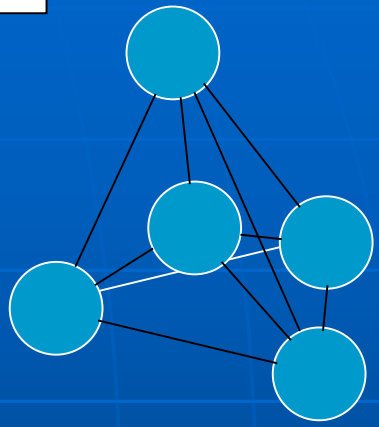




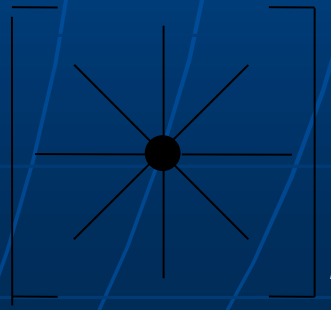
The structure of the cognitive model of chemical element (nuclear polymer) with five (and more) nucleus (plasm. formations) in the view of the five (and more)-cognitive sphere



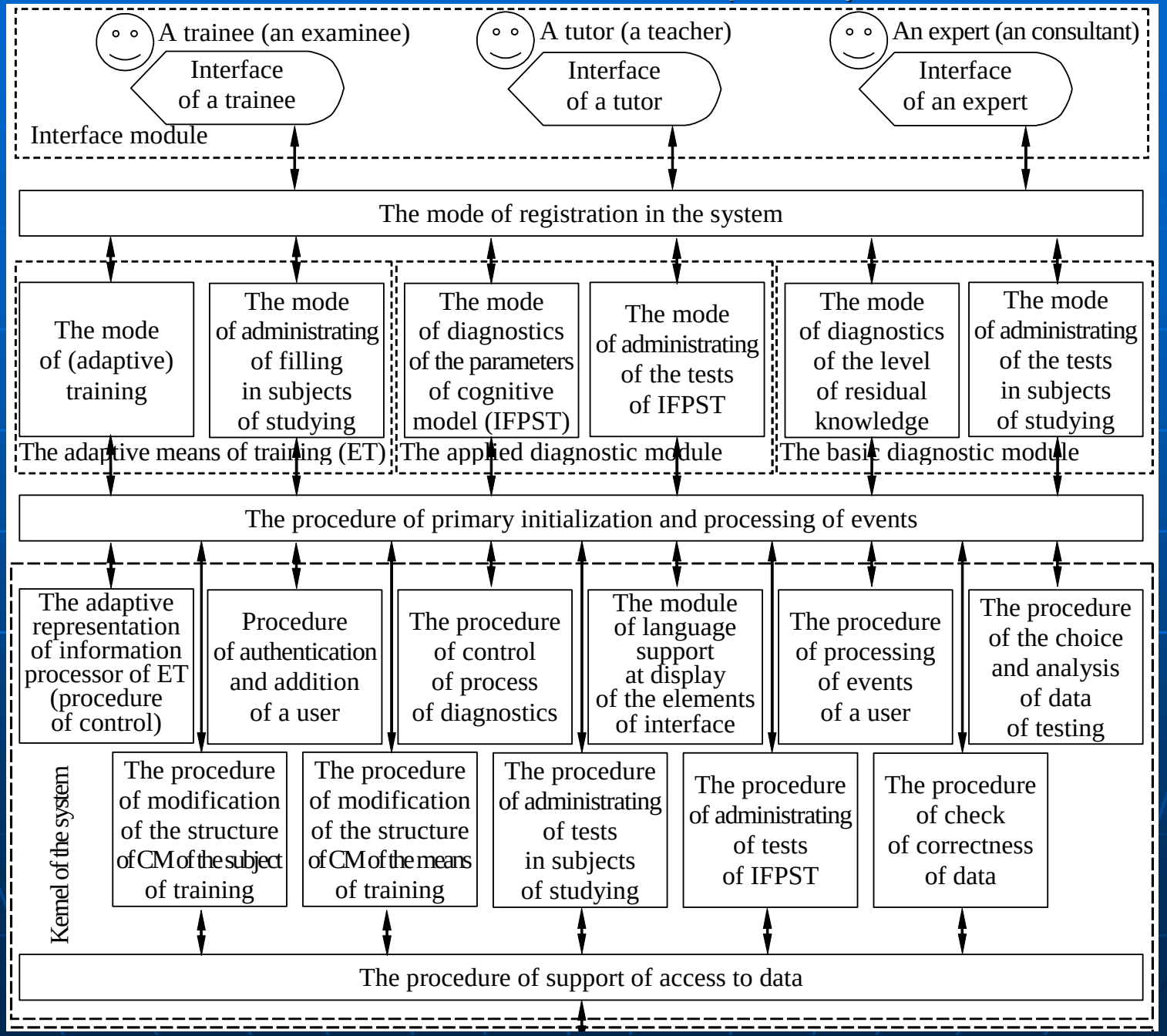
The structure of chemical element with five nucleus (PF)



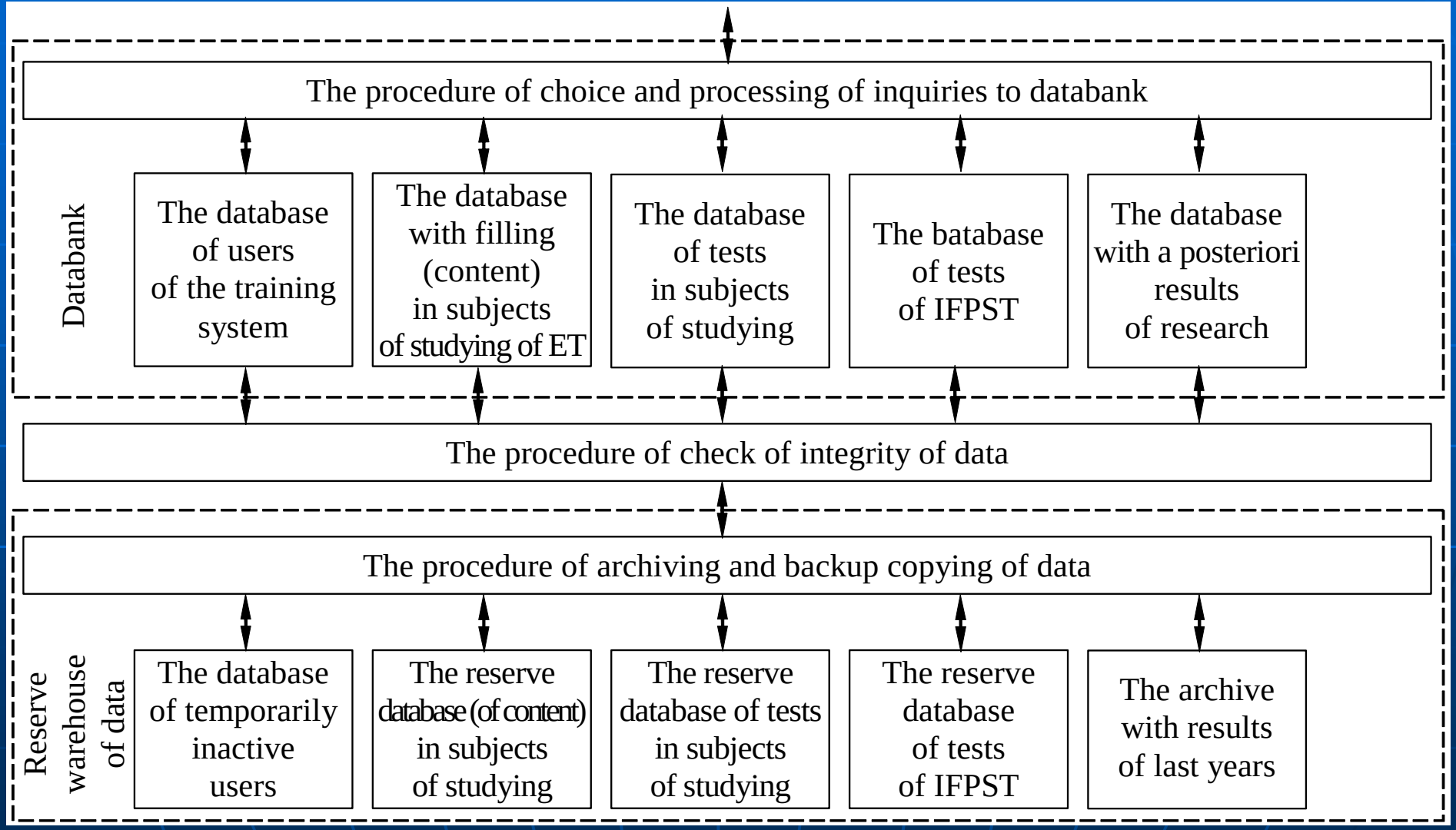
The structure of chemical element with *n*-nucleus (PF)



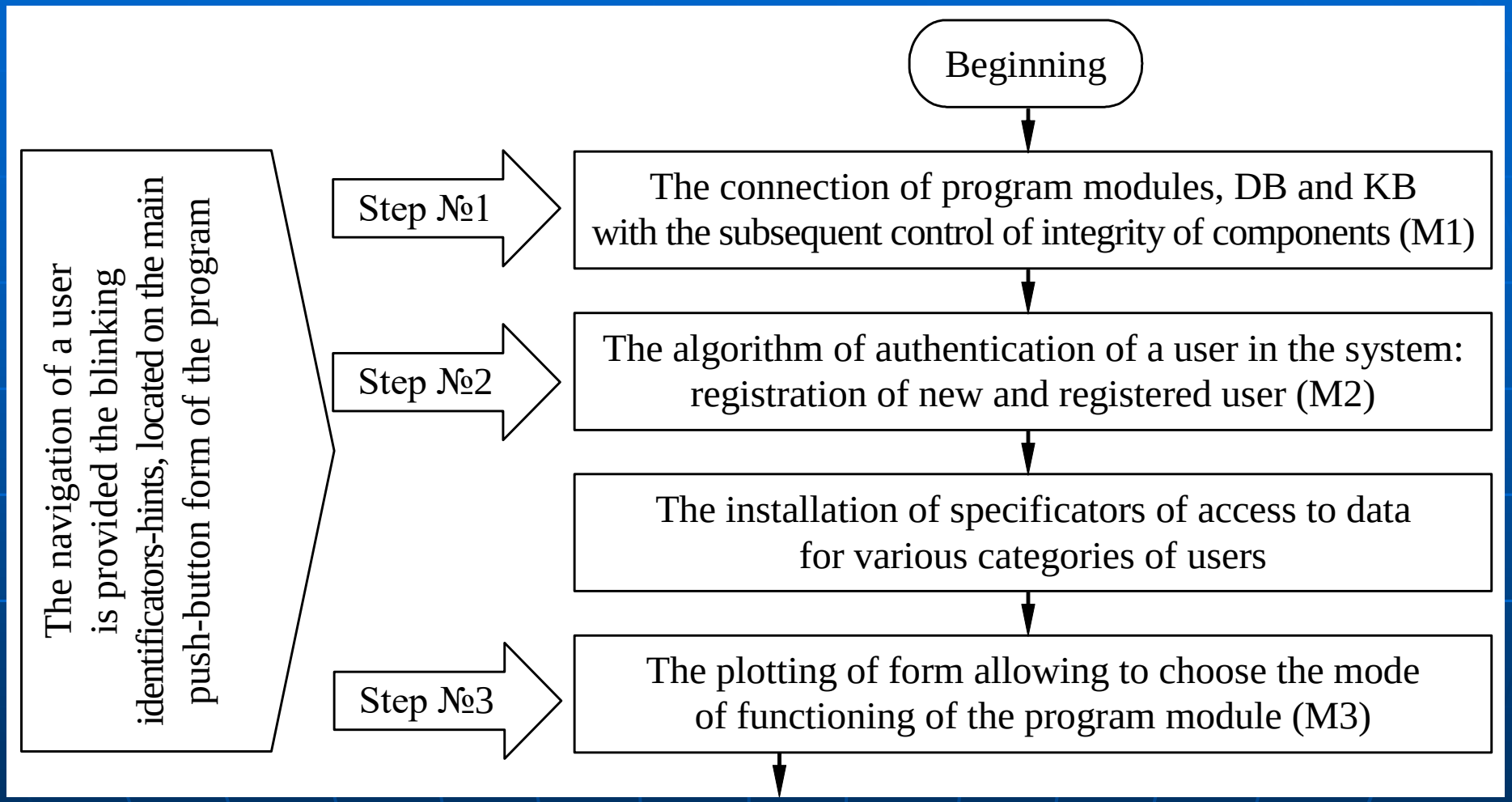
The structurally-functional scheme of the complex of programs for the automation of research tasks (1 from 2)



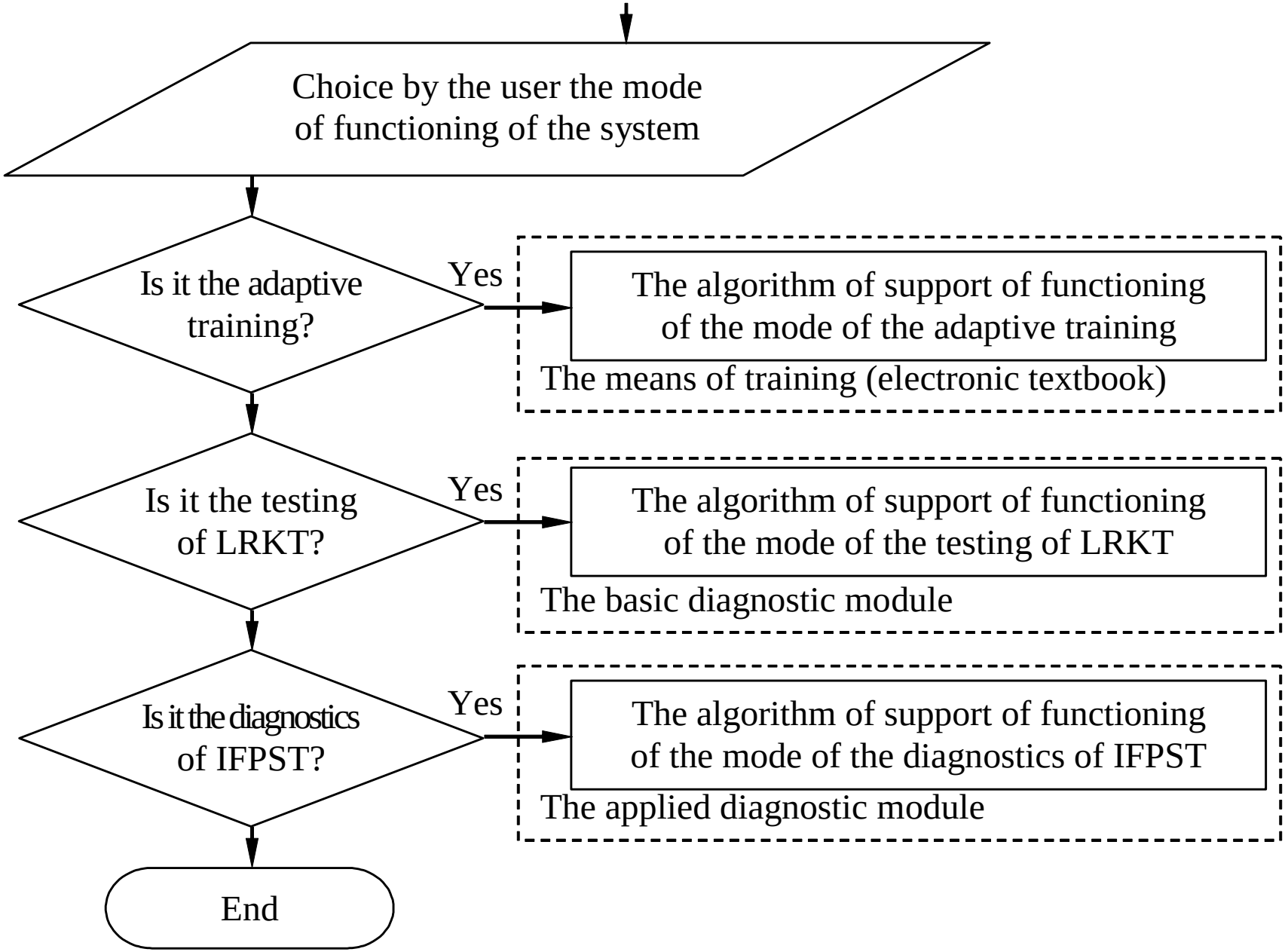
The structurally-functional scheme of the complex of programs for the automation of research tasks (2 from 2)



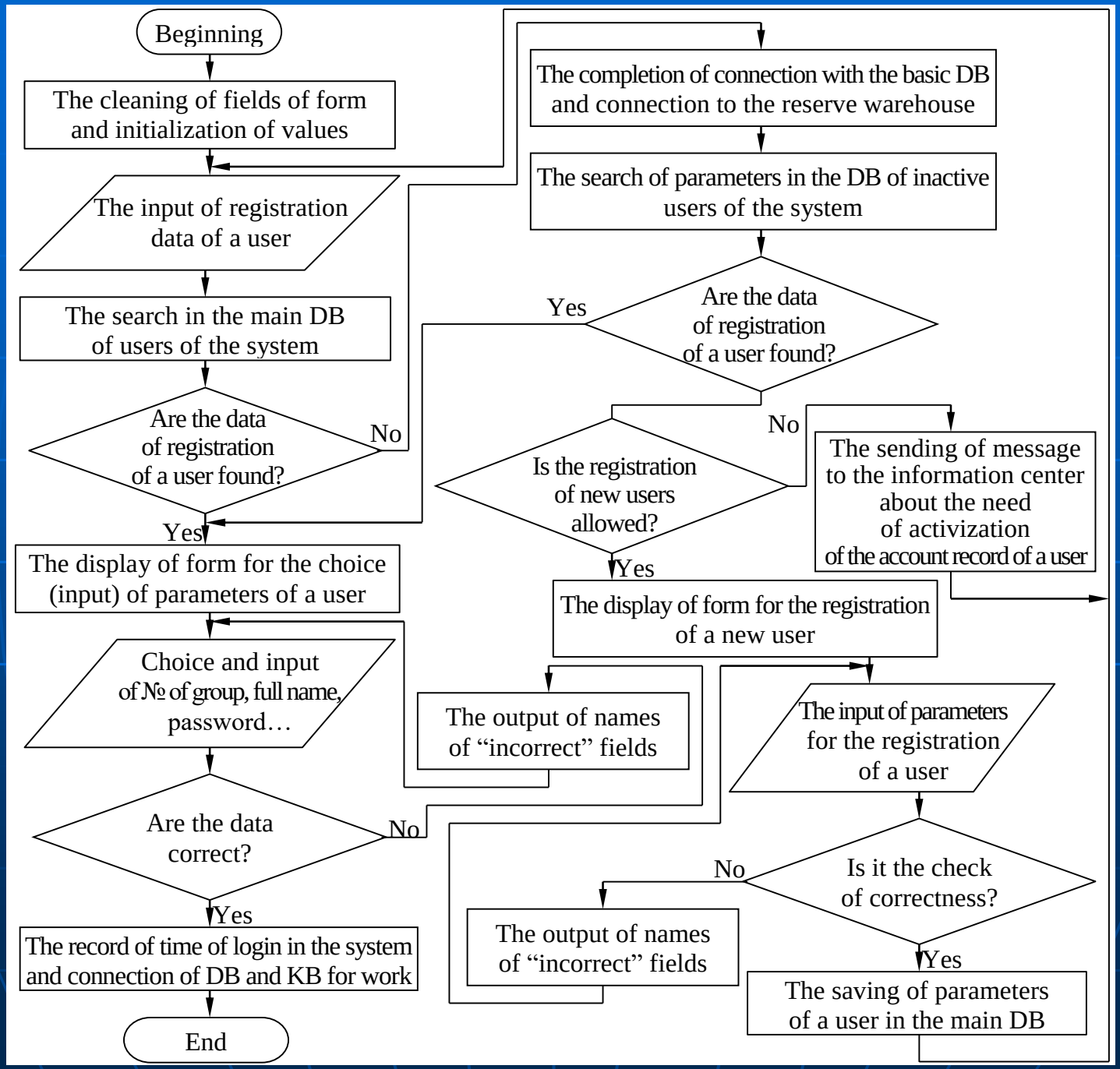
The algorithm of primary initialization of database and switching of the modes of functioning of the complex of programs for the automation of tasks of the system analysis (1 from 2)



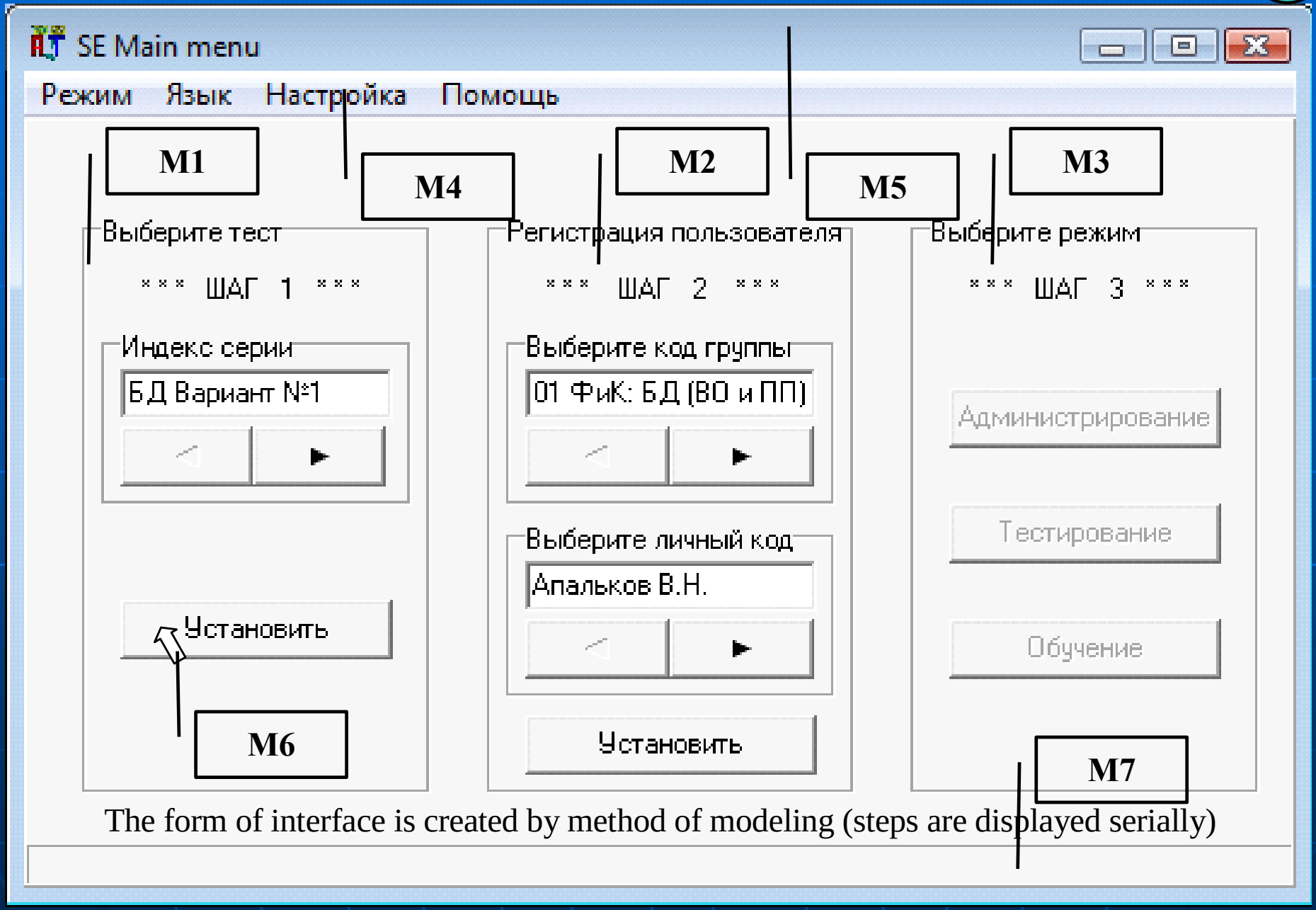
The algorithm of primary initialization of database and switching of the modes of functioning of the complex of programs for the automation of tasks of the system analysis (2 from 2)



The algorithm of authentication of a user in the automated training system

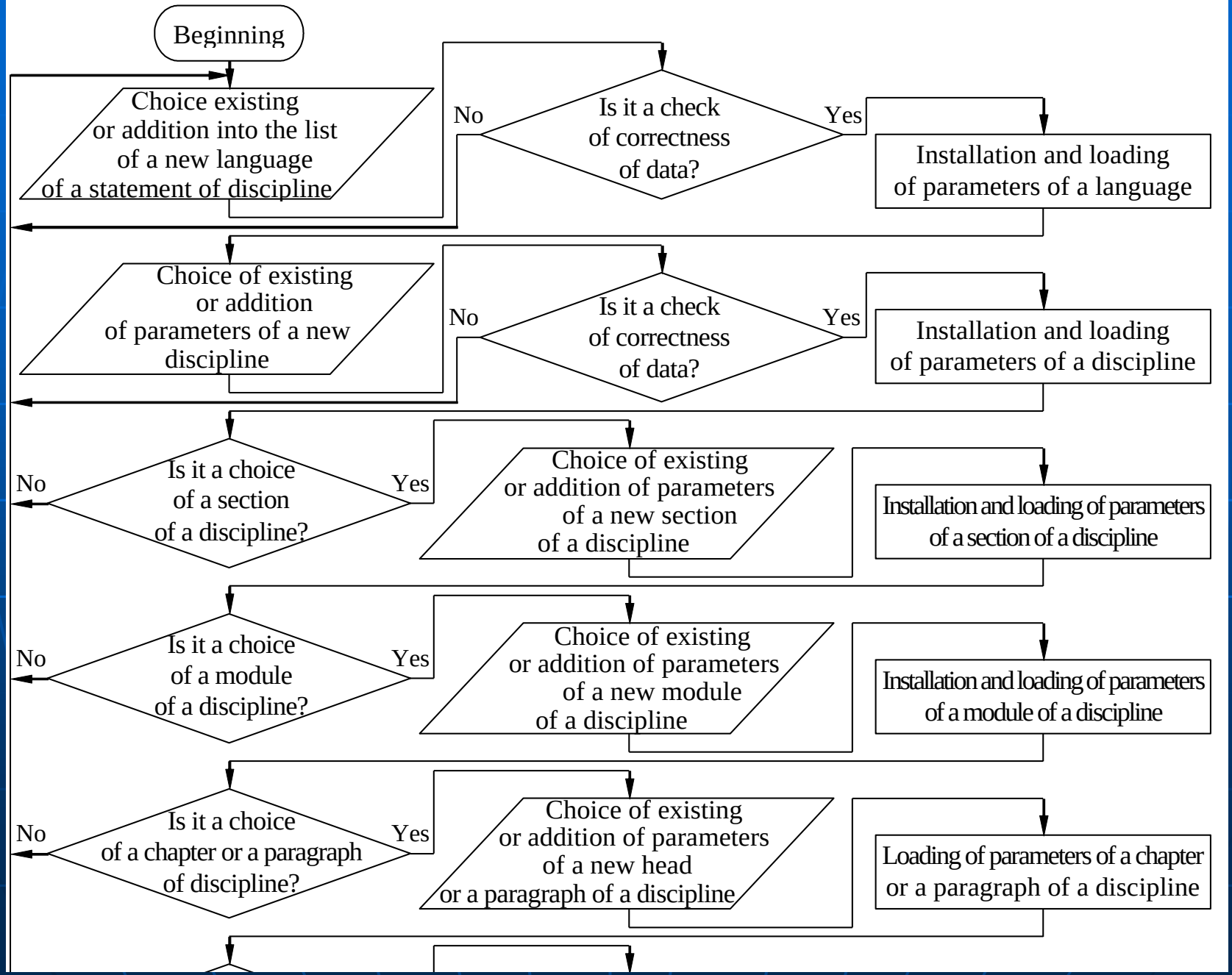


The interface of the complex of programs in the mode of main button form: the basic diagnostic module

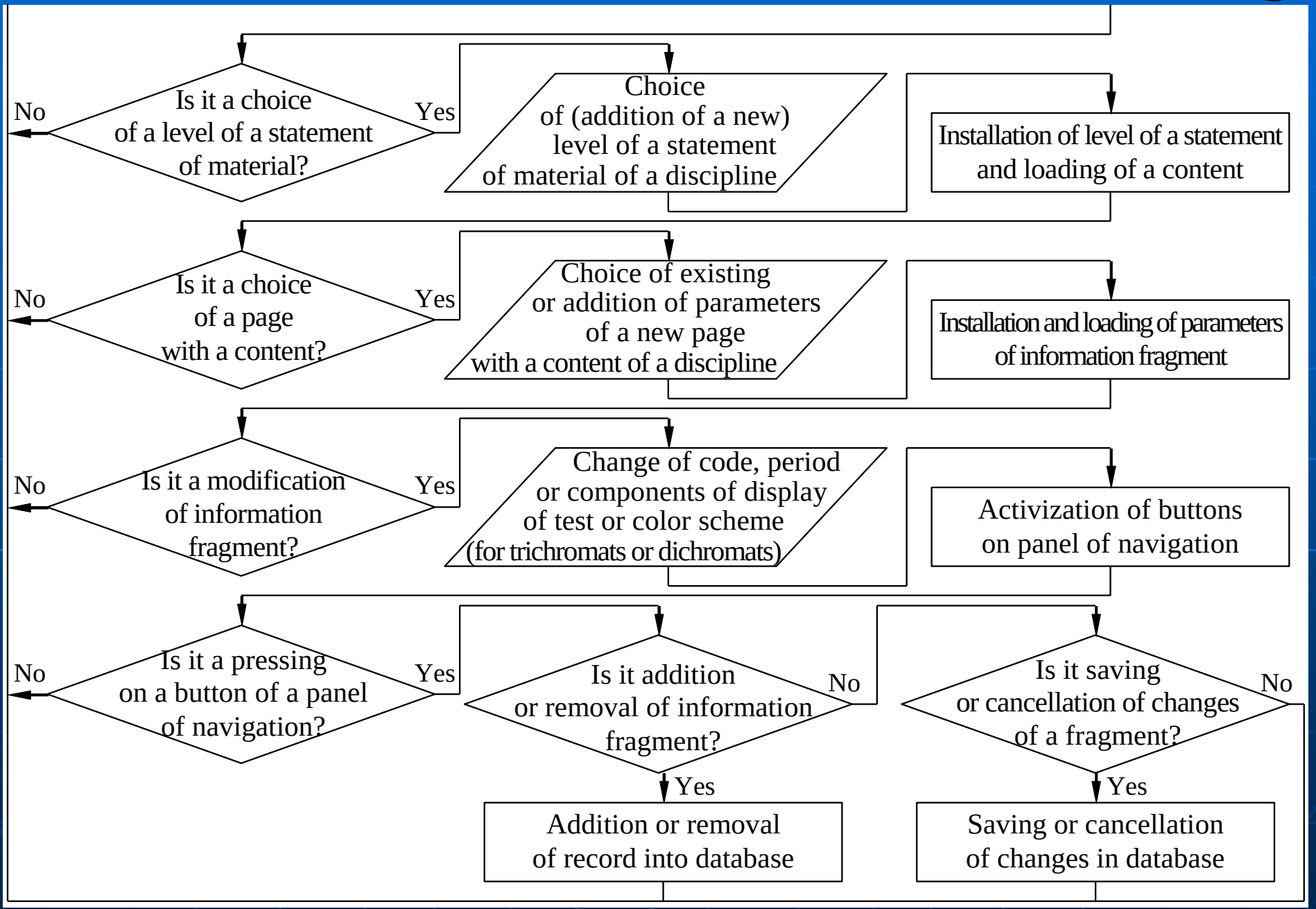


The form of interface is created by method of modeling (steps are displayed serially)

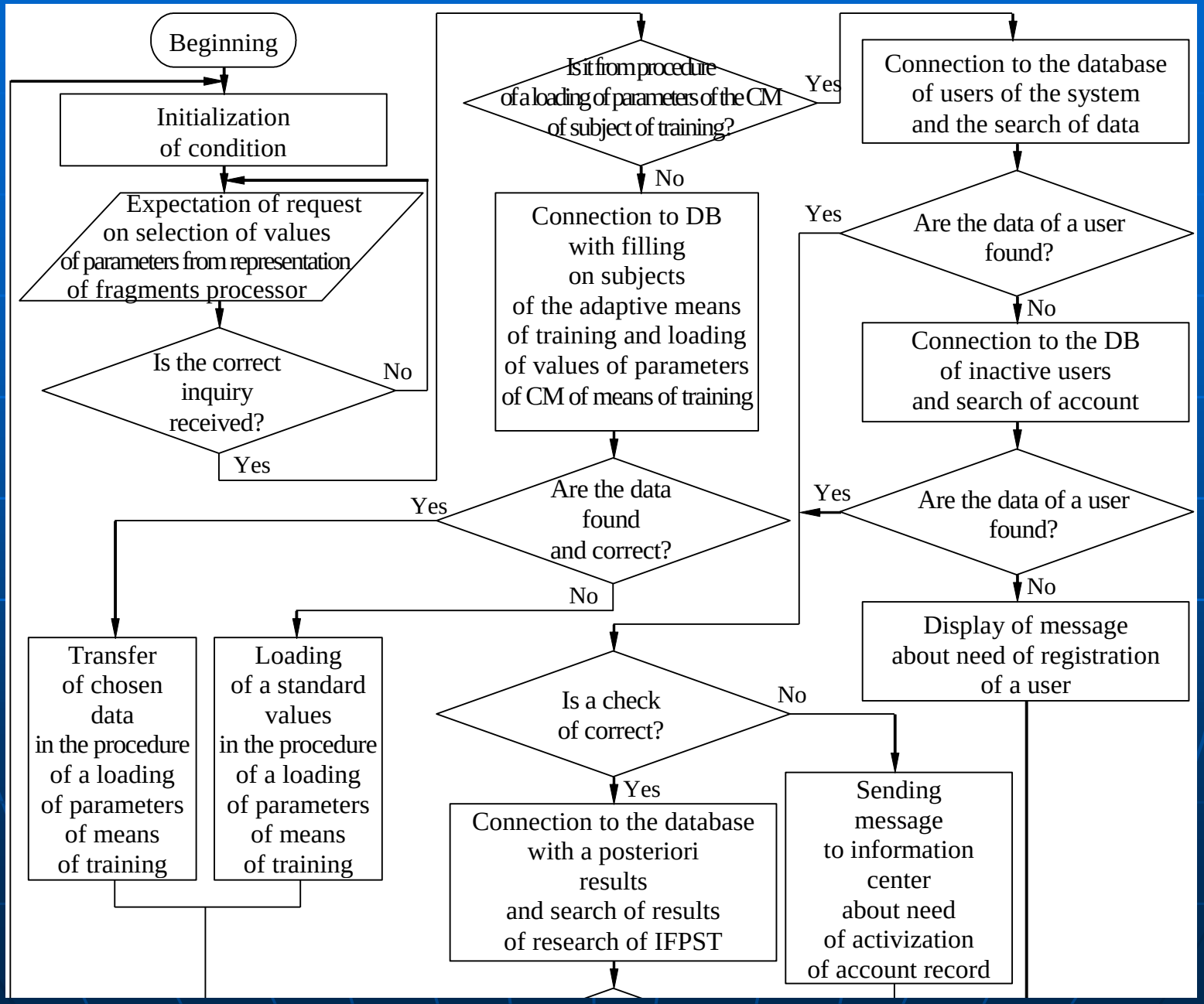
The algorithm of filling of content of the adaptive electronic textbook on the basis of the information (semantic) model of a subject of studying (1 from 2)



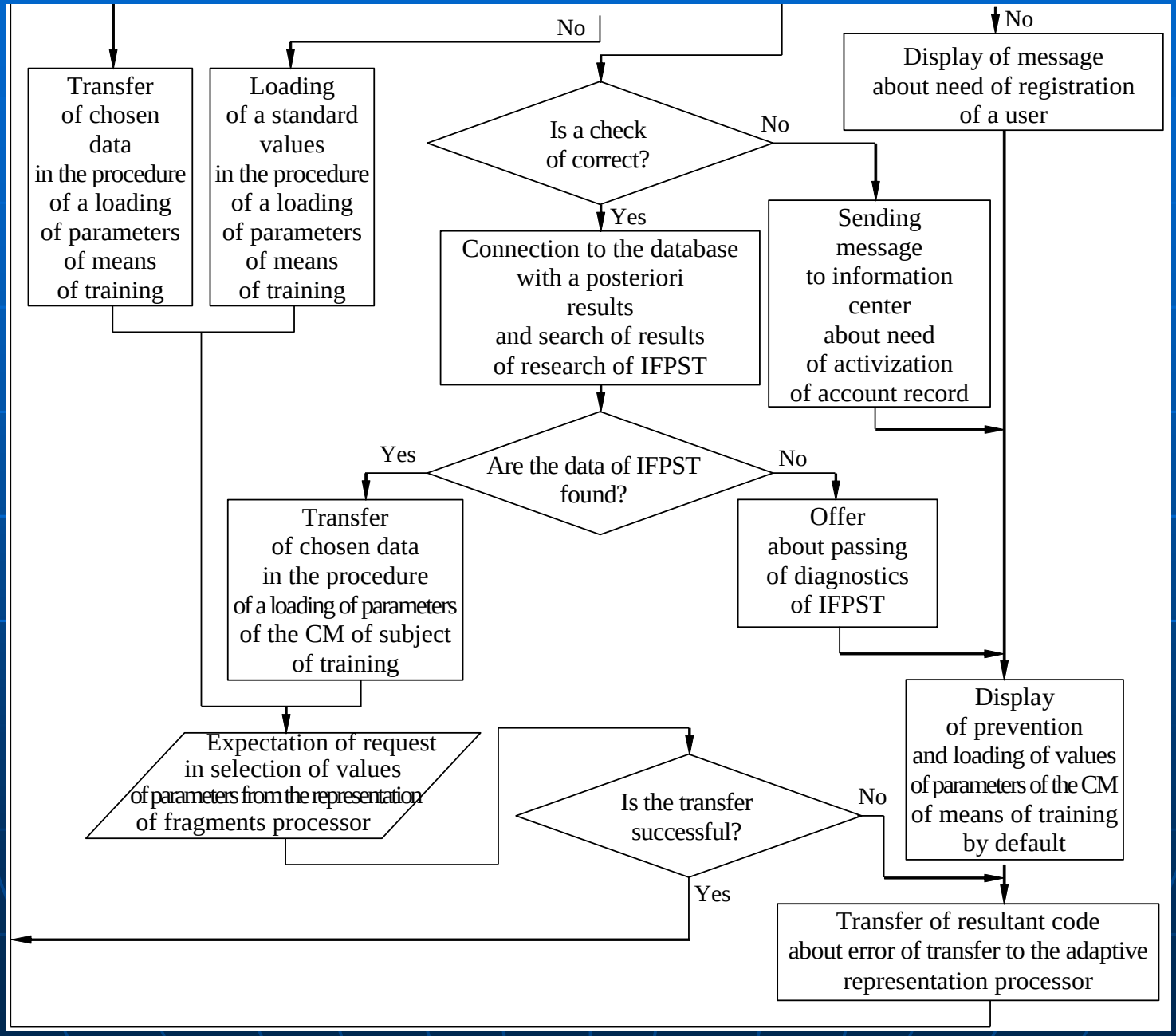
The algorithm of filling of content of the adaptive electronic textbook on the basis of the information (semantic) model of a subject of studying (2 from 2)



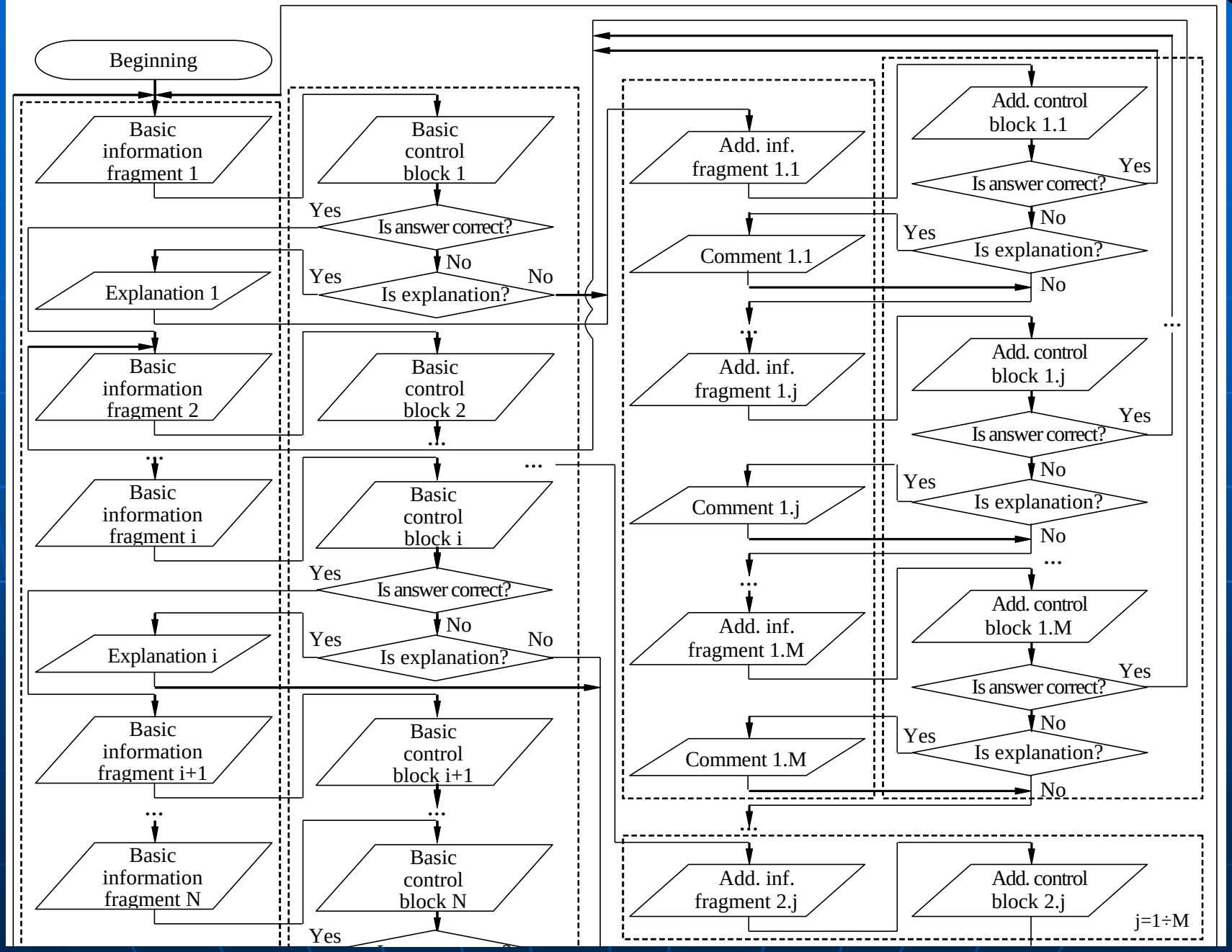
The algorithm of extraction of information fragments of the adaptive means of training (electronic textbook) on the basis of the adaptive representation of information fragments processor (1 from 2)



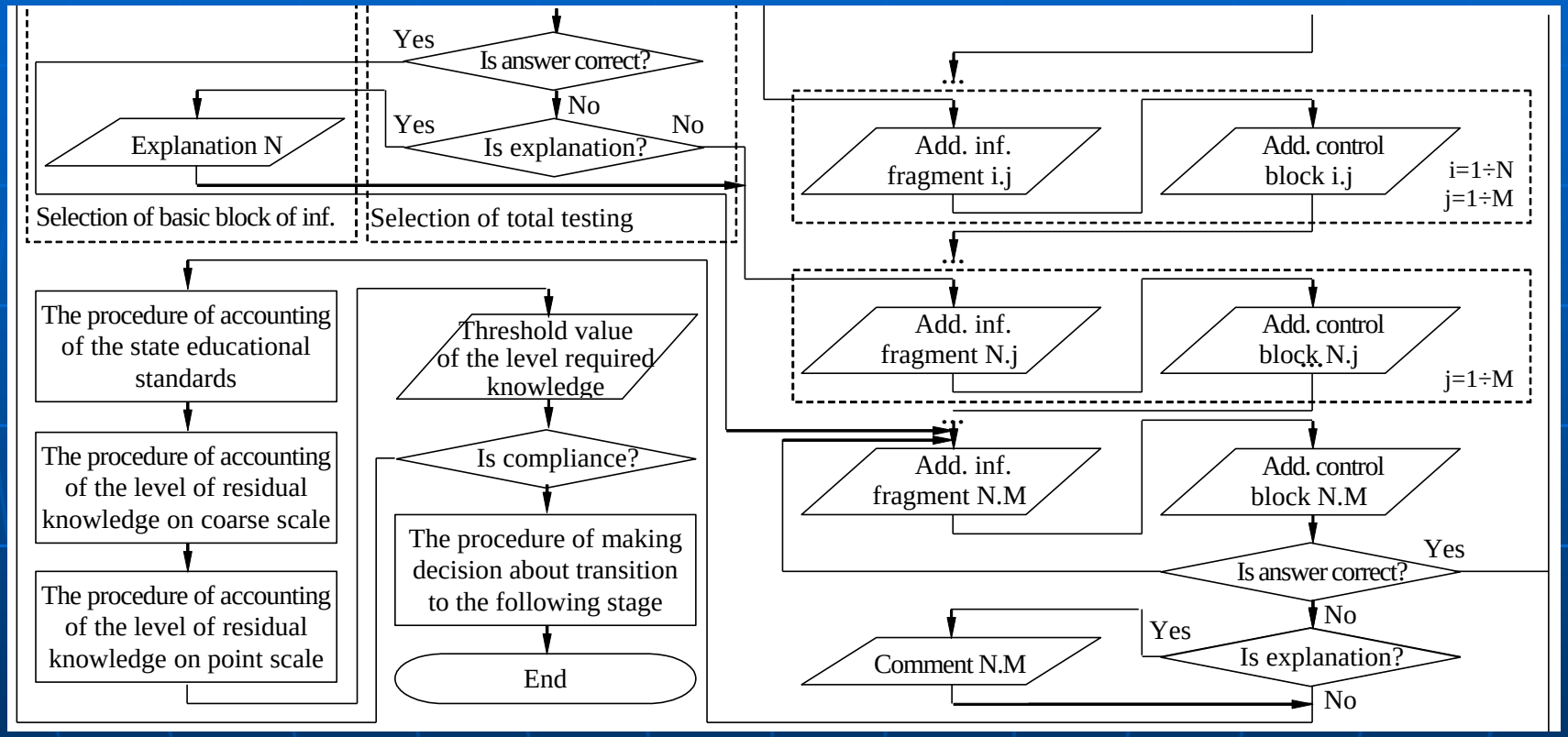
The algorithm of extraction of information fragments of the adaptive means of training (electronic textbook) on the basis of the adaptive representation of information fragments processor (2 from 2)



The algorithm of functioning of the adaptive electronic textbook jointly with the diagn. module (realized the more precise definition of the level of statem. of mat.) (1 from 2)

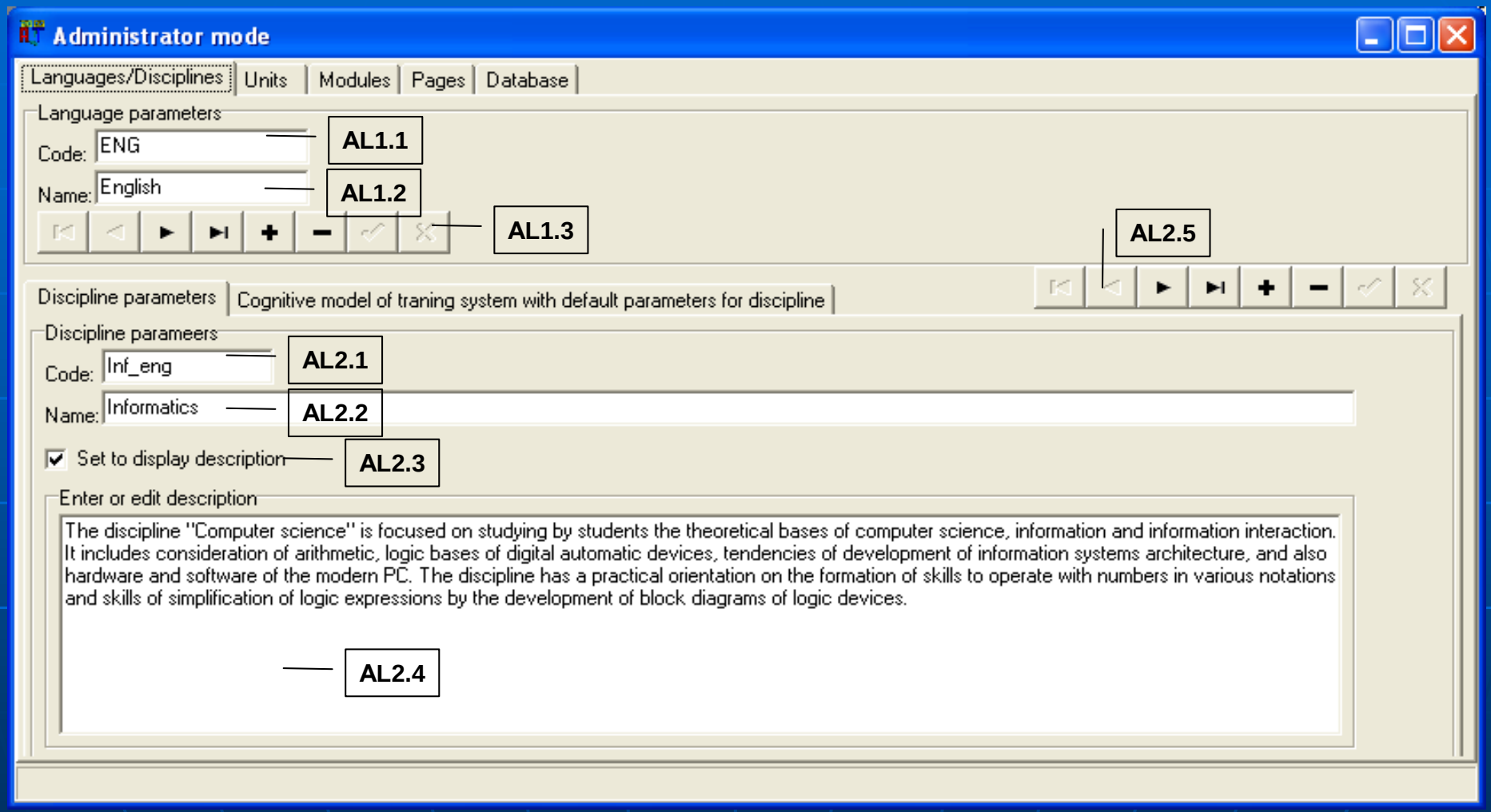


The algorithm of functioning of the adaptive electronic textbook jointly with the diagn. module (realized the more precise definition of the level of statem. of mat.) (2 from 2)



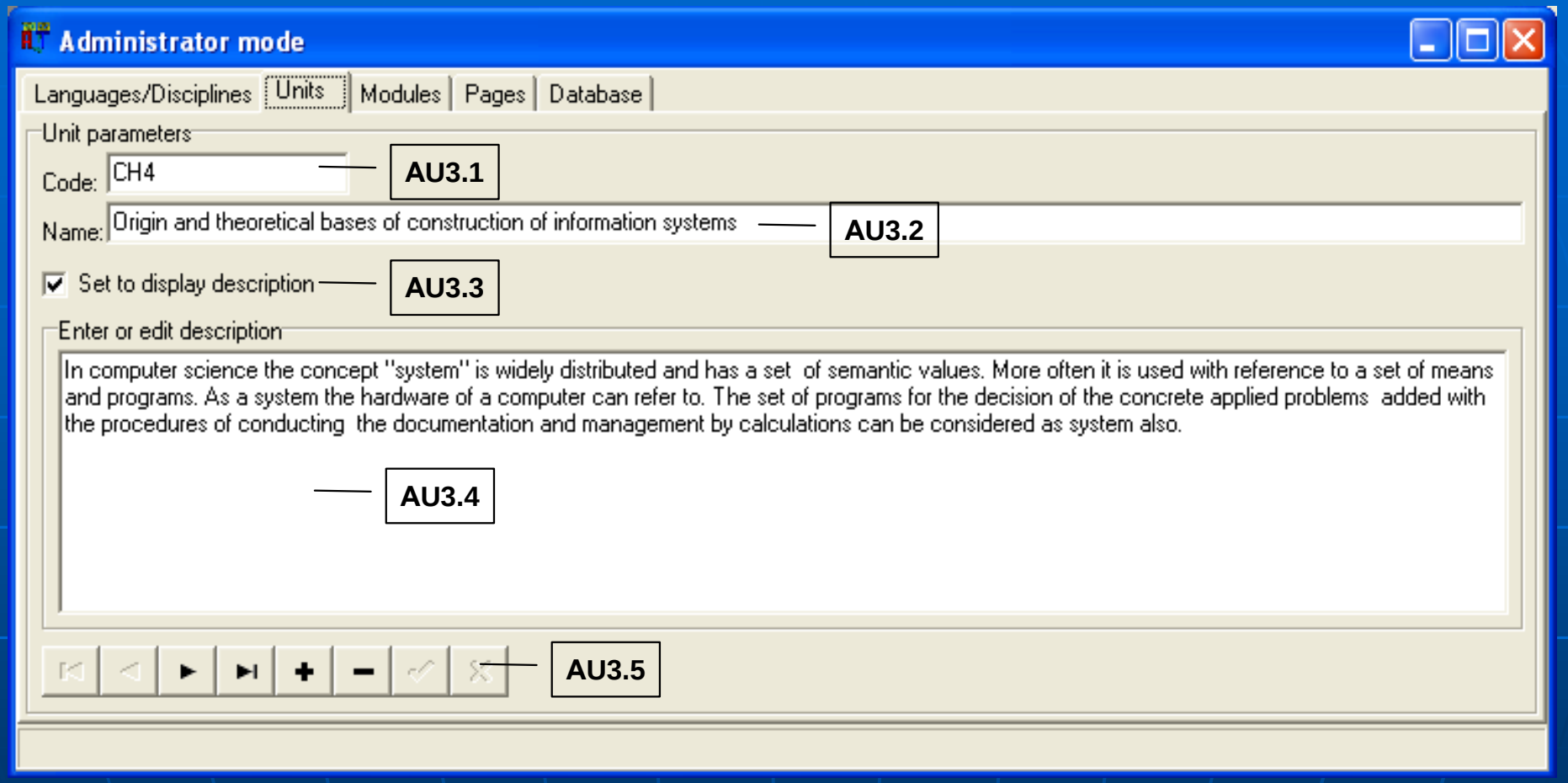
The interface of the adaptive electronic textbook in the mode of administrating: the review and modification of the parameters of the subjects of studying

4.7.1

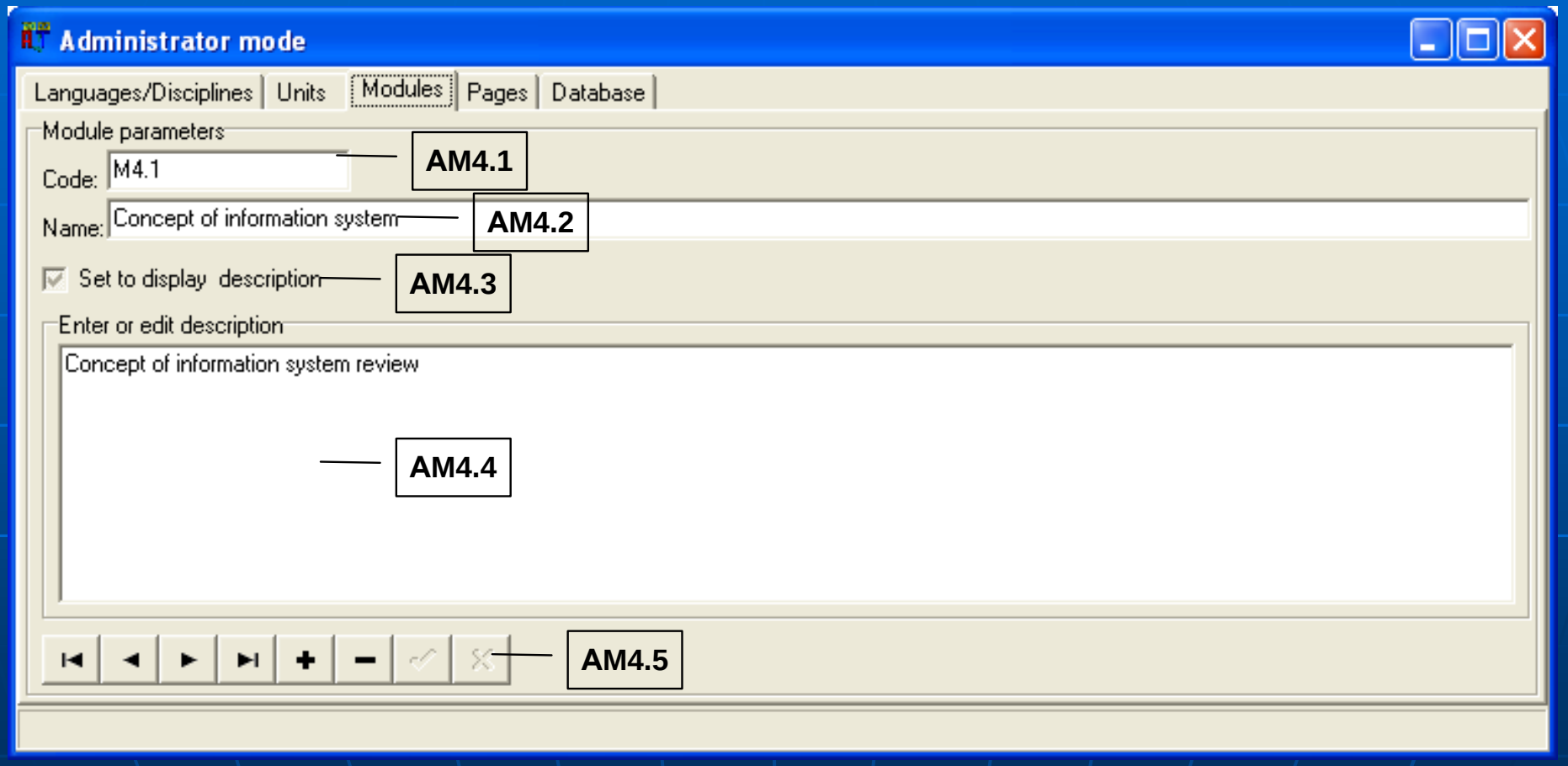


The interface of the adaptive electronic textbook in the mode of administrating: the review and modification of the parameters of units of the subject of studying

4.7.2

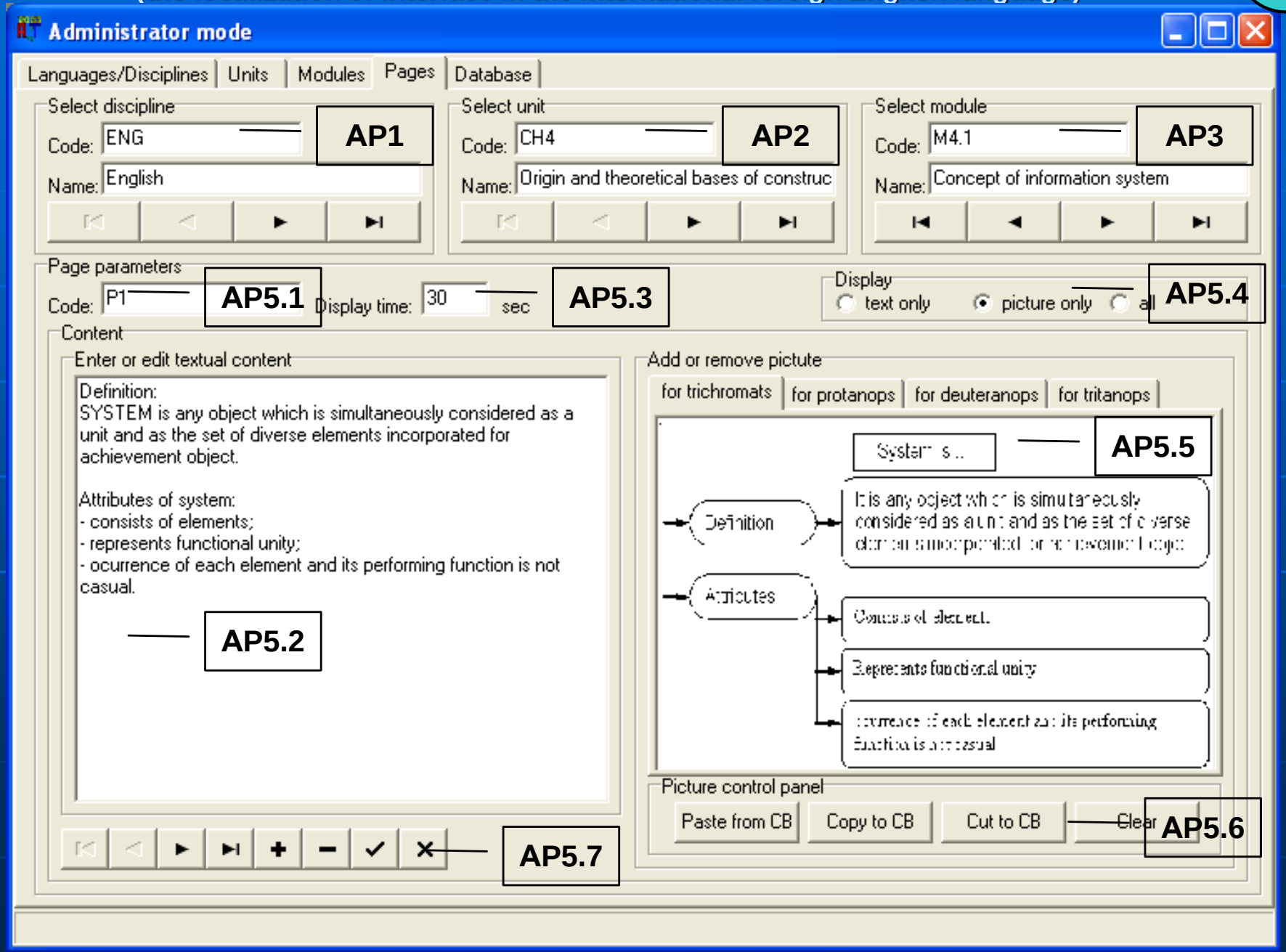


The interface of the adaptive electronic textbook in the mode of administrating: the review and modification of the parameters of modules of unit of the subject of studying



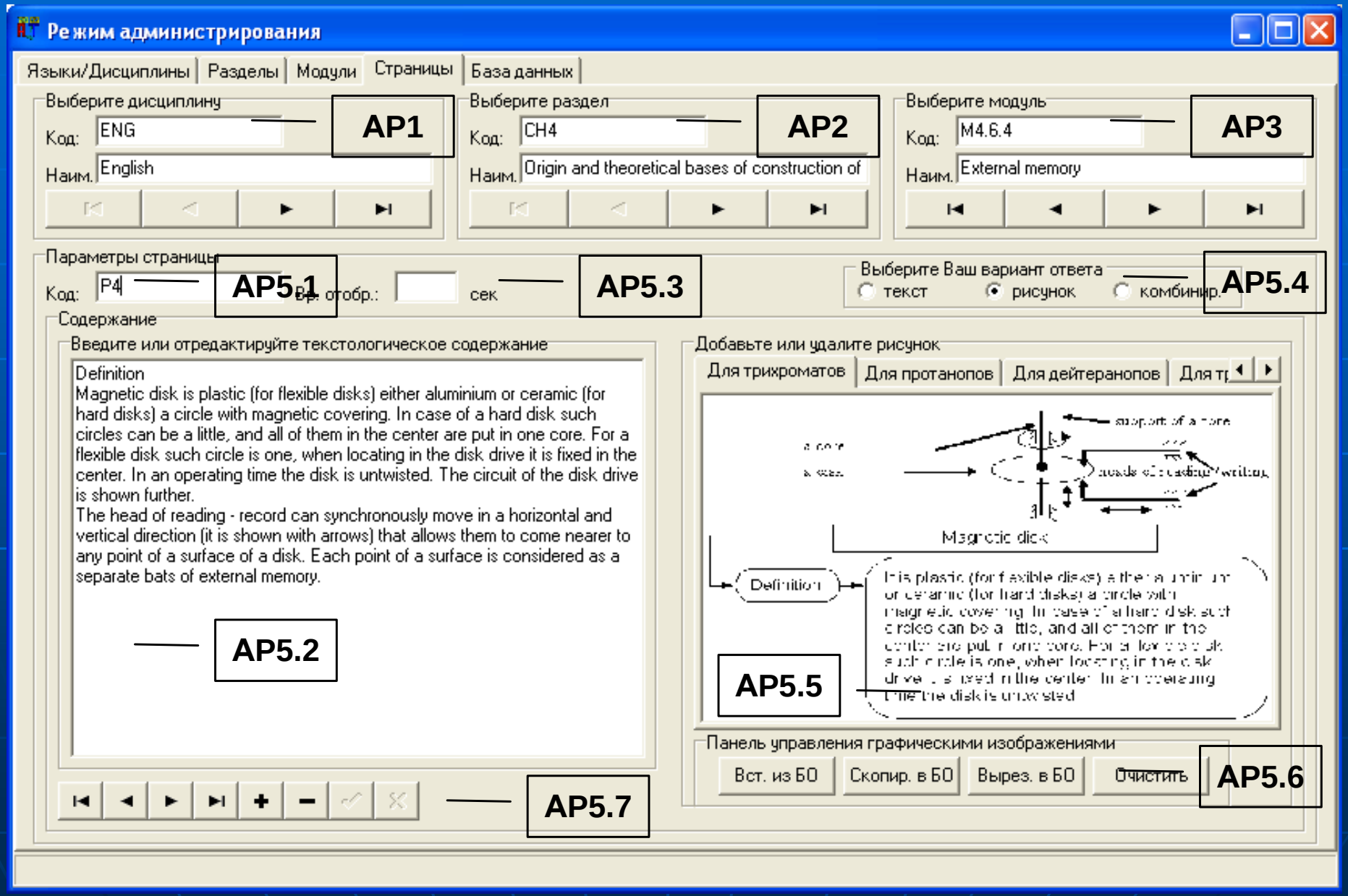
The interface of the adaptive electronic textbook in the mode of administrating: the review and modification of the parameters of page of module of unit of the subject of studying (the localization of interface in the international foreign English language)

4.7.4



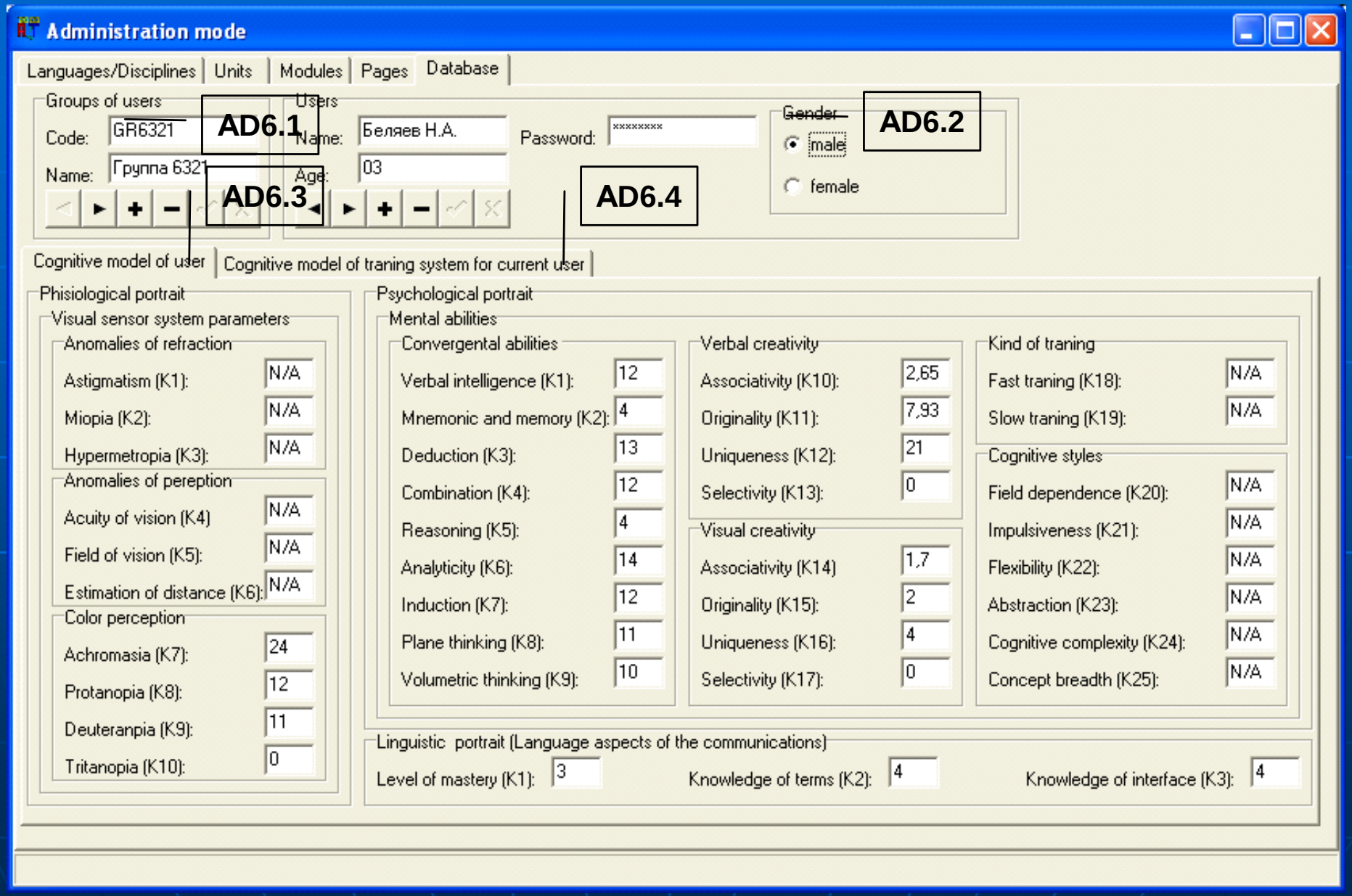
The interface of adaptive electronic textbook in the mode of administrating: the review and modification of the parameters of page of module of unit of the subject of studying (the localization of interface in the national Russian language)

4.7.5



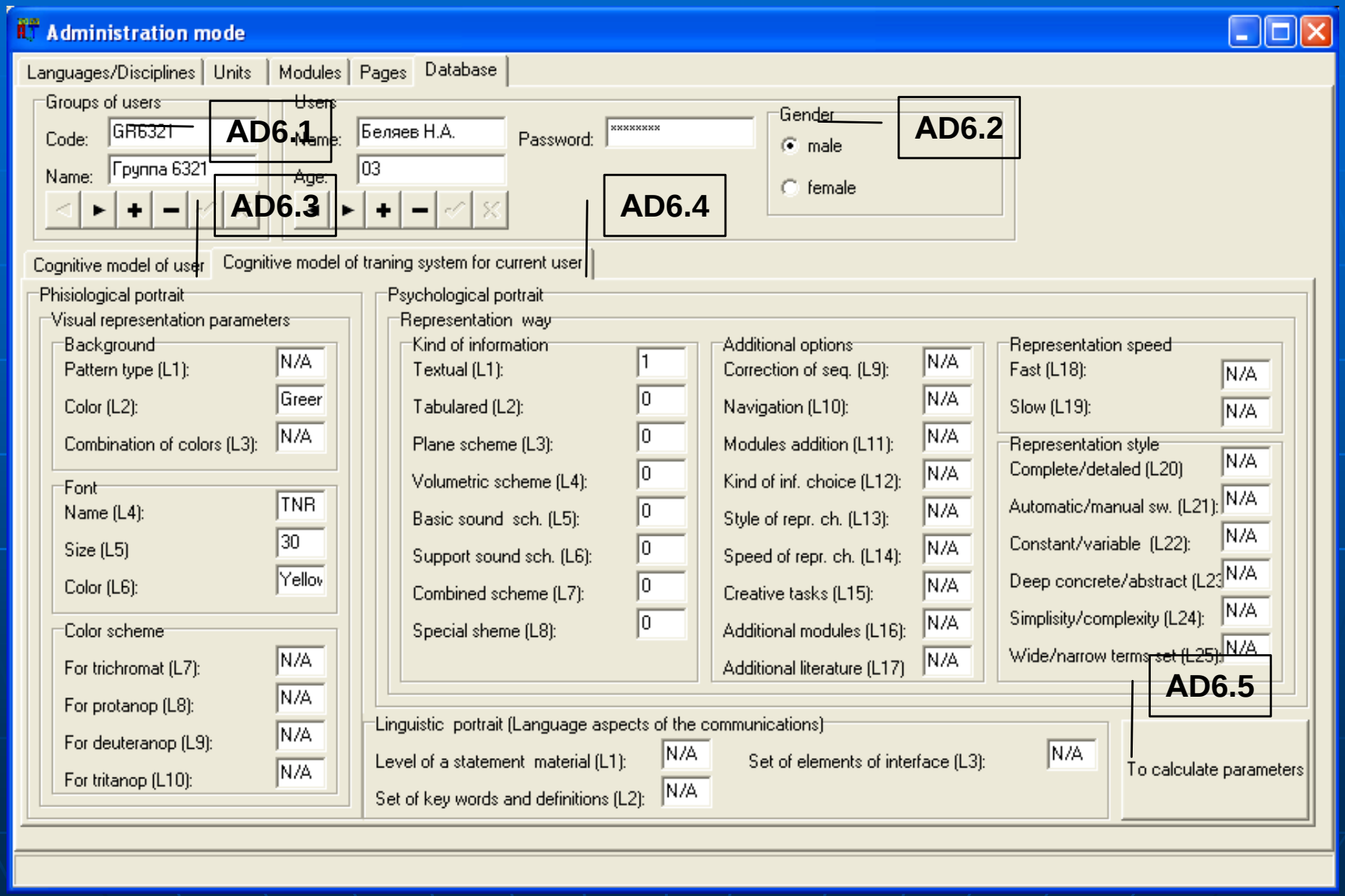
The administrating of database with the values of parameters of the param. cogn. models block: the review and modification of the parameters of the cognitive model of subject of training

4.8.1



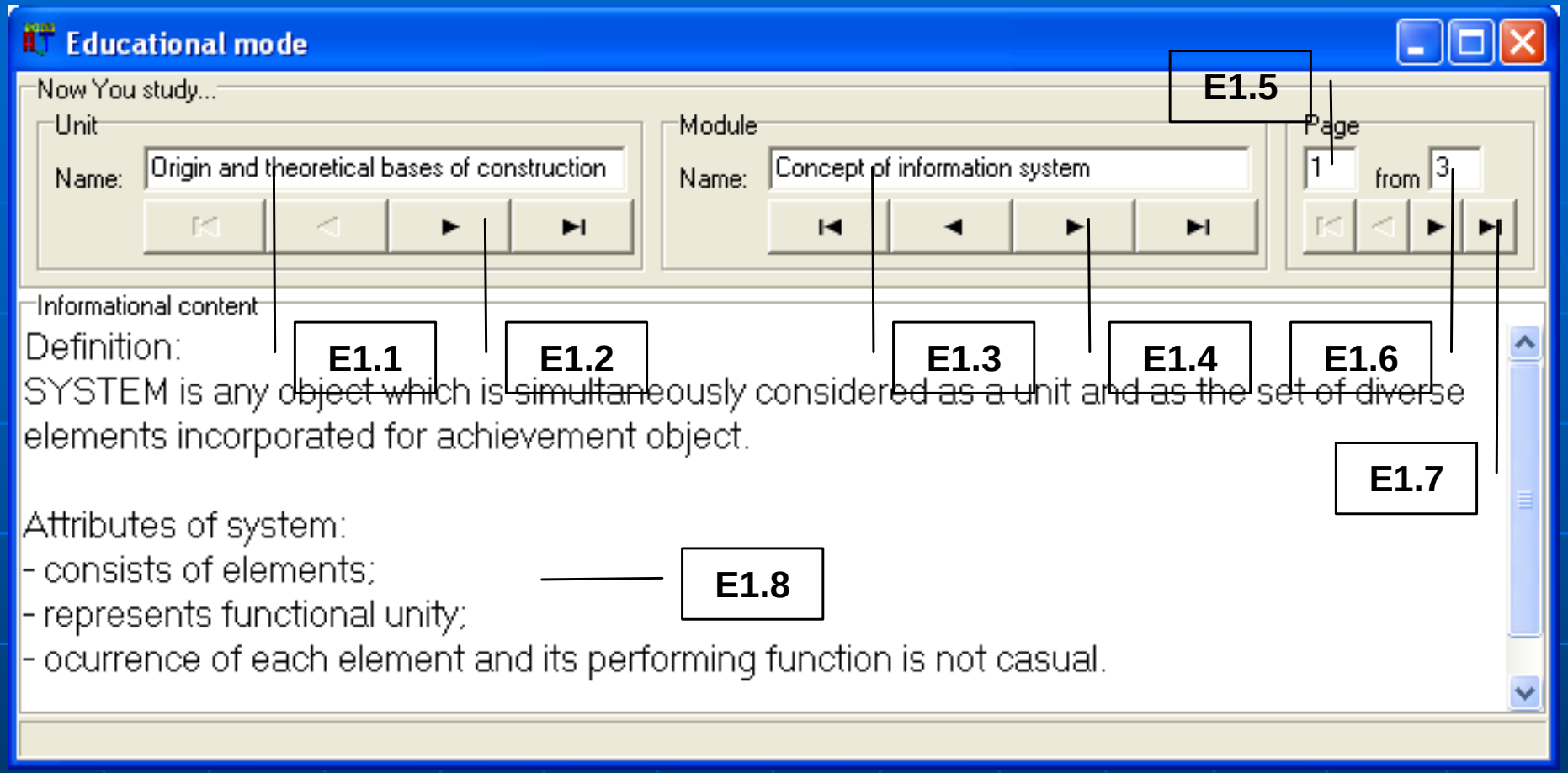
The administrating of database with the values of parameters of the param. cogn. models block: the review and modification of the parameters of the cognitive model of means of training

4.8.2

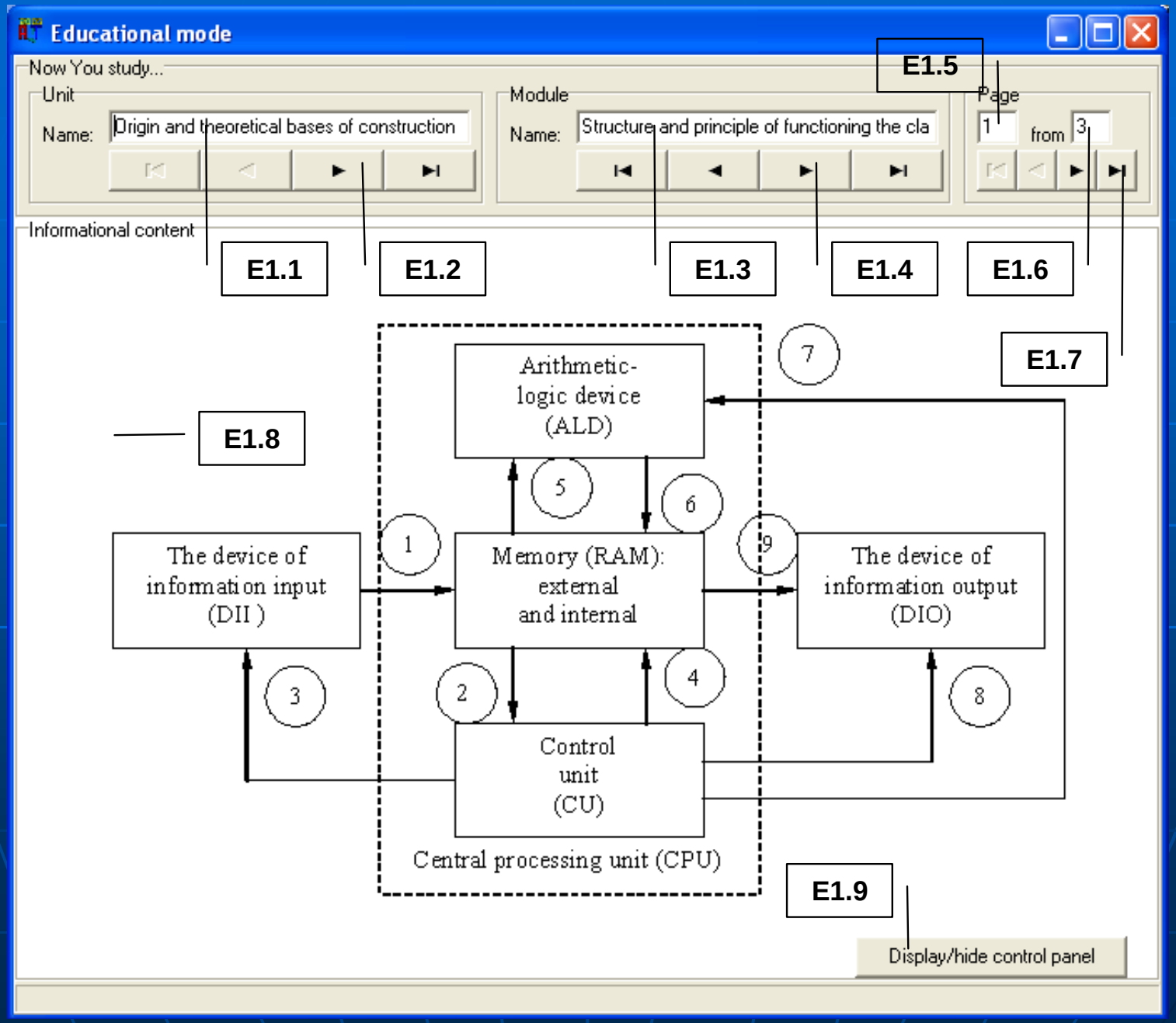


The interface of the adaptive electronic textbook in the mode of adaptive training: the textual representation of information fragment (text)

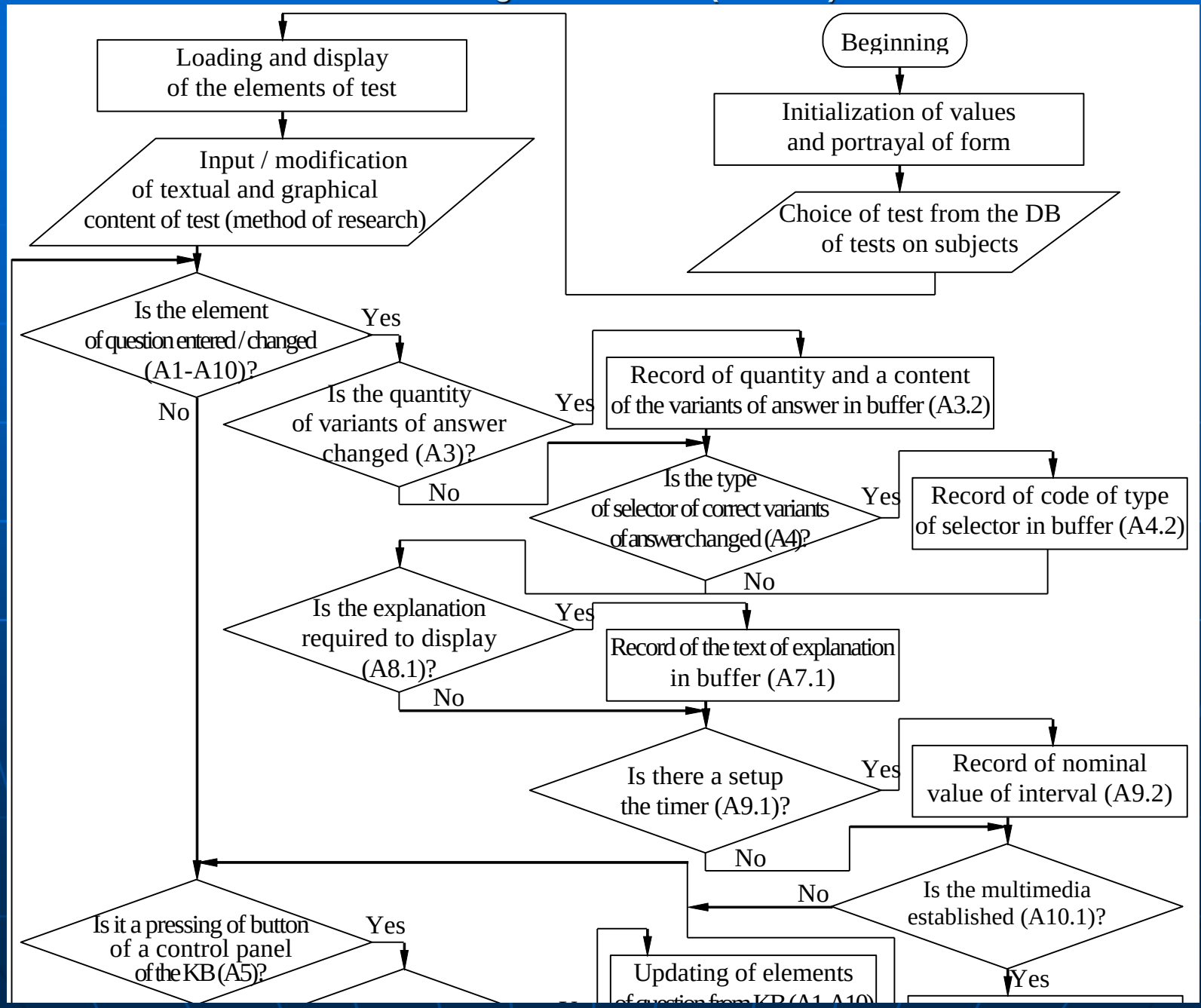
4.9.1



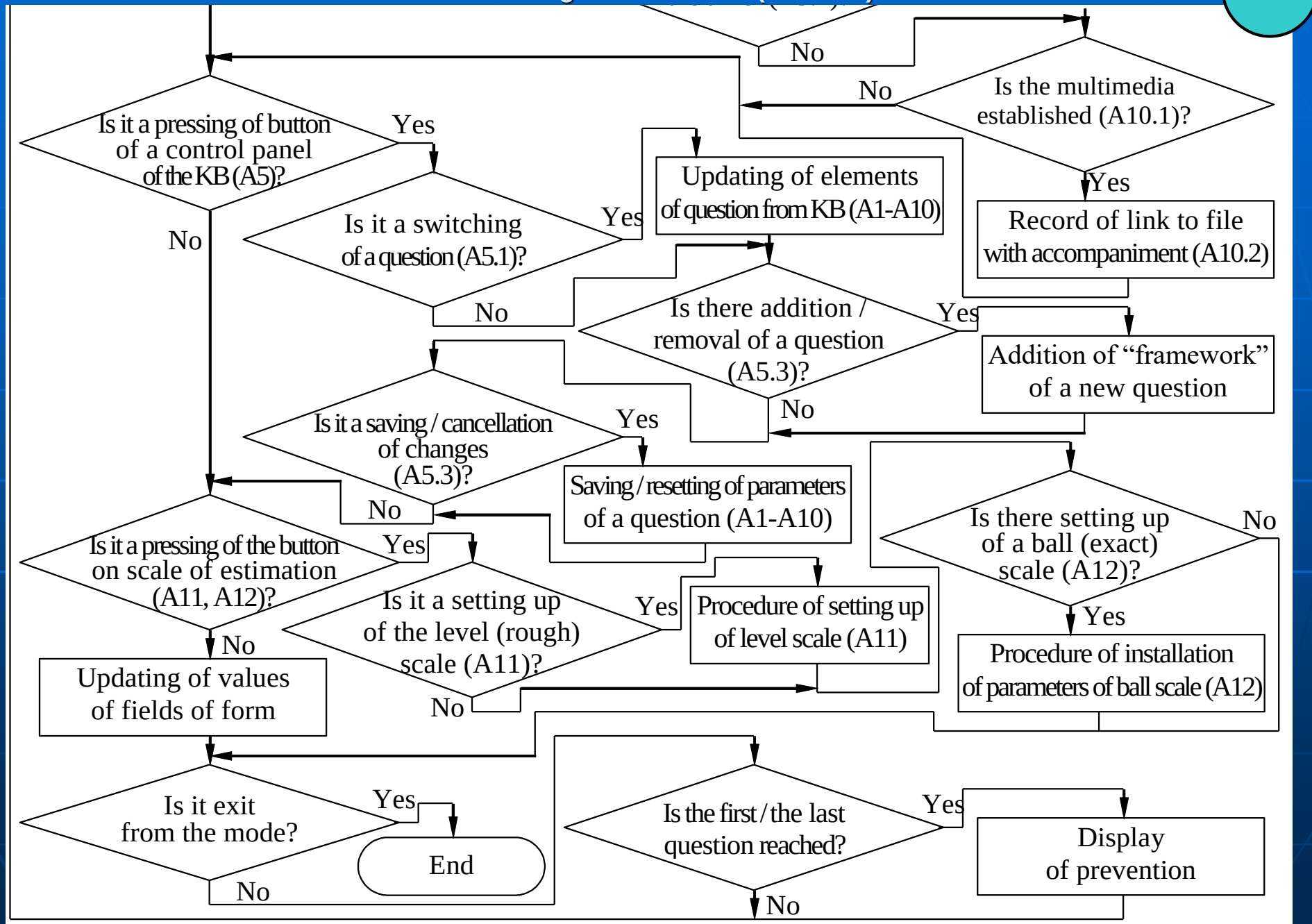
The interface of the adaptive electronic textbook in the mode of adaptive training: the graphical representation of information fragment (flat scheme)



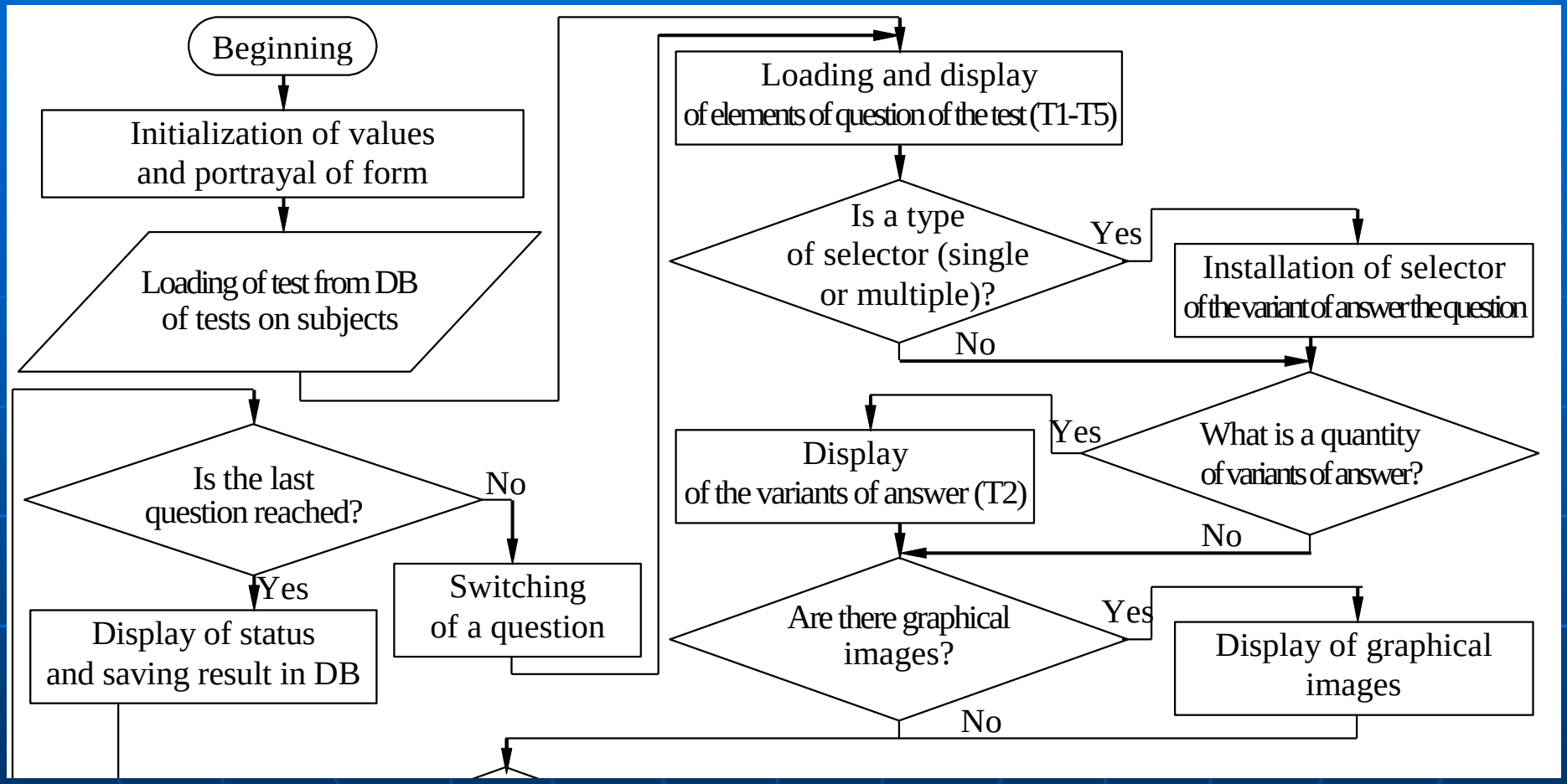
The algorithm of functioning of the mode of administrating of the basic diagnostic module (1 from 2)



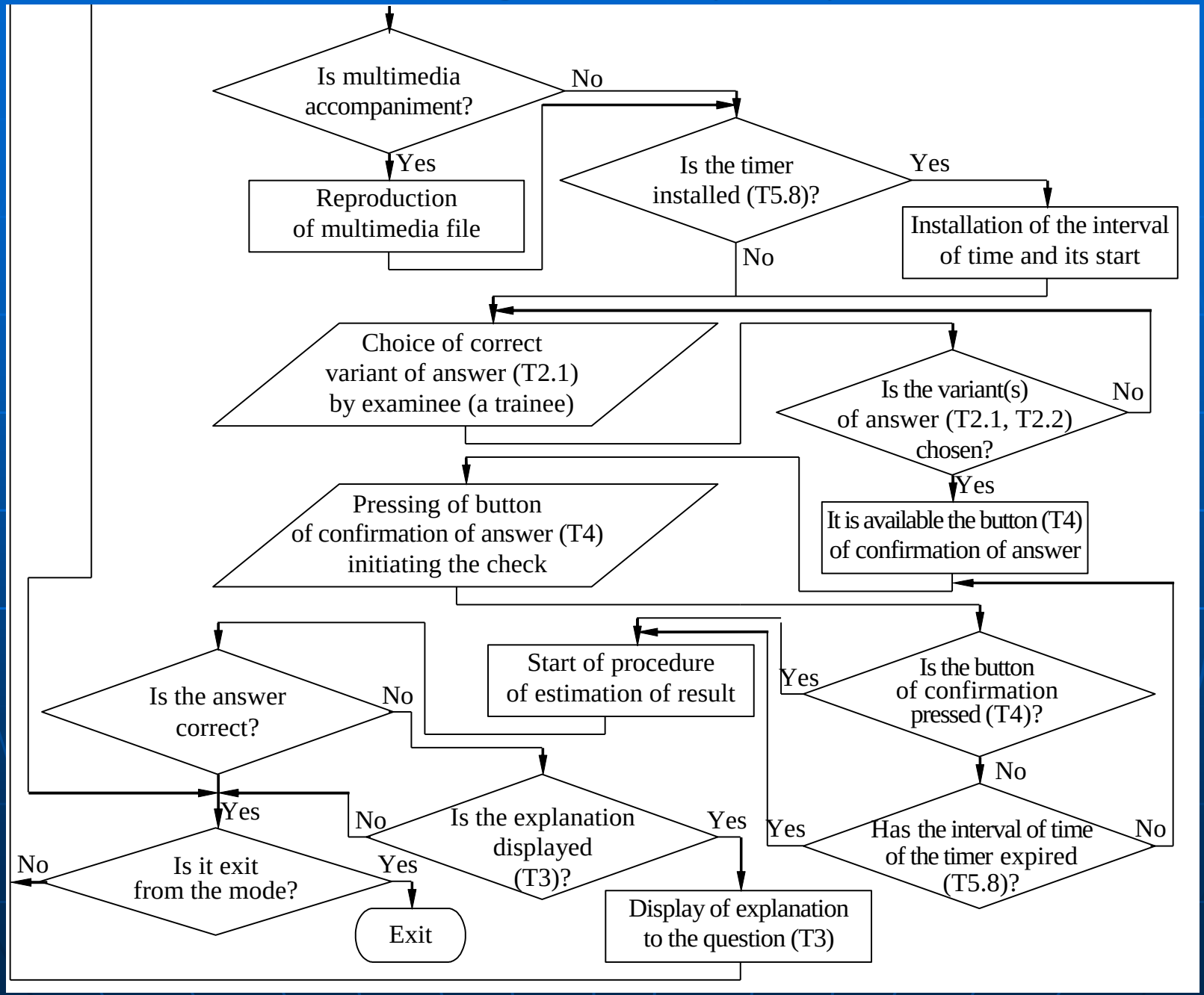
The algorithm of functioning of the mode of administrating of the basic diagnostic module (2 from 2)



The algorithm of functioning of the mode of diagnostics in the form of testing of the basic diagnostic module (1 from 2)

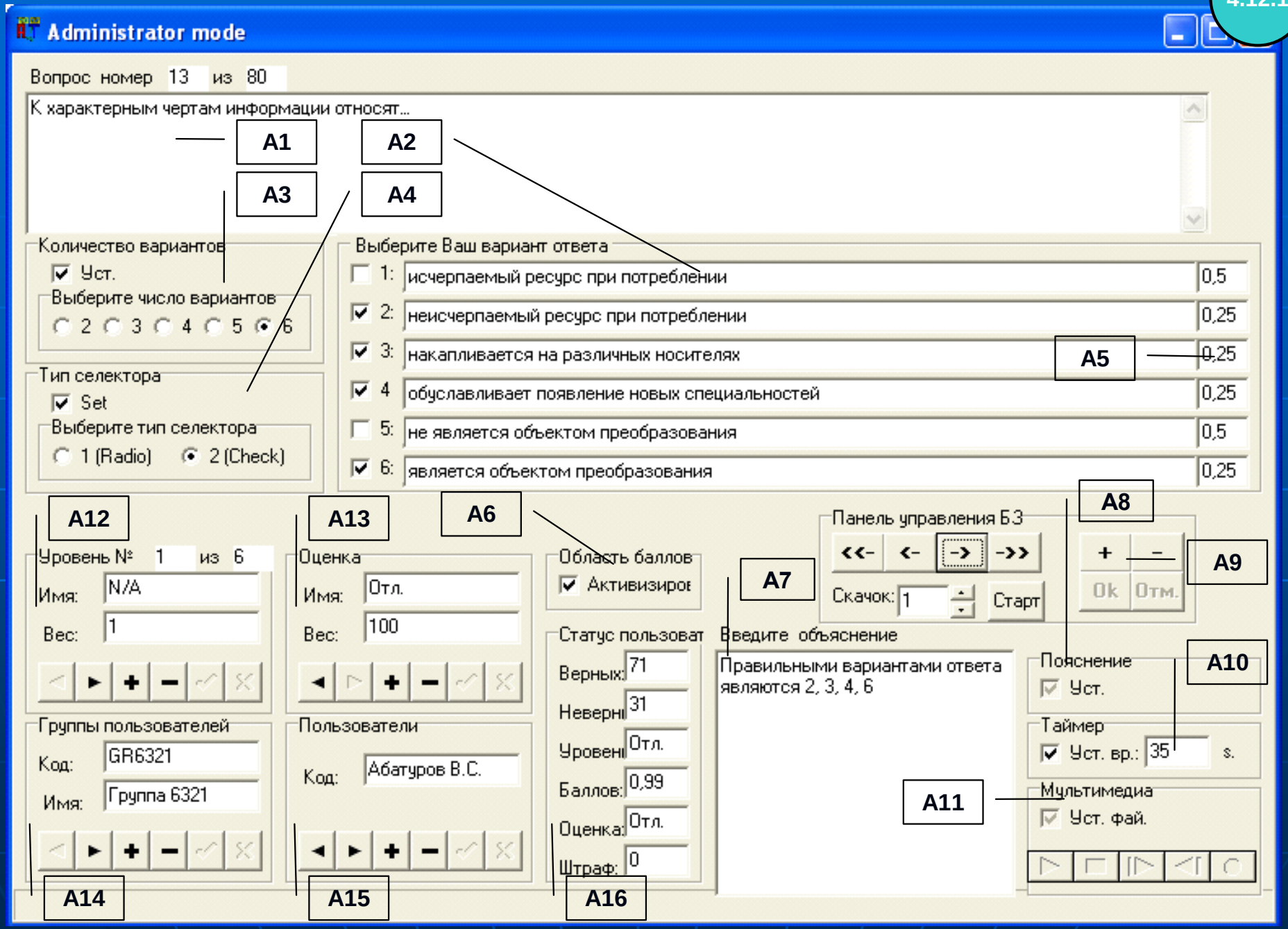


The algorithm of functioning of the mode of diagnostics in the form of testing of the basic diagnostic module (2 from 2)



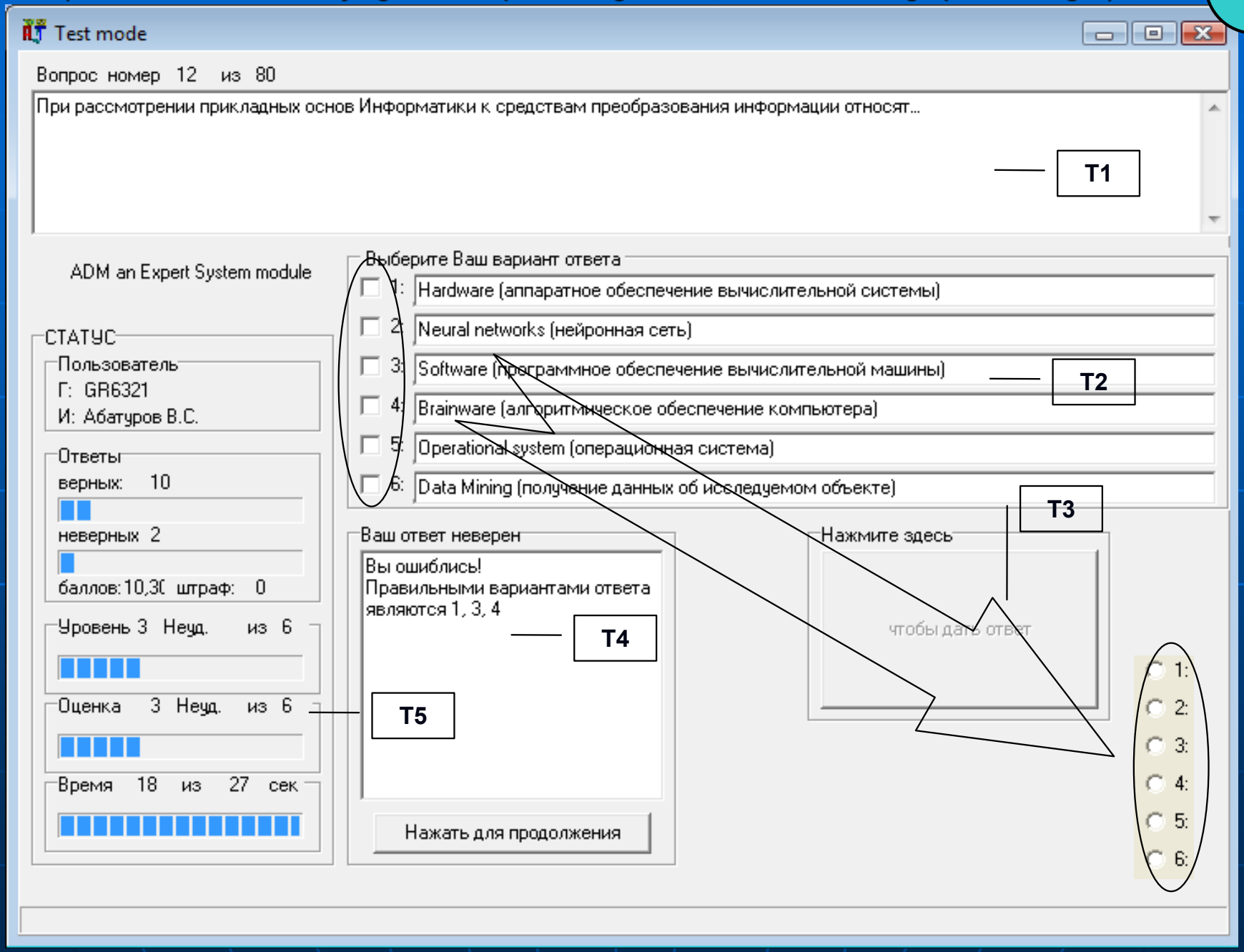
The interface of the basic diagnostic module in the mode of administrating

4.12.1

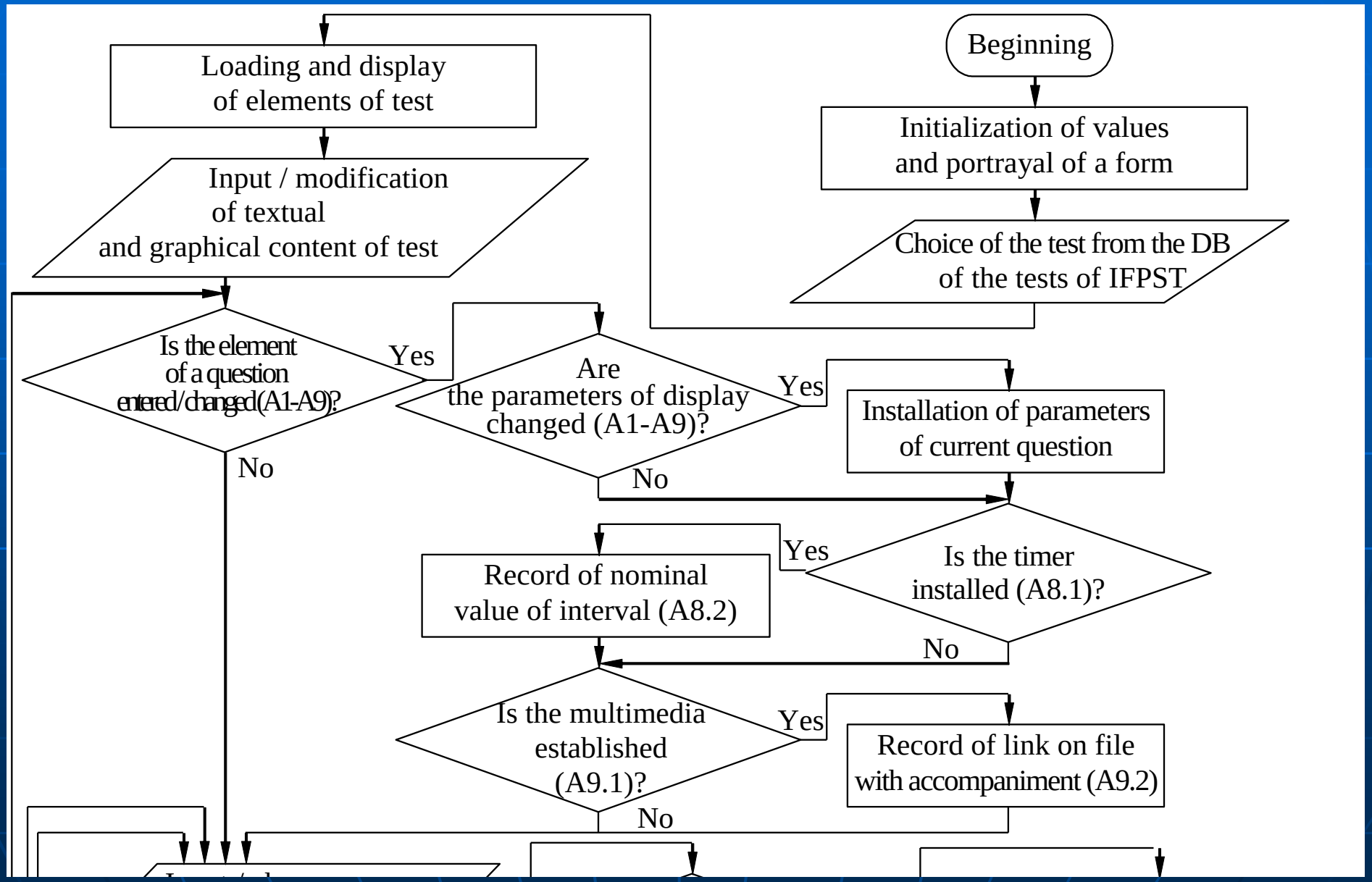


The interface of the basic diagnostic module in the mode of diagnostics (the version for the carrying out of express diagnostics, without use of graphical images)

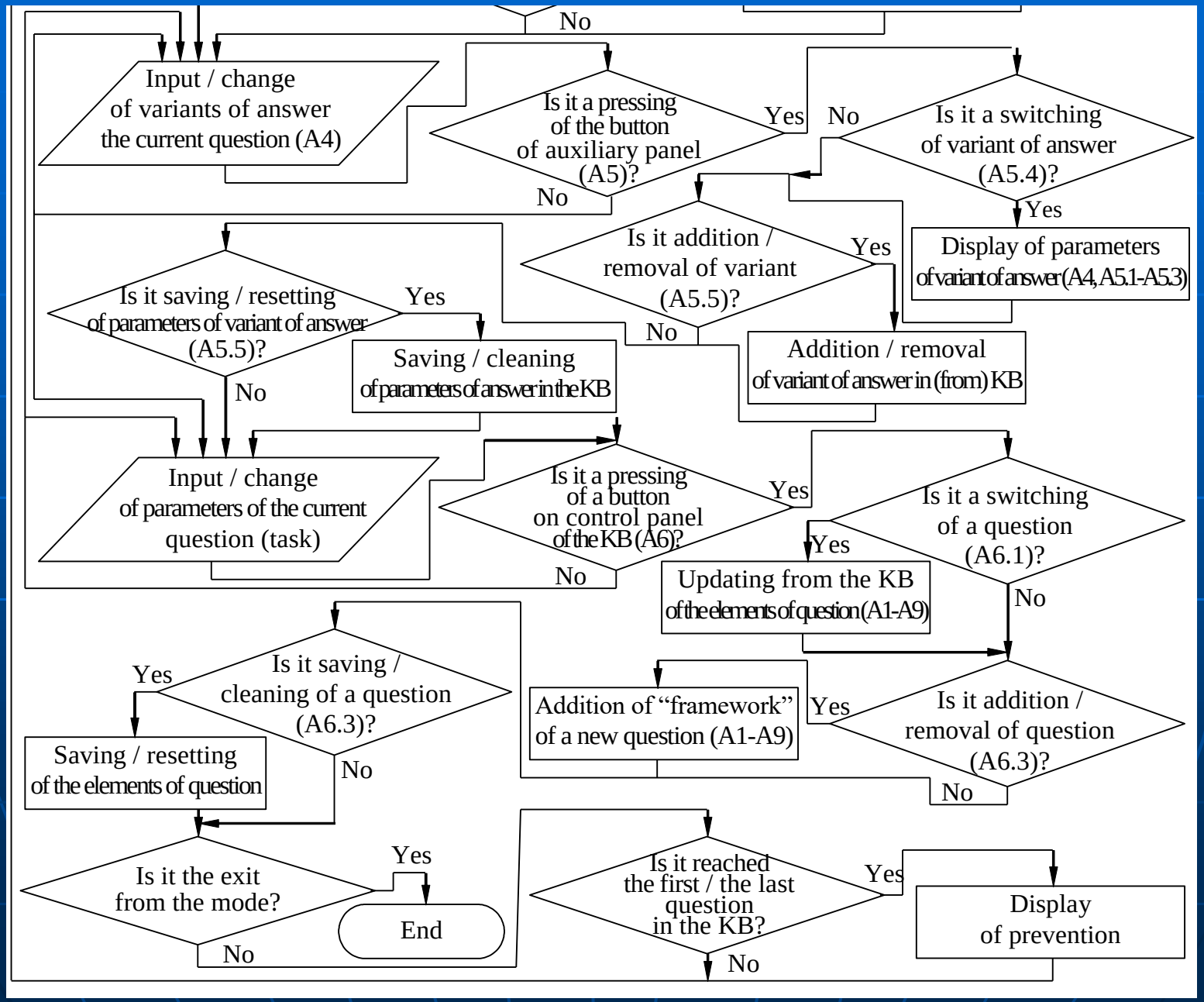
4.12.2



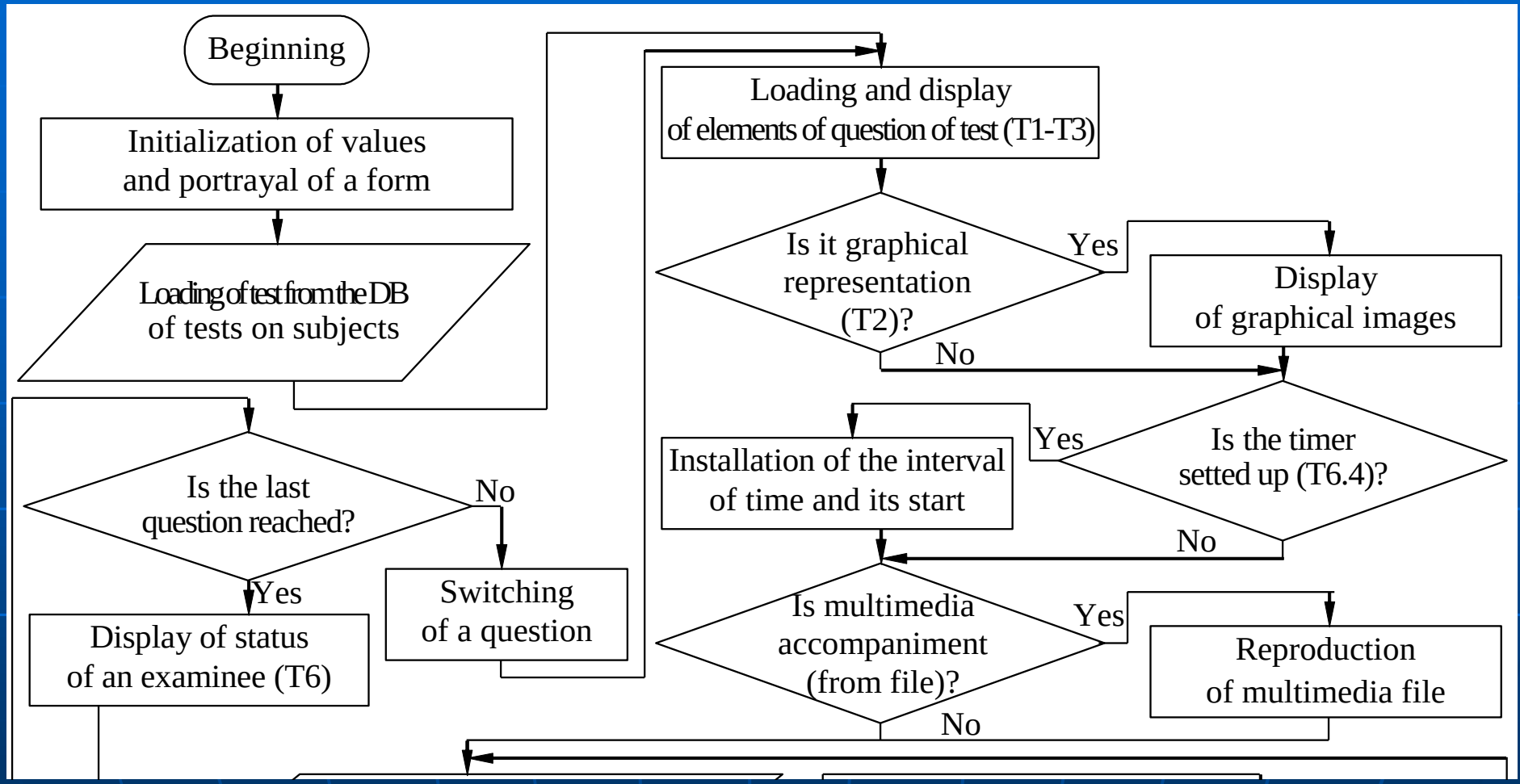
The algorithm of functioning of the applied diagnostic module in the mode of administrating of the question-answers structures of the methods of research of the individual features of the contingent of examinees (1 from 2)



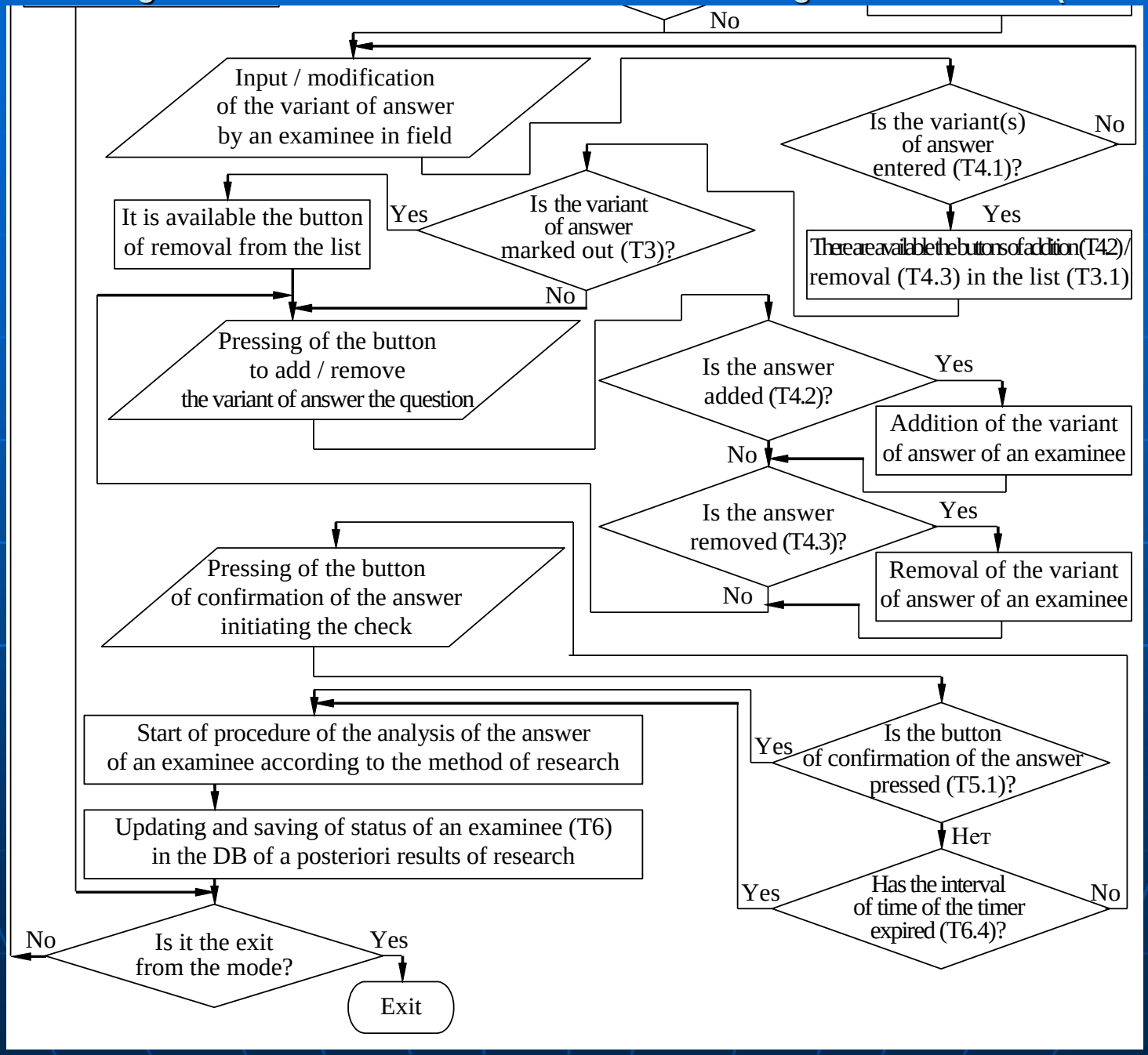
The algorithm of functioning of the applied diagnostic module in the mode of administrating of the question-answers structures of the methods of research of the individual features of the contingent of examinees (2 from 2)



The algorithm of functioning of the applied diagnostic module in the mode of diagnostics of the individual features of the contingent of examinees (1 from 2)

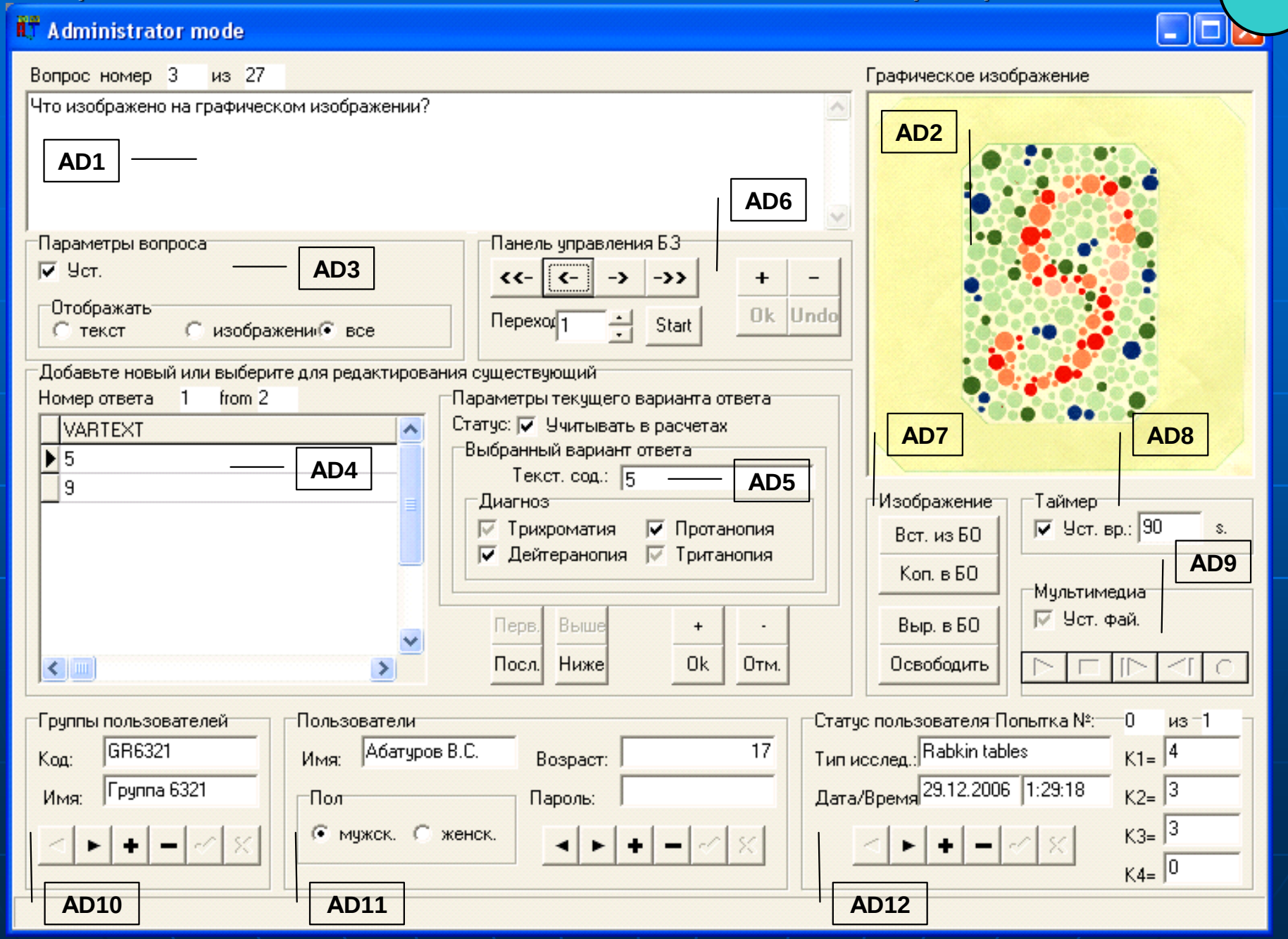


The algorithm of functioning of the applied diagnostic module in the mode of diagnostics of the individual features of the contingent of examinees (2 from 2)



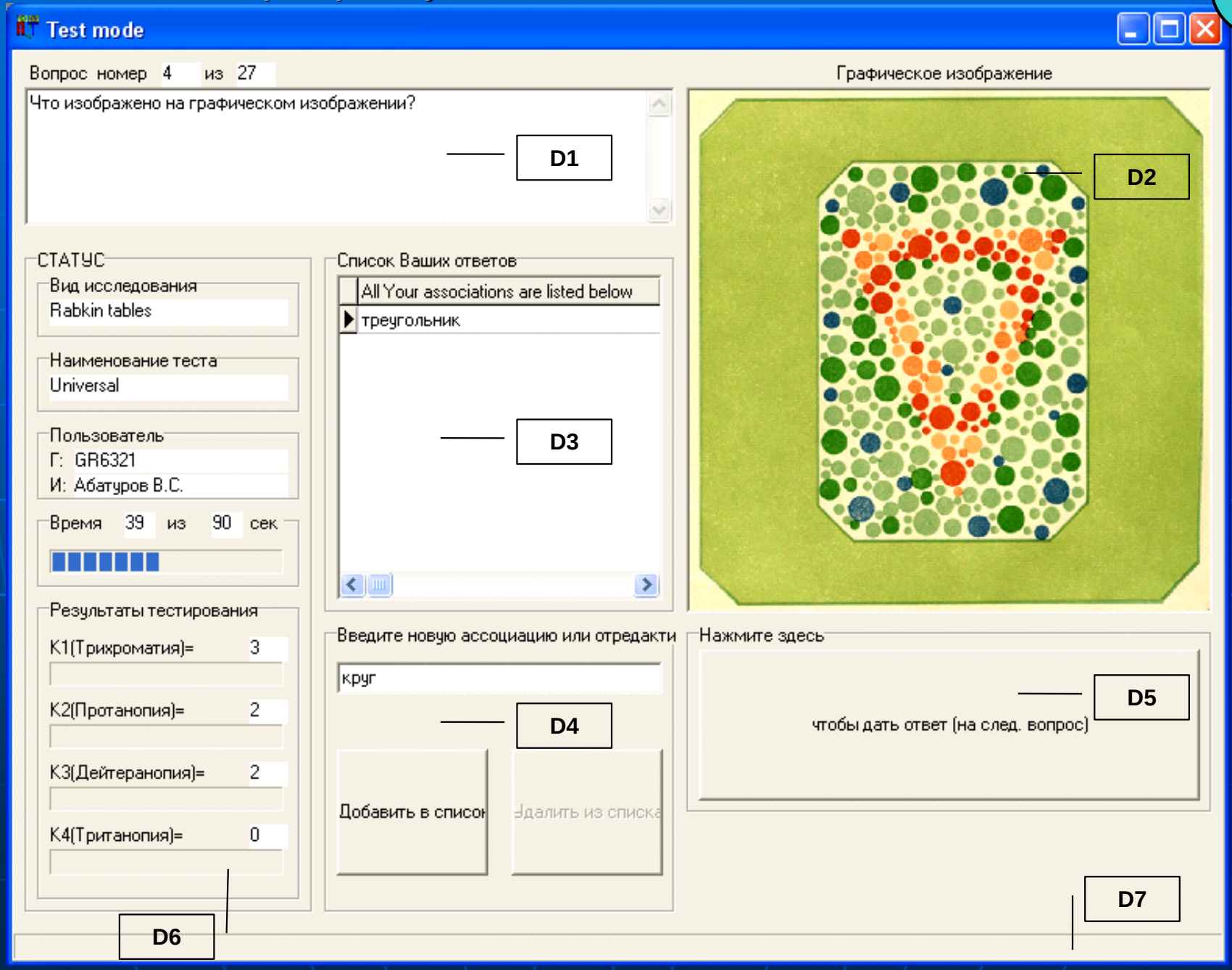
The interface of the applied diagnostic module in the mode of administrating of the question-answers structures of the method of research of the color perception of Rabkin E.B

4.15.1



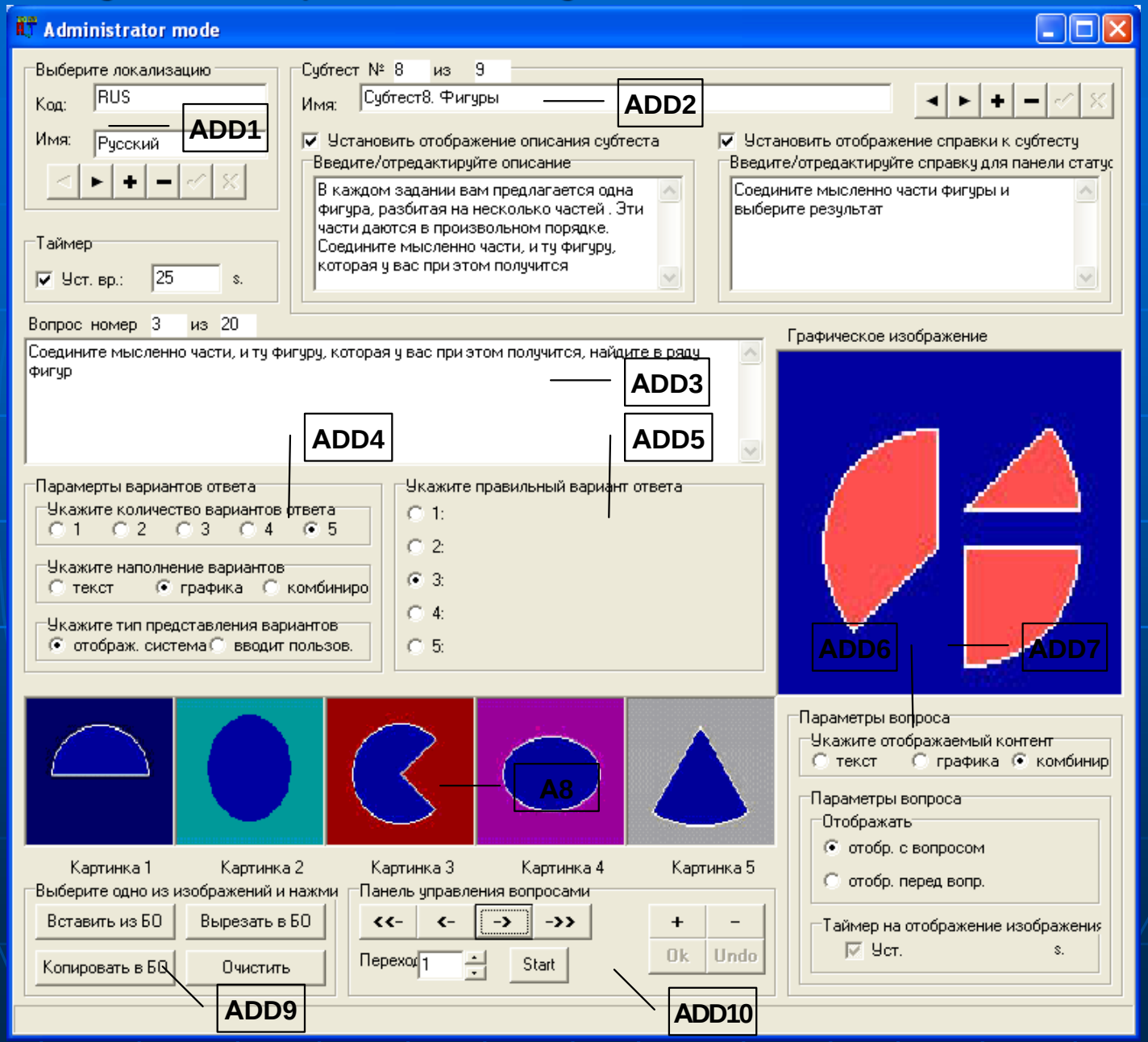
The interface of the applied diagnostic module in the mode of diagnostics of the color perception by means of the method of research of Rabkin E.B.

4.15.2



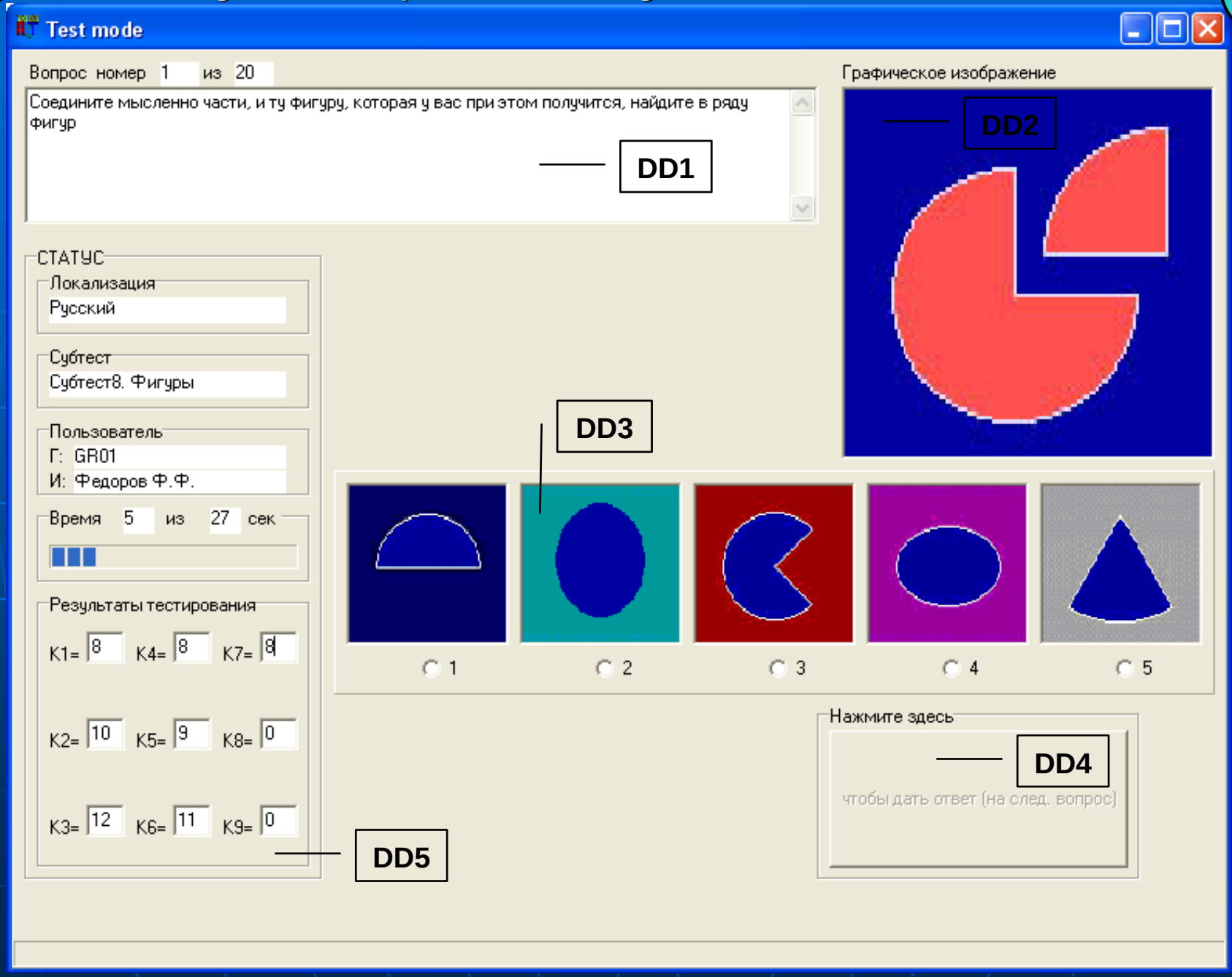
The interface of the applied diagnostic module in the mode of administrating of the question-answers structures of the subtest of plane thinking by means of the eighth block of questions “Plane figures” of the method of research of R. Amthauer

4.16.1



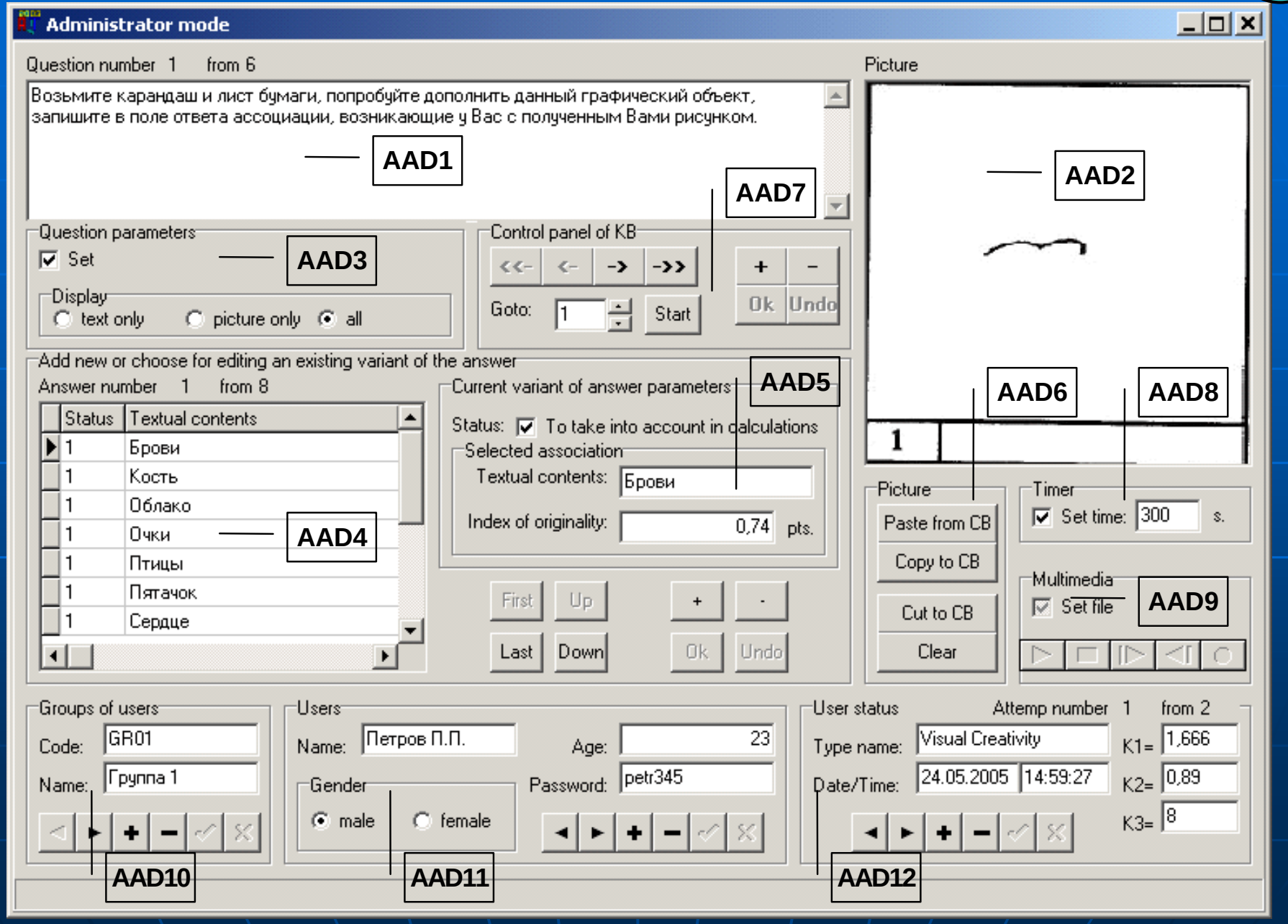
The interface of the applied diagnostic module in the mode of diagnostics of the plane thinking by means of the eighth block of questions “Plane figures” of the method of res. of R. Amthauer

4.16.2



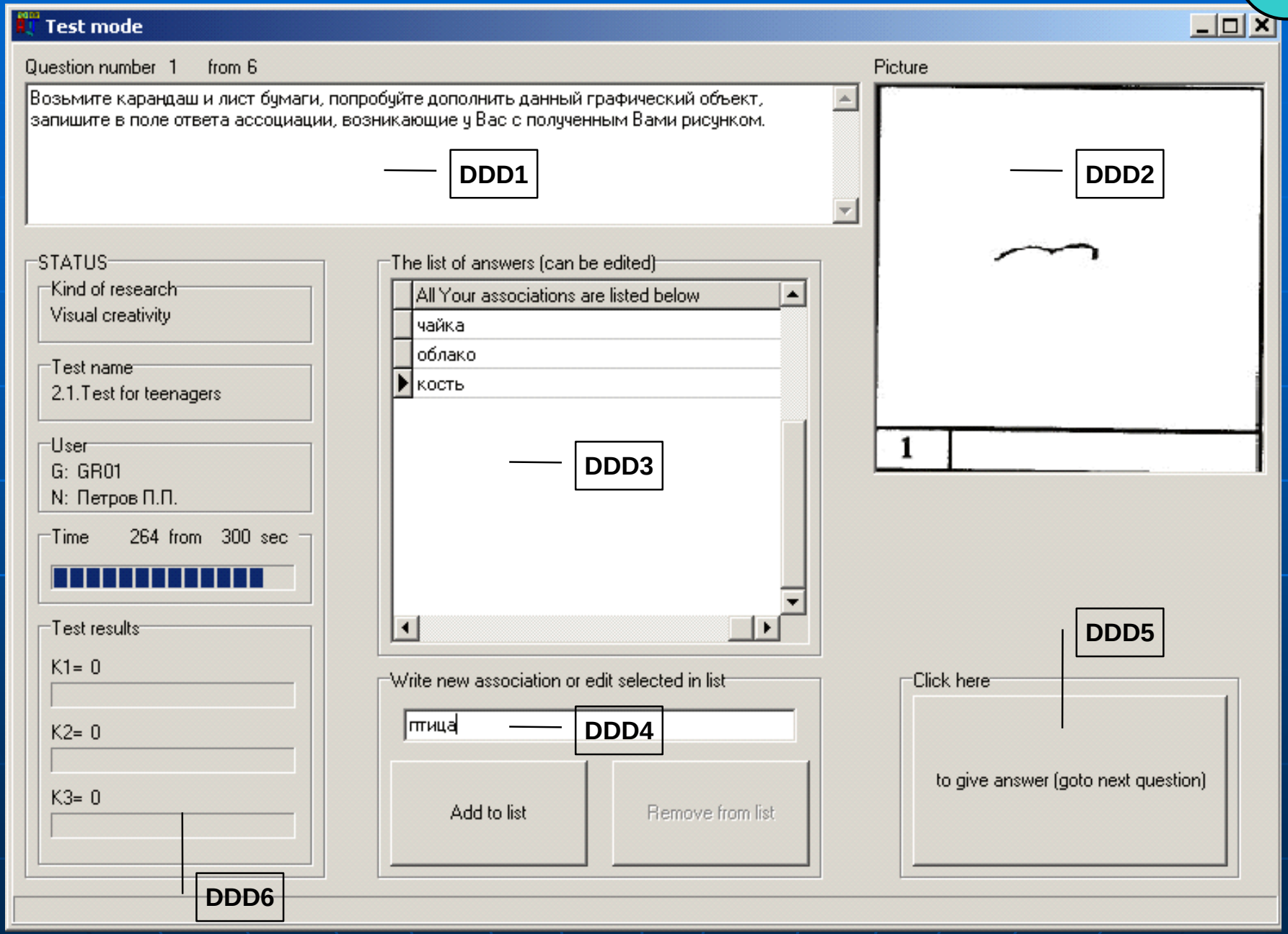
The interface of the applied diagnostic module in the mode of administrating of the question-answers structures of the subtest of figurative creativity by means of the method of research of Torrance E.P.

4.17.1



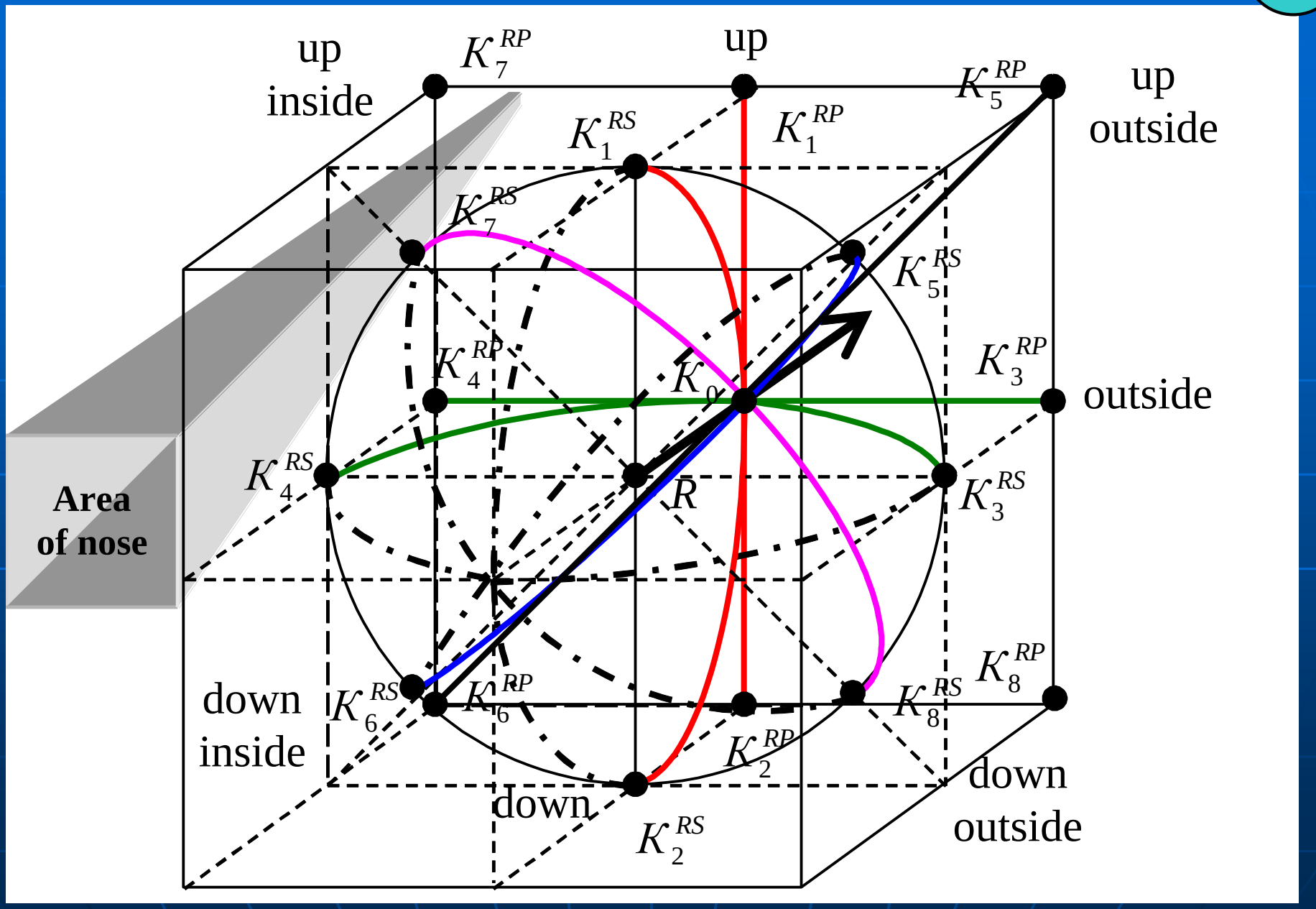
The interface of the applied diagnostic module in the mode of diagnostics of the figurative creativity by means of the method of research of Torrance E.P.

4.17.2



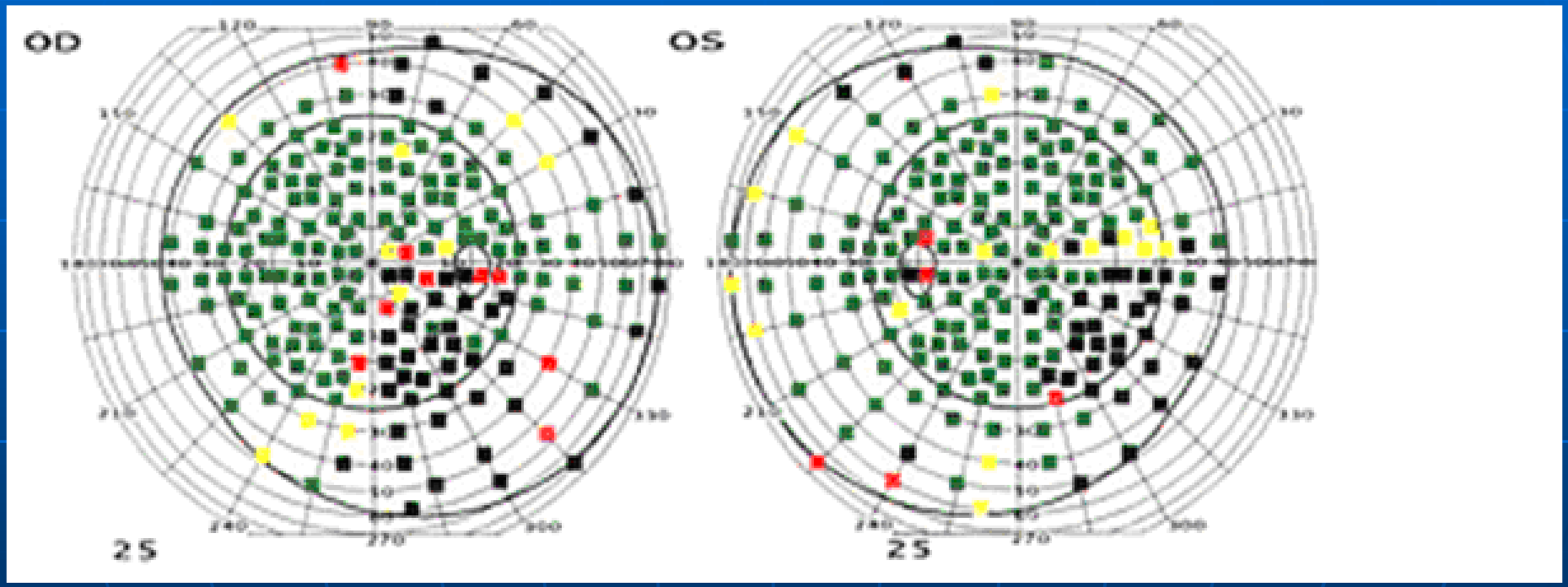
The mathematical model of the spherical perimeter of Forster K.F.R.

4.18.1



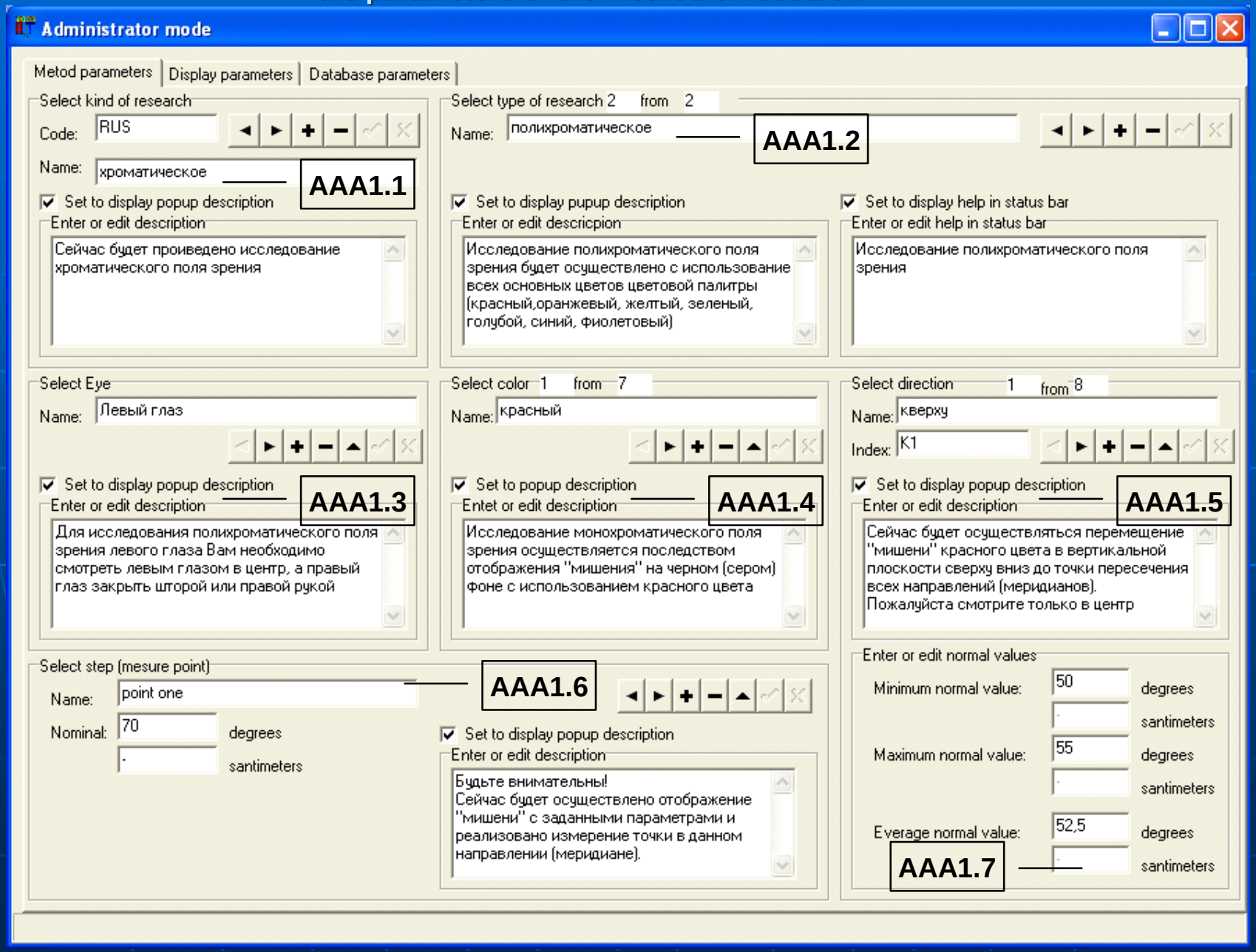
The features of a posteriori data of research of the achromatic and chromatic field of vision of examinee

4.18.2



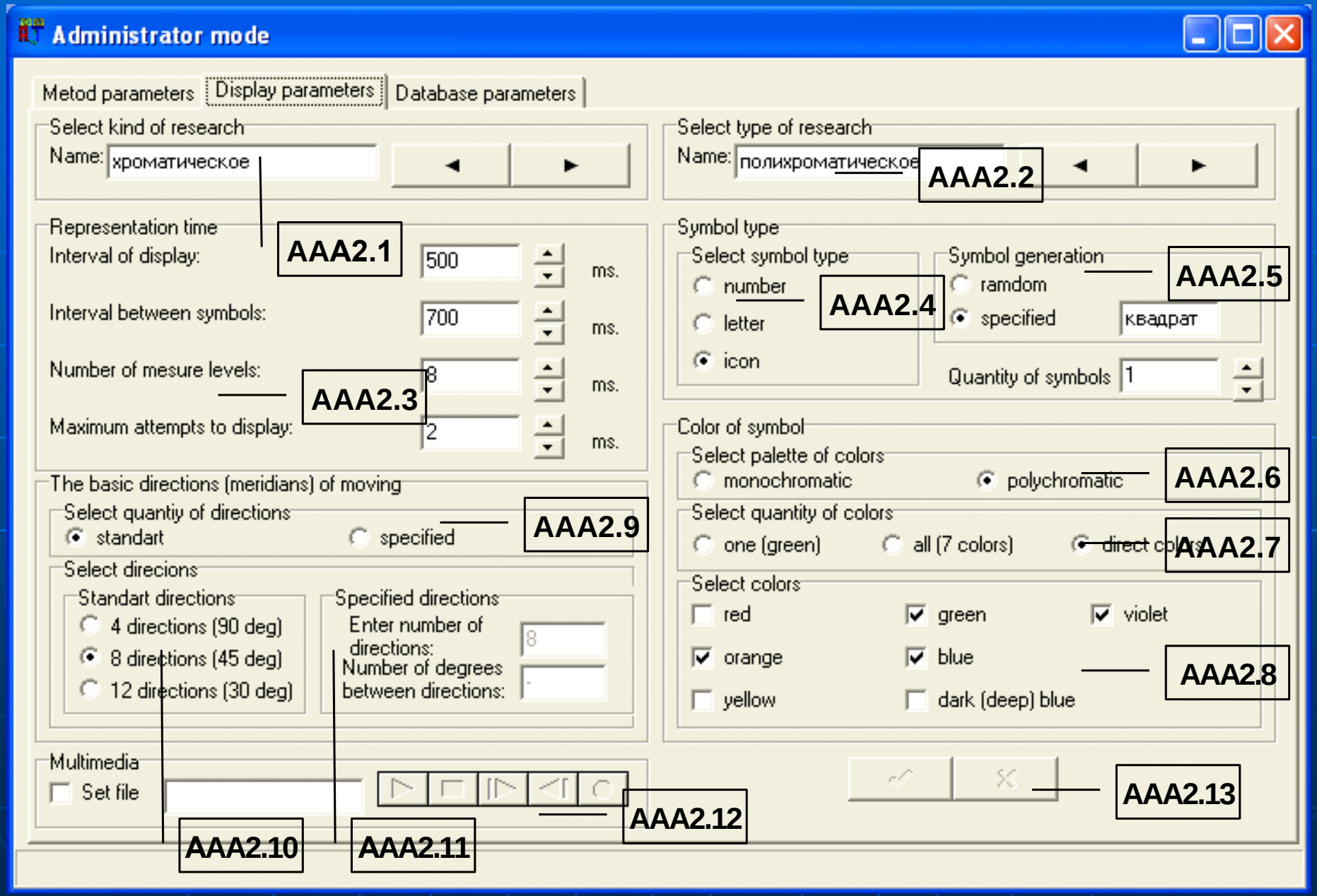
The interface of the applied diagnostic module in the mode of administrating of the question-answers structures of the method of research of the achromatic and chromatic field of vision of examinee by means of the computer perimetry: the parameters of the method of research

4.19.1



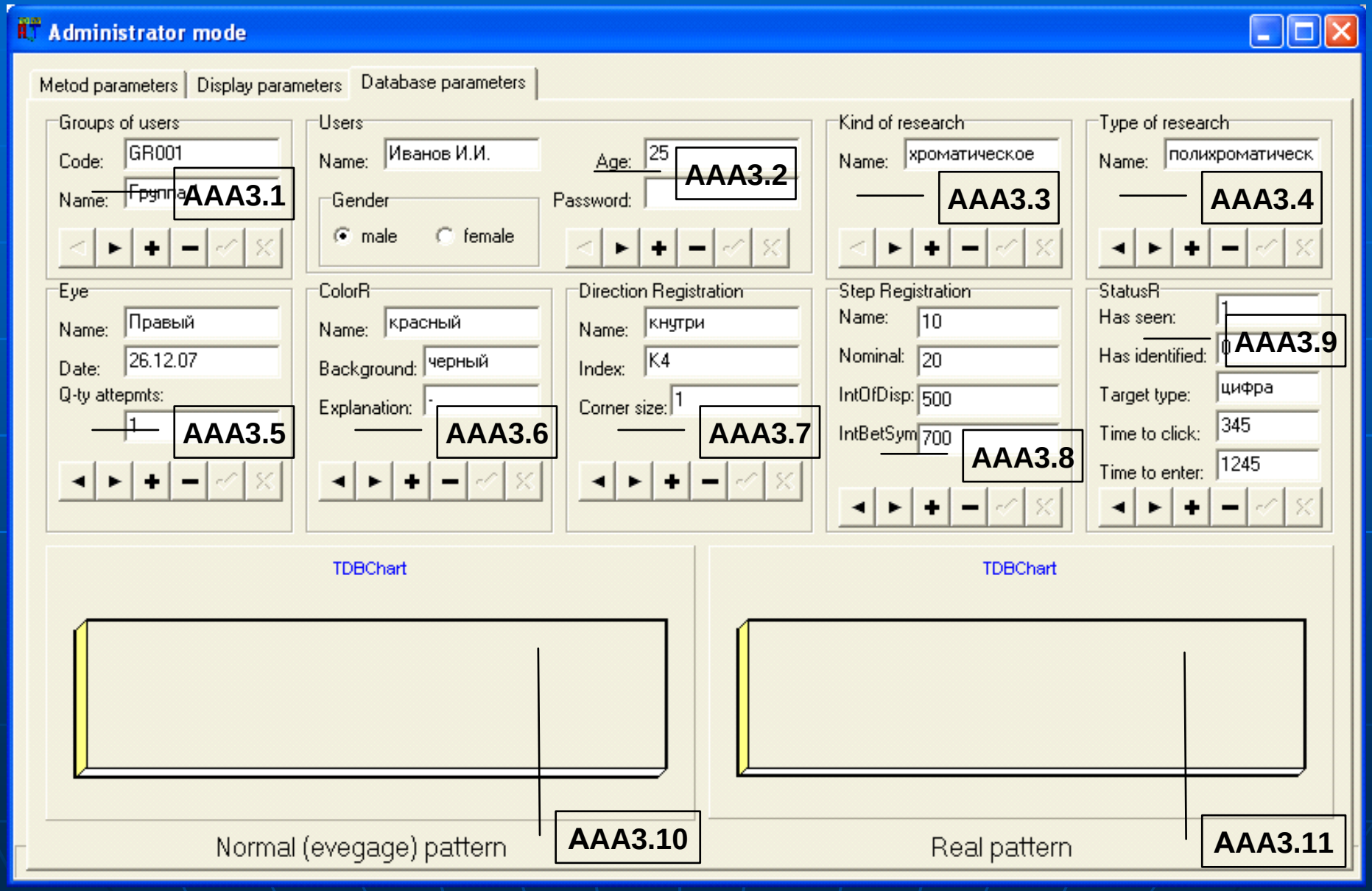
The interface of the applied diagnostic module in the mode of administrating of the question-answers structures of the method of research of the achromatic and chromatic field of vision of examinee by means of the computer perimetry: the parameters of display

4.19.2



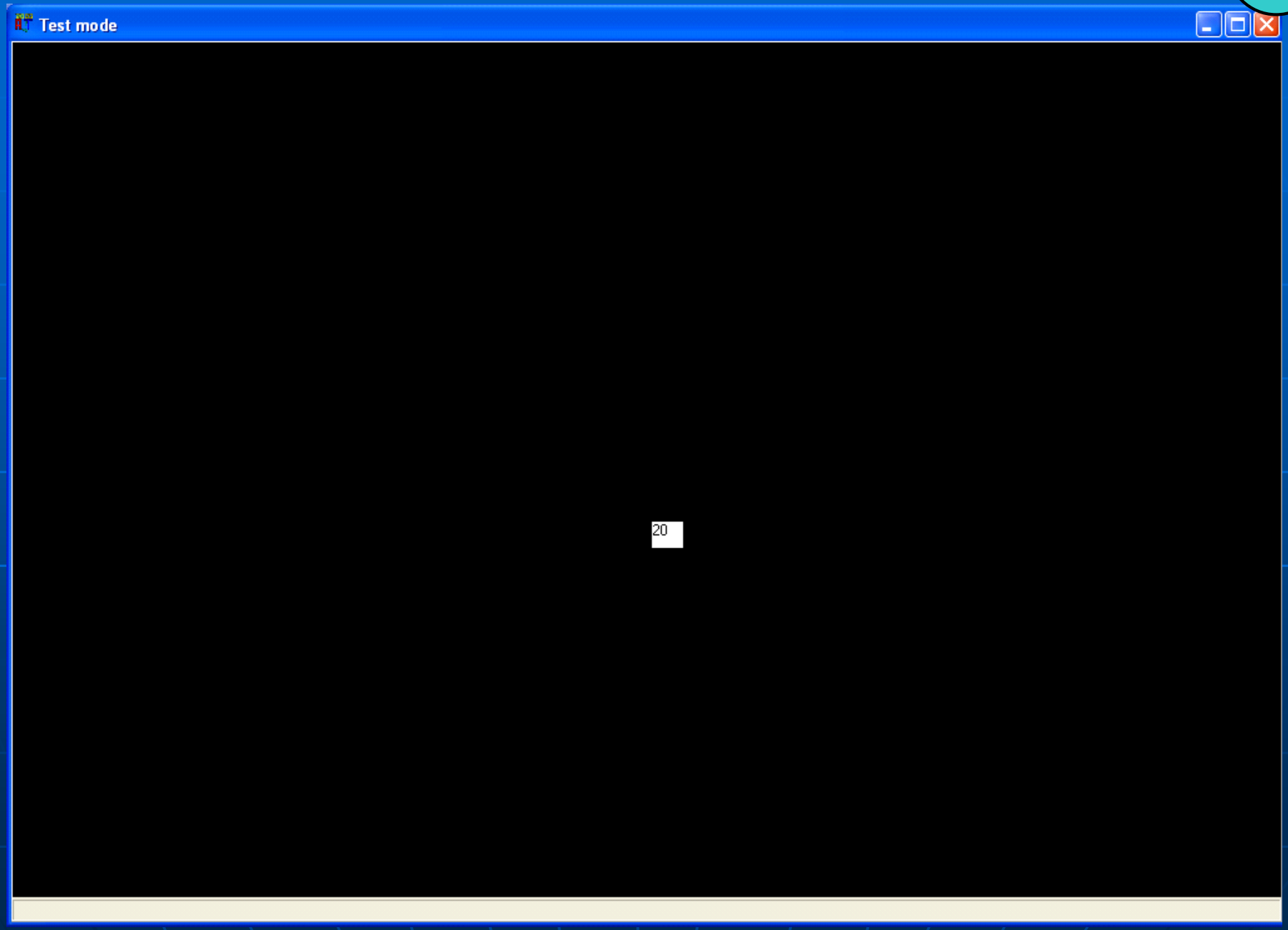
The interface of the applied diagnostic module in the mode of administrating of the question-answers structures of the method of research of the achromatic and chromatic field of vision of examinee by means of the computer perimetry: the parameters of database

4.19.3

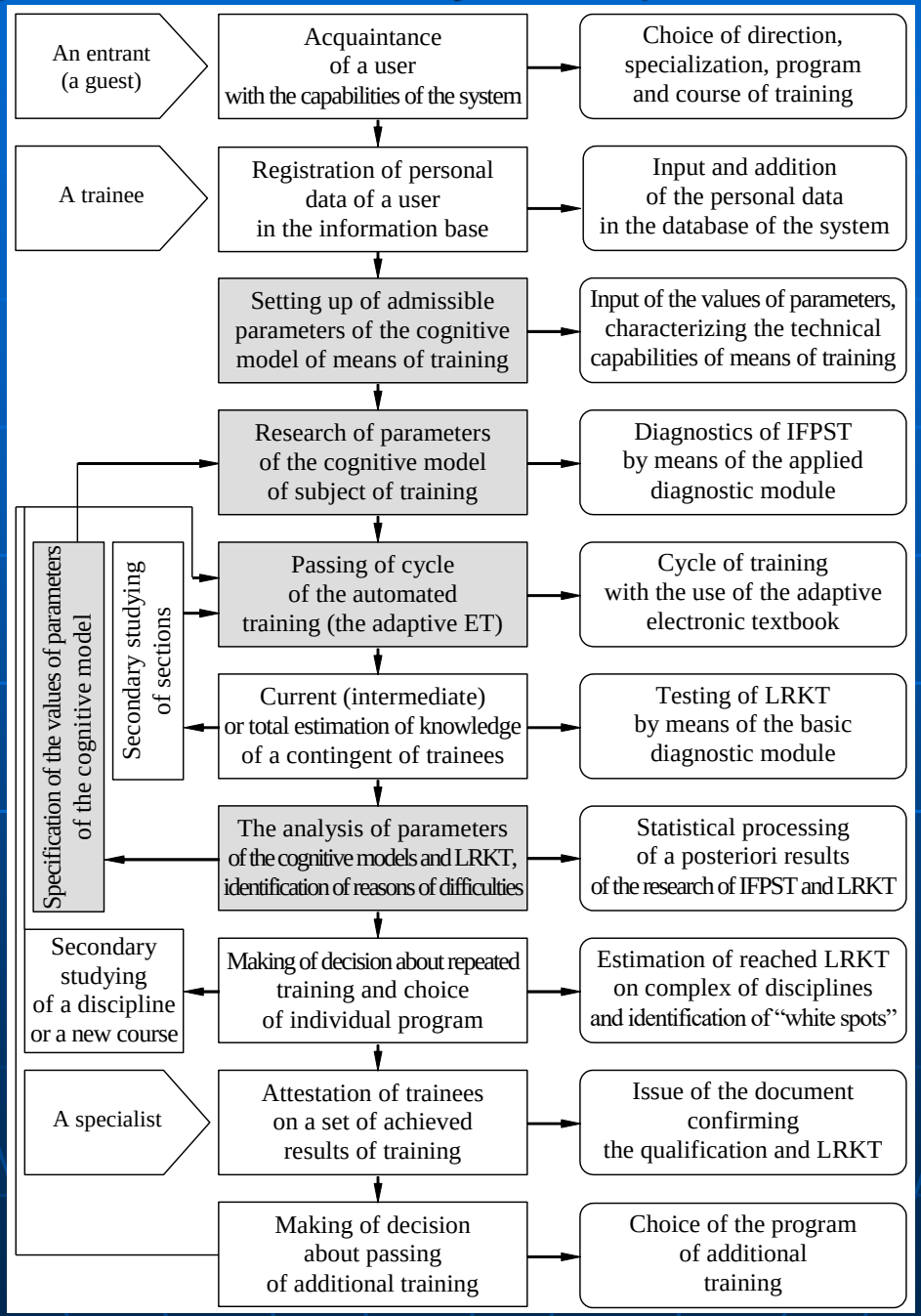


The interface of the applied diagnostic module in the mode of diagnostics of the achromatic and chromatic field of vision of examinee by means of the computer perimetry

4.20.1



The scheme, reflecting the sequence of actions for the support of researches of the cycle of adaptive automated training



The summary results of the mathematical processing of a posteriori data of the experiment (1 from 4)

Previously there was carried out the analysis of the dynamics of a change of the indicator of resultativity of training (LRKT) for the last three years and there was estimated the efficiency of the use of the CMT in the educational process (from 2004-2006 y.), the results of which are presented in the tab. 1.

Table 1

The results of the preliminary statistical analysis of resultativity of the (adaptive) training

Name of indicator	Number of group of examinees							
	1	2	3	4	5	6	7	8
The indicators of resultativity of the training for 2004 year (without CMT in the three groups, private estimation on the fourth section of discipline “Computer science”)								
Quantity of trainees	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 average point	0,686	0,845	0,779	0,502	0,802	0,507	-	-
The indicators of resultativity of the training for 2005 year (without CMT in the three groups, private estimation on the fourth section of discipline “Computer science”)								
Quantity of trainees	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 average point	0,817	0,785	0,824	0,8	0,859	0,811	0,559	0,894
The indicators of resultativity of the training for 2006 year (with CMT in the three groups, private estimation on the fourth section of discipline “Computer science”)								
Quantity of trainees	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 average point	0,707	0,656	0,775	0,751	0,572	0,612	0,858	0,853

The summary results of the mathematical processing of a posteriori data of the experiment (2 from 4)

Previously there was carried out the analysis of the dynamics of a change of the indicator of resultativity of training (LRKT) for the last three years and there was estimated the efficiency of the use of the CMT in the educational process (from 2007-2009 y.), the results of which are presented in the tab. 1.

Table 1

The results of the preliminary statistical analysis of resultativity of the (adaptive) training

Name of indicator	Number of group of examinees							
	1	2	3	4	5	6	7	8
The indicators of resultativity of the training for 2007 year (with CMT in the three groups, private estimation on the fourth section of discipline “Computer science”)								
Quantity of trainees	21	16	17	23	21	16	20	18
Average point Y_3	4,524	4,5	4,588	4,174	4,571	4,375	3,9	3,167
AQD of average point	0,680	0,633	0,507	0,778	0,507	0,619	0,968	0,384
The indicators of resultativity of the training for 2008 year (with CMT in the three groups, private estimation on the fourth section of discipline “Computer science”)								
Quantity of trainees	17	20	19	18	20	18	15	18
Average point Y_3	4,588	4,550	4,684	4,167	4,45	4,778	3,933	4,111
AQD of average point	0,507	0,759	0,582	0,707	0,686	0,428	0,799	0,758
The indicators of resultativity of the training for 2009 year (with CMT in the three groups, private estimation on the fourth section of discipline “Computer science”)								
Quantity of trainees	15	14	14	14	14	14	18	-
Average point Y_3	4,6	4,571	4,714	4	4,357	4,786	3,944	-
AQD of average point	0,507	0,756	0,469	0,679	0,633	0,426	0,725	-

The summary results of the mathematical processing of a posteriori data of the experiment (3 from 4)

End of the tab. 1

Total results of the statistical analysis								
The indicators, reflecting the change of the efficiency of the 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	-	-
Change of AQD	0,13	-0,06	0,045	0,298	0,056	0,304		
The indicators, reflecting the change of the efficiency of the training for 2005-2006 year (with the use of CMT)								
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	0,970	0,922	0,949	0,955
k_3, %	**3,846**	**13,923**	0,099	-10,857	-3,01	-7,778	-5,135	-4,546
Change of AQD	-0,109	-0,129	-0,049	-0,049	-0,287	-0,199	0,299	-0,042
The indicators, reflecting the change of the efficiency of the training for 2006-2007 year (with the use of CMT)								
k_1	0,024	-0,109	0,209	0,466	0,651	0,602	-0,555	-0,652
k_2	1,005	0,976	1,048	1,126	1,166	1,160	0,876	0,829
k_3, %	0,529	-2,359	**4,771**	12,555	16,618	15,964	**-12,449**	**-17,064**
Change of AQD	-0,028	-0,024	-0,268	0,027	-0,065	0,007	0,110	-0,469

The summary results of the mathematical processing of a posteriori data of the experiment (4 from 4)

End of the tab. 1

Total results of the statistical analysis								
The indicators, reflecting the change of the efficiency of the training for 2007-2008 year (with the use of CMT)								
k_1	0,064	0,050	0,096	-0,007	-0,121	0,403	0,033	0,944
k_2	1,014	1,011	1,021	0,998	0,973	1,092	1,009	1,298
k_3, %	**1,424**	**1,111**	**2,092**	-0,174	-2,656	**9,206**	0,855	**29,825**
Change of AQD	-0,172	0,127	0,075	-0,071	0,179	-0,191	-0,169	0,375
The indicators, reflecting the change of the efficiency of the training for 2008-2009 year (with the use of CMT)								
k_1	0,012	0,021	0,030	-0,167	-0,093	0,008	0,011	-4,111
k_2	1,003	1,005	1,006	0,960	0,979	1,002	1,003	0,000
k_3, %	0,256	0,471	0,642	-4,000	-2,087	0,166	0,283	**-100 [?]**
Change of AQD	0,000	-0,003	-0,114	-0,028	-0,053	-0,002	-0,074	-0,758

The results of the regression analysis (1 from 3)

1. As the result of the carried-out regression analysis the received values of coefficient of multiple correlation (CMC) and coefficient of multiple determination (CMD) demonstrate, that **minimum 38,9%** (at the reduced set of predictors and the rough scale of estimation on the basis of the sum of the correct answers the questions) and **maximum 59,0%** (at the full set of predictors and the exact scale of estimation on the basis of the sum of the gained points) of dispersion of dependent variable Y (estimation of the LRKT) is defined by the variation of the values of the reduced and full set of independent variables of the linear regression model $Y(K_i)$.
2. As predictors in the received linear multiple regression model is accepted the reduced (Age, K_7, K_8, K_9, K_{14}, K_{15}, K_{16}, K_{17}, K_{18}, K_{19}, K_{20}, K_{21}, K_{22}, K_{23}, K_{24}, K_{25}, K_{27}, K_{28}, K_{29}, K_{45}) and the full set (Age, RU, LIT, LG, HIS, GEO, BIO, ALG, GEOM, FIZ, CHE, SCH, AST, K_7, K_8, K_9, K_{14}, K_{15}, K_{16}, K_{17}, K_{18}, K_{19}, K_{20}, K_{21}, K_{22}, K_{23}, K_{24}, K_{25}, K_{27}, K_{28}, K_{29}, K_{45}, L_{31N}, L_{36N}, L_{37}, L_{38N}) of independent variables (predictors), and as the factor (dependent variable) directly supports the resultativity of technological process of controlled formation of knowledge Y (Y_2 – the estimation of LRKT on the rough scale on the basis of the sum of the correct answers the questions and Y_4 – the estimation of LRKT on the exact scale on the basis of the sum of the gained points for each correct variant of answer the question).

The results of the regression analysis (2 from 3)

During the regression analysis the equations of multiple regression are received:

$$Y_2=2{,}545-0{,}012Age+0{,}031K_7+0{,}020K_8-0{,}029K_9+0{,}057K_{14}-0{,}017K_{15}-0{,}019K_{16}-$$
$$-0{,}017K_{17}+0{,}038K_{18}+0{,}012K_{19}+0{,}015K_{20}+0{,}030K_{21}-0{,}003K_{22}-0{,}031K_{23}+0{,}004K_{24}-$$
$$-0{,}005K_{25}+0{,}075K_{27}-0{,}035K_{28}+0{,}006K_{29}+0{,}037K_{45},\ \mathbf{CMC=0{,}389},\ \mathbf{CMD=0{,}151}.$$

$$Y_4=4{,}924-0{,}108Age+0{,}028K_7+0{,}005K_8-0{,}025K_9+0{,}016K_{14}-0{,}038K_{15}-0{,}016K_{16}-$$
$$-0{,}003K_{17}+0{,}038K_{18}-0{,}015K_{19}+0{,}021K_{20}+0{,}068K_{21}-0{,}019K_{22}-0{,}040K_{23}-0{,}015K_{24}+$$
$$+0{,}008K_{25}+0{,}090K_{27}-0{,}096K_{28}+0{,}020K_{29}+0{,}075K_{45},\ \mathbf{CMC=0{,}509},\ \mathbf{CMD=0{,}259}.$$

$$Y_2=0{,}824-0{,}008Age-0{,}161RU+0{,}049LIT+0{,}147LG+0{,}244HIS-0{,}128GEO-0{,}008BIO+$$
$$+0{,}040ALG+0{,}120GEOM-0{,}100FIZ-0{,}077CHE+0{,}148SCH+0{,}041AST+0{,}030K_7+$$
$$+0{,}021K_8-0{,}035K_9+0{,}067K_{14}-0{,}005K_{15}-0{,}034K_{16}-0{,}022K_{17}+0{,}040K_{18}+0{,}006K_{19}+$$
$$+0{,}007K_{20}+0{,}027K_{21}+0{,}000K_{22}-0{,}022K_{23}-0{,}003K_{24}-0{,}003K_{25}+0{,}062K_{27}-0{,}046K_{28}+$$
$$+0{,}008K_{29}+0{,}028K_{45}+0{,}087L_{31N}-0{,}020L_{36N}+0{,}025L_{37}-0{,}003L_{38N},\ \mathbf{CMC=0{,}491},\ \mathbf{CMD=0{,}241}.$$

$$Y_4=3{,}035-0{,}098Age-0{,}106RU+0{,}034LIT-0{,}015LG-0{,}111HIS-0{,}077GEO-0{,}021BIO+$$
$$+0{,}259ALG-0{,}142GEOM+0{,}171FIZ+0{,}142CHE+0{,}024SCH+0{,}332AST+0{,}015K_7-$$
$$-0{,}002K_8-0{,}022K_9+0{,}011K_{14}-0{,}035K_{15}-0{,}021K_{16}+0{,}003K_{17}+0{,}034K_{18}-0{,}021K_{19}+$$
$$+0{,}007K_{20}+0{,}055K_{21}-0{,}013K_{22}-0{,}050K_{23}-0{,}023K_{24}+0{,}011K_{25}+0{,}136K_{27}-0{,}089K_{28}+$$
$$+0{,}001K_{29}+0{,}097K_{45}+0{,}033L_{31N}-0{,}019L_{36N}+0{,}014L_{37}+0{,}005L_{38N},\ \mathbf{CMC=0{,}590},\ \mathbf{CMD=0{,}348}.$$

The results of the regression analysis (3 from 3)

In the equations of multiple regression the following designations are used (see the slide 3.1 – the CM of subject of training and see the slide 3.2 – the CM of means of training): Age – age, RU – estimation of LRKT in Russian language, LIT – estimation of LRKT in literature, LG – estimation of LRKT in foreign (English) language, HIS – estimation of LRKT in history, GEO – estimation of LRKT in geography, BIO – estimation of LRKT in biology, ALG – estimation of LRKT in algebra, GEOM – estimation of LRKT in geometry, FIZ – estimation of LRKT in physics, CHE – estimation of LRKT in chemistry, SCH – estimation of LRKT in drawing, AST – estimation of LRKT in astronomy, $K_7=\Pi^1_7$ – achromasia, $K^1_8=\Pi^1_8$ – protanopia, $K^1_9=\Pi^1_9$ – deuteranopia, $K^1_{10}=\Pi^1_{10}$ – tritanopia, $K^1_{14}=\Pi^1_{14}$ – verbalization (logical selection), $K^1_{15}=\Pi^1_{15}$ – deductive generalization (search of general signs), $K^1_{16}=\Pi^1_{16}$ – associative combinatory, $K^1_{17}=\Pi^1_{17}$ – classification and reasoning, $K^1_{18}=\Pi^1_{18}$ – the mathematical analysis (arithmetic abilities), $K^1_{19}=\Pi^1_{19}$ – numerical induction (recombining of numbers), $K^1_{20}=\Pi^1_{20}$ – mnemonics and memory (storing), $K^1_{21}=\Pi^1_{21}$ – plane thinking, $K^1_{22}=\Pi^1_{22}$ – volumetric imagination (volumetric thinking), $K^1_{23}=\Pi^1_{23}$ – verbal associativity, $K^1_{24}=\Pi^1_{24}$ – verbal originality, $K^1_{25}=\Pi^1_{25}$ – verbal uniqueness, $K^1_{26}=\Pi^1_{26}$ – verbal selectivity, $K^1_{27}=\Pi^1_{27}$ – figurative associativity, $K^1_{28}=\Pi^1_{28}$ – figurative originality, $K^1_{29}=\Pi^1_{29}$ – figurative uniqueness, $K^1_{30}=\Pi^1_{30}$ – figurative selectivity, $K^1_{45}=\Pi^1_{21}$ – level of proficiency in language of statement, $L2_{31N}=\Pi^2_2$ – color of background, $L_{36N}=\Pi^2_4$ – set of font, $L_{37}=\Pi^2_5$ – size of pointtype of symbol $L_{38N}=\Pi^2_6$ – color of symbol (the specified and other parameters of the parametrical CM block are located in the database with a posteriori results of research of LRKT and IFPST).

The results of the discriminant analysis (1 from 2): own values for the canonical discriminant functions

5.4.1

The discriminant analysis allows to receive the own values of canonical functions and the chart of relative arrangement of the centroids of the classes, selected on the indicator of resultativity of the training, allowing to provide the evident interpretation of the differences between the classes of excellent, good, mediocre and poor pupils on the basis of a set of the values of parameters in the parametrical CM block (the CM of subject of training and the CM of means of training), which essential for the analysis of efficiency of a formation of knowledge of trainees in the IEE of the ART.

Table 2

The own values for the canonical functions (Eigenvalues)

The reduced set of independent variables K_i and dependent variable Y_2

Function	Own value	Share of dispersion	Saved-up dispersion	Correlation
1	0,183	51,6	51,6	0,393
2	0,131	37,2	88,8	0,341
3	0,040	11,2	100,0	0,196

The reduced set of independent variables K_i and dependent variable Y_4

Function	Own value	Share of dispersion	Saved-up dispersion	Correlation
1	0,414	76,6	76,6	0,541
2	0,082	15,3	91,9	0,276
3	0,044	8,1	100,0	0,205

The full set of independent variables K_i and dependent variable Y_2

Function	Own value	Share of dispersion	Saved-up dispersion	Correlation
1	0,350	52,9	52,9	0,509
2	0,206	31,1	84,0	0,413
3	0,106	16,0	100,0	0,309

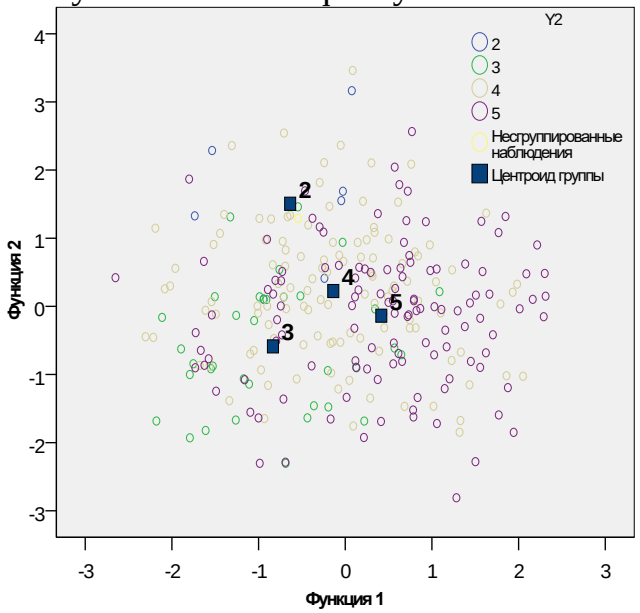
The full set of independent variables K_i and dependent variable Y_4

Function	Own value	Share of dispersion	Saved-up dispersion	Correlation
1	0,582	67,8	67,8	0,607
2	0,169	19,6	87,4	0,380
3	0,108	12,6	100,0	0,313

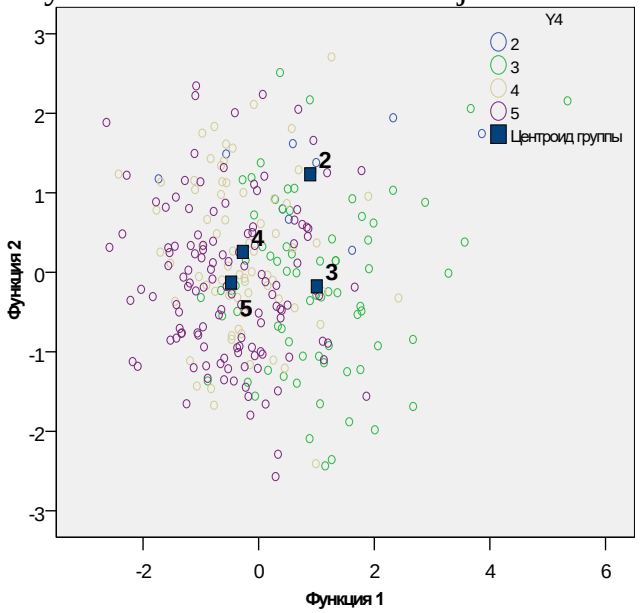
The informativity of the presented canonical functions is approximately equal.

The results of the discriminant analysis (2 from 2): the position of centroids of classes in the space of two discriminant functions

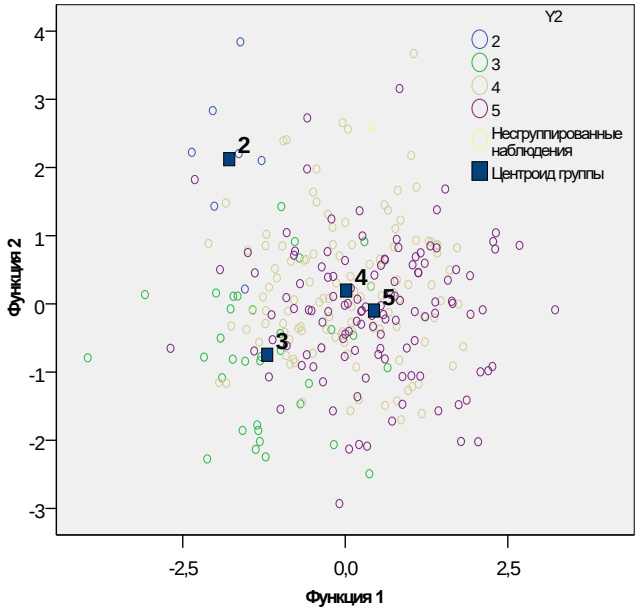
The graphical interpretation allows to analyze the received canonical functions and visually to estimate the quality of classification by the density of the distribution of the objects inside class.



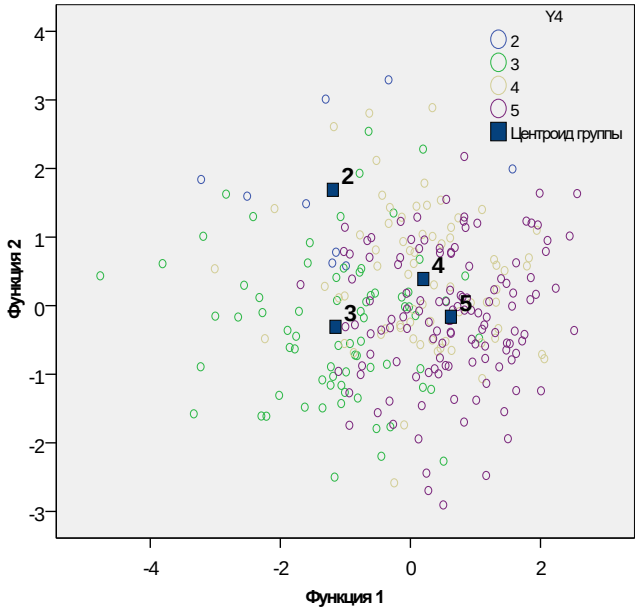
a



b



c

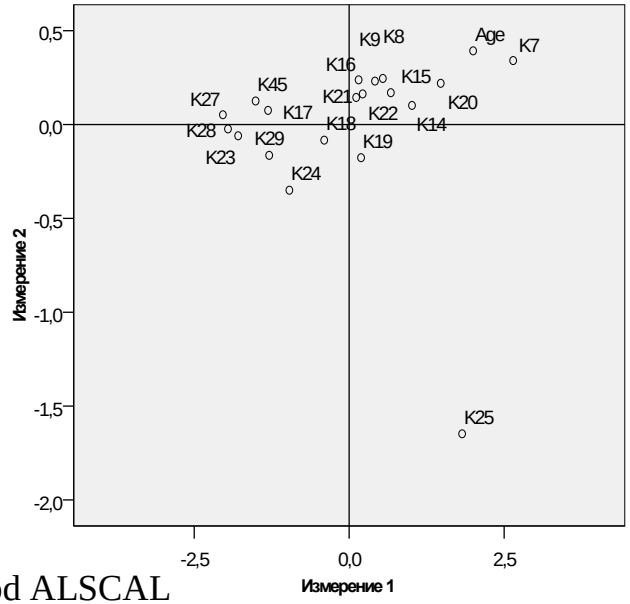


d

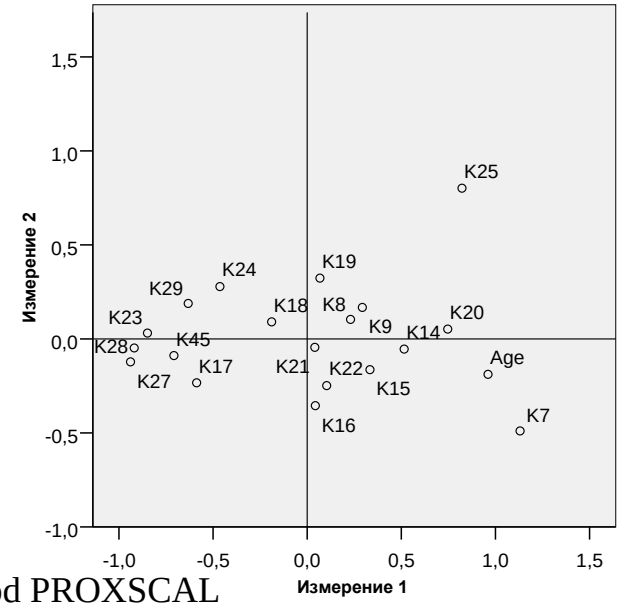
The results of the multidimensional scaling

5.5.1

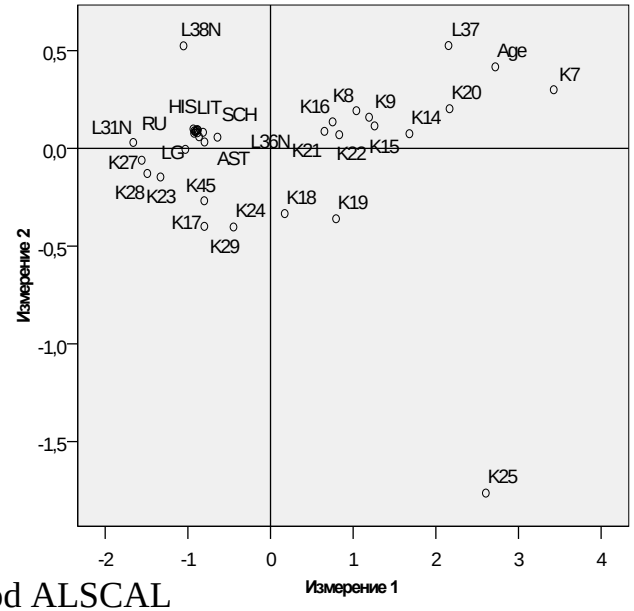
Multidimencional scaling allowed to reflect the geometrical place of points of the reduced (a – method ALSCAL, c – method PROXSCAL) and the full set (b – method ALSCAL, d – method PROXSCAL) of independent variables in space of two scales by means of two specified methods.



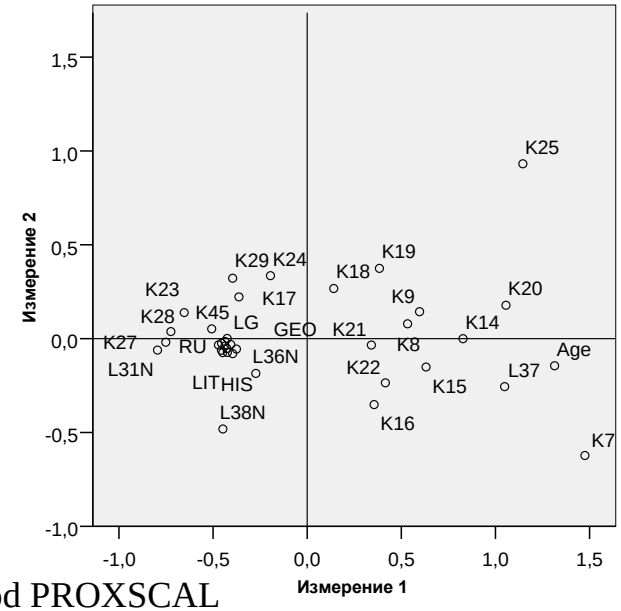
method ALSCAL a



b method PROXSCAL



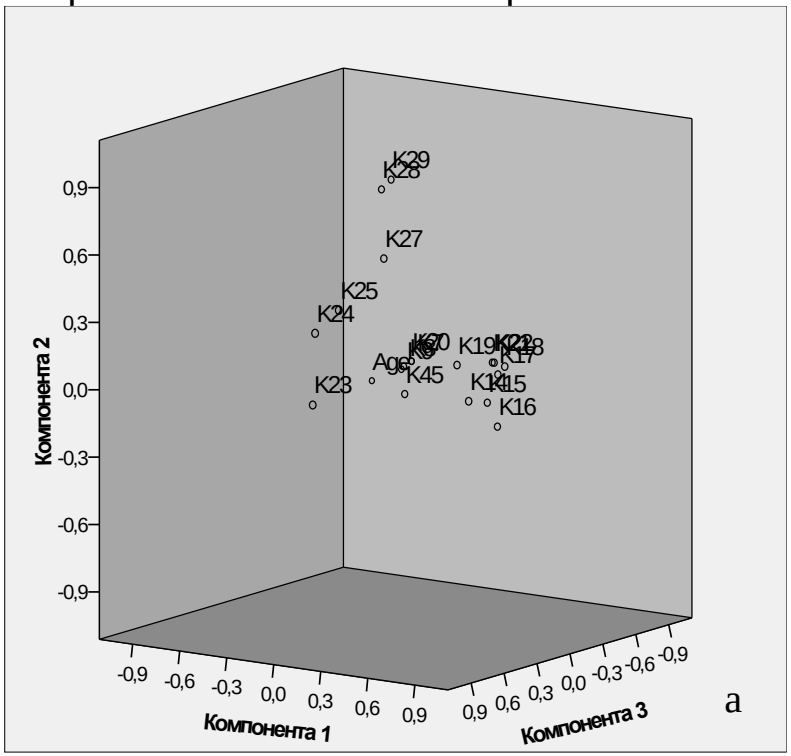
method ALSCAL c



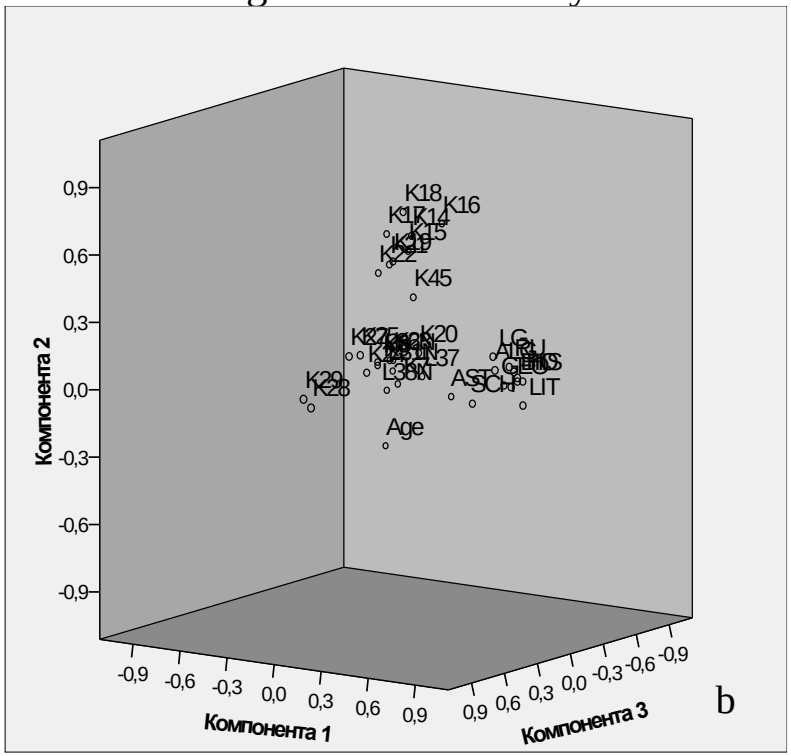
d method PROXSCAL

The results of the factorial analysis

The geometrical location of the reduced set (a) and the full set (b) of independent variables in space of three components forming several locality is received.



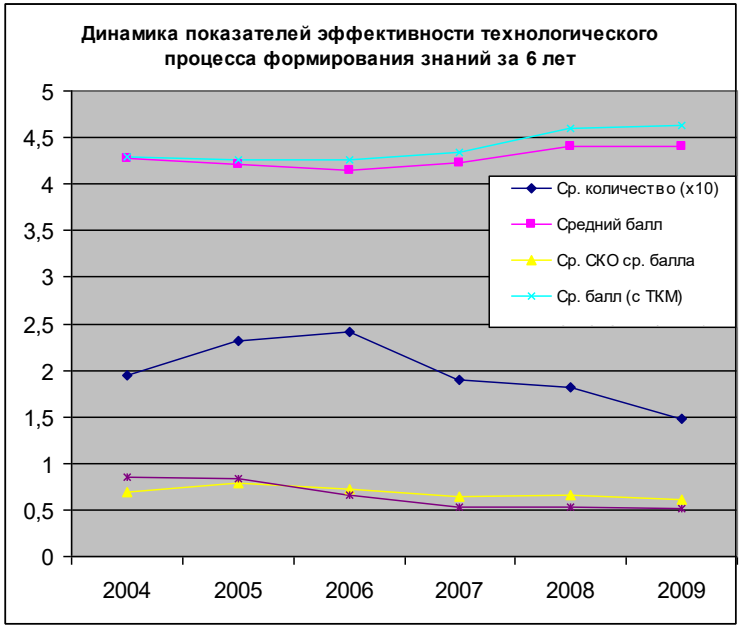
a

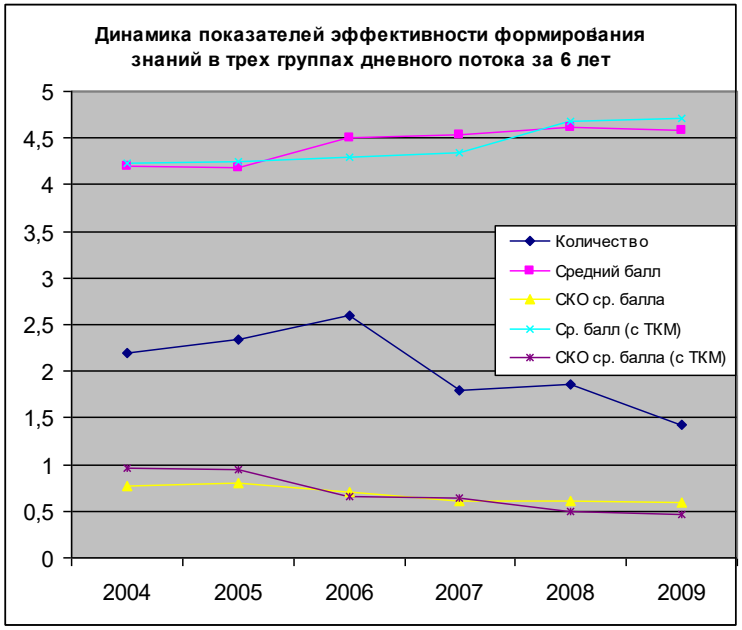


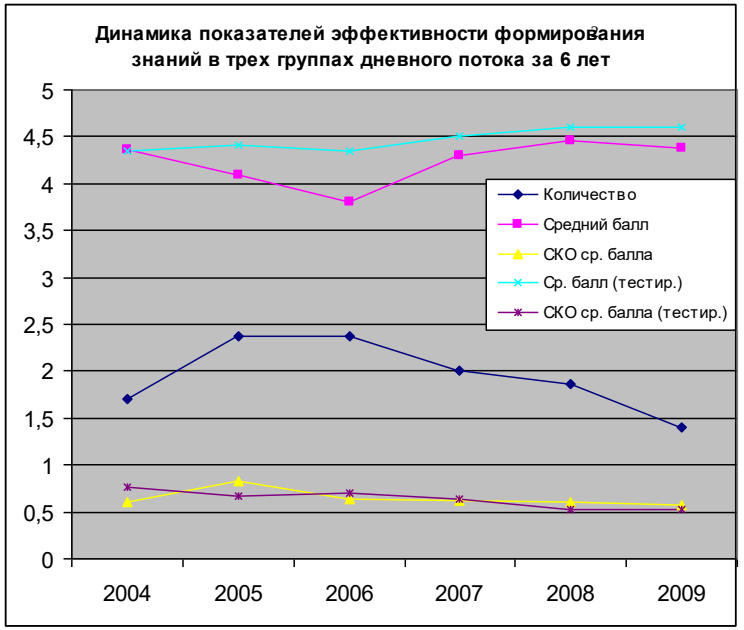
b

The dynamics of the indicators of efficiency (resultativity) of the technological process of controlled formation of knowledge of trainees (1 from 2)

The dynamics of indicators of resultativity of training for 6 years (2004-2009 y.) is presented.







The dynamics of the indicators of efficiency (resultativity) of the technological process of controlled formation of knowledge of trainees (2 from 2)

The statistical analysis of a posteriori data received at the practical use of results of research in the learning process of "The Saint-Petersburg state electrotechnical university "LETI"" and "The international banking institute" allow to draw the following conclusions:

- the effective use of CMT in the automated IEE assumes the modification of the IEE of the ART and the modernization of electronic means of training and TMM of different appointment;
- the degree of influence of the parameters of CM on efficiency (resultativity) of process of training (formation of knowledge) depends on the contingent of trainees and has individual character;
- the increase of efficiency of formation of knowledge of trainees with the use of CMT is defined by the opportunities of means of IEE, the content of ET containing the structured information on the cycle of disciplines is adequate to the purposes of training, varied according to the algorithms in the basis of various components, techniques, learning plans and working programs.

In my scientific works and the next report on SRW "The research of the information environment of the automated training with properties of adaptation based on the cognitive models and the financial analysis of the organization by means of cognitive modeling technology" for 2006-2008 y., which is carried out in the process of writing of dissertation, on fact of the difficult theoretical and practical scientific-technical work:

- the CMT for the system analysis of IEE and the increase of efficiency of the system of ART is created – this dissertation;
- the aggregate of CMT for the financial analysis of organizational structure is developed – the dissertation on spec. 08.00.10 – "Finance, monetary circulation and credit" is formed.

"The Saint-Petersburg state university"
faculty "Applied mathematics – control processes"
chair "Information systems"

Part III. The answers the questions of the foreign and national of member of "The dissertation council" on dissertation

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

on the competition of scientific degree of the candidate technical sciences
on spec. 05.13.01 – "The system analysis, control and information processing"

Reporter (applicant): the author of the unique cognitive modeling technology for the system, financial and complex analysis *Vetrov Anatoly Nikolaevich*.

The Russian Federation, Saint-Petersburg city, 2019 y.

“The Saint-Petersburg state university”
faculty “Applied mathematics – control processes”
chair “Information systems”

The question of the foreign member of “The dissertation council” 1.1.

“The content of question”

The author of question:
the head of chair “The name of chair”
of the faculty “The name of faculty”
of “The Lappeenranta technological university”
(The republic of Finland,
Lappeenranta city),
d.t.s., prof. *John Johnson*.

The Russian Federation, Saint-Petersburg city, 2019 y.

“The Saint-Petersburg state university”
faculty “Applied mathematics – control processes”
chair “Information systems”

The question of the foreign member of “The dissertation council” 2.1.

“The content of question”

The author of question:
the head of chair “The name of chair”
of the faculty “The name of faculty”
of “The Helsinki university”
(The republic of Finland, Helsinki city),
d.t.s., prof. *John Johnson*.

The Russian Federation, Saint-Petersburg city, 2019 y.

“The Saint-Petersburg state university”
faculty “Applied mathematics – control processes”
chair “Information systems”

The question of the national member of “The dissertation council” 3.1.

“The content of question”

The author of question:
the head of chair “The name of chair”
of the faculty of “The name of faculty”
of “The Saint-Petersburg state university”
(The RF, Saint-Petersburg city),
d.t.s., prof. *Ivanov Ivan Ivanovich*.

The Russian Federation, Saint-Petersburg city, 2019 y.

“The Saint-Petersburg state university”
faculty “Applied mathematics – control processes”
chair “Information systems”

The question of the national member of “The dissertation council” 4.1.

“The content of question”

The author of question:
the head of chair “The name of chair”
of the faculty of “The name of faculty”
of “The Saint-Petersburg state university”
(The RF, Saint-Petersburg city),
d.t.s., prof. *Petrov Petr Petrovich*.

The Russian Federation, Saint-Petersburg city, 2019 y.

"The Saint-Petersburg state university"
faculty "Applied mathematics – control processes"
chair "Information systems"

Part IV. The performances of the members "The dissertation council", the representative of opposing (leading) organization, the official opponents and the scientific supervisor on dissertation

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

on the competition of scientific degree of the candidate technical sciences
on spec. 05.13.01 – "The system analysis, control and information processing"

Applicant: the author of the unique cognitive modeling technology
for the system, financial and complex analysis *Vetrov Anatoly Nikolaevich*.

The Russian Federation, Saint-Petersburg city, 2019 y.

"The Saint-Petersburg state university"
faculty "Applied mathematics – control processes"
chair "Information systems"

Part IV.1. The performance of the members of "The dissertation council" on dissertation

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

on the competition of scientific degree of the candidate technical sciences
on spec. 05.13.01 – "The system analysis, control and information processing"

Applicant: the author of the unique cognitive modeling technology
for the system, financial and complex analysis *Vetrov Anatoly Nikolaevich*.

The Russian Federation, Saint-Petersburg city, 2019 y.

"The Saint-Petersburg state university"
faculty "Applied mathematics – control processes"
chair "Information systems"

Part IV.2. The performance of the representative of opposing (leading) organization on dissertation

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

on the competition of scientific degree of the candidate technical sciences
on spec. 05.13.01 – "The system analysis, control and information processing"

The representative of opposing (leading) organization:
the head of chair "The name of chair"
of the faculty "The name of faculty"
of "The name of opposing (leading) organization"
(The country, city),
d.t.s., prof. *Ivanov Ivan Ivanovich*.

Applicant: the author of the unique cognitive modeling technology
for the system, financial and complex analysis *Vetrov Anatoly Nikolaevich*.

The Russian Federation, Saint-Petersburg city, 2019 y.

“The Saint-Petersburg state university”
faculty “Applied mathematics – control processes”
chair “Information systems”

Part IV.3. The performances of official opponents on dissertation

“The environment of automated training with properties of adaptation based on cognitive models”

on the competition of scientific degree of the candidate technical sciences
on spec. 05.13.01 – “The system analysis, control and information processing”

The first official opponent:
the head of chair “The name of chair”
of the faculty “The name of faculty”
of “The opposing (leading) organization”
(The country, city),
d.t.s., prof. *Ivanov Ivan Ivanovich*.

The second official opponent:
the head of chair “The name of chair”
of the faculty “The name of faculty”
of “The opposing (leading) organization”
(The country, city),
d.t.s., prof. *Ivanov Ivan Ivanovich*.

The Russian Federation, Saint-Petersburg city, 2019 y.

"The Saint-Petersburg state university"
faculty "Applied mathematics – control processes"
chair "Information systems"

Part IV.4. The performance of scientific supervisor on dissertation

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

on the competition of scientific degree of the candidate technical sciences
on spec. 05.13.01 – "The system analysis, control and information processing"

The scientific supervisor: the prof. of chair "Information system" of "The SPbSU",
the member of "The American mathematical society",
d.ph.-m.s., prof. *Kvitko Alexander Nikolaevich*.

Applicant: the author of the unique cognitive modeling technology
for the system, financial and complex analysis *Vetrov Anatoly Nikolaevich*.

The Russian Federation, Saint-Petersburg city, 2019 y.

"The Saint-Petersburg state university"
faculty "Applied mathematics – control processes"
chair "Information systems"

Part V. The vote of the members of "The dissertation council" on dissertation

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

on the competition of scientific degree of the candidate technical sciences
on spec. 05.13.01 – "The system analysis, control and information processing"

Applicant: the author of the unique cognitive modeling technology
for the system, financial and complex analysis *Vetrov Anatoly Nikolaevich*.

The Russian Federation, Saint-Petersburg city, 2019 y.

"The Saint-Petersburg state university"
faculty "Applied mathematics – control processes"
chair "Information systems"

The results of vote
of the members of "The dissertation council"
on the question of assignment of scientific degree:
"Yes" – 00, "No" – 00 and "Refrained" – 00.

The chairman of "The dissertation council" (scientific consultant):
the head of chair "Modeling of electromechanical and computer system",
"The honorary professor of "The SPbSU"", d.ph.-m.s., prof. *Egorov Nikolay Vasilyevich*.

The scientific supervisor: the prof. of chair "Information system" of "The SPbSU",
the member of "The American mathematical society",
d.ph.-m.s., prof. *Kvitko Alexander Nikolaevich*.

Applicant: the author of the unique cognitive modeling technology
for the system, financial and complex analysis *Vetrov Anatoly Nikolaevich*.

The Russian Federation, Saint-Petersburg city, 2019 y.

"The Saint-Petersburg state university"
faculty "Applied mathematics – control processes"
chair "Information systems"

Part VI. The concluding remarks of the chairman and the members of "The dissertation council" on dissertation

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

on the competition of scientific degree of the candidate technical sciences
on spec. 05.13.01 – "The system analysis, control and information processing"

Applicant: the author of the unique cognitive modeling technology
for the system, financial and complex analysis *Vetrov Anatoly Nikolaevich*.

The Russian Federation, Saint-Petersburg city, 2019 y.