

Cognitive Map of the Pedagogical Situation as a Component of the Pedagogical Situation Cognitive Model (as Exemplified by Analyzing Natural Science and Vocational Training in Colleges of the Republic of Tatarstan)

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Abstract-Introduction-the purpose of the article is to give theoretical justification for the phased design of a cause-and-effect cognitive model; to develop and analyze a cognitive map of the pedagogical situation of this model (as exemplified by analyzing the state of natural science and vocational training in the colleges of the Republic of Tatarstan in the context of integrating new educational and professional standards). The authors tested the hypothesis of the relationship between the identified six factors (when creating a cognitive map) in the process of building a directed graph aimed at developing the student's cognitive tools. **Materials and methods:** to objectively determine the problem field of the object under study, presented in the form of a cognitive map, a SWOT- analysis of the strengths and weaknesses of developing the pedagogical state was used based on a survey of college teachers from the Republic of Tatarstan. Processing the results was carried out on the basis of probabilistic assessment methods using complex factors that made it possible to identify strengths, weaknesses, drawbacks, and possible threats of the pedagogical situation under study. **Results of the research:** a methodology for designing a cause-effect cognitive model of a pedagogical state of natural science and vocational training was theoretically substantiated and developed based on creating and analyzing a cognitive map of this situation in the process of studying the teachers' opinion on implementing integration processes in the system of Secondary Vocational Education at the regional level. The dynamics of the teachers' opinion was studied using a SWOT-analysis of the results of a questionnaire which is an adapted didactic tool. It allows describing both quantitative and qualitative characteristics of the six factors identified in the process of building a cognitive map. The scientists' works on modern Russian professional education in the context of developing cognitive pedagogy were studied and analyzed.

Discussion and conclusions: the study quite adequately shows that the SWOT-analysis of the state of natural science and vocational training of the colleges in the RT which is a region with a fairly high level of economic development reveals that amid the generally positive pedagogical situation at the time being studied, a number of shortcomings have been identified: the proportion of teachers with an average age of 50 and 60 is more than 66%; shortage of educational

literature; difficulties in designing curricula in accordance with the Federal State Standard-4 Secondary Vocational Education, namely in selecting and correcting educational material; in applying project technology, case-technology, playing technologies; in organizing students' independent work. The results of the study on the cognitive modeling of the pedagogical situation may be useful to specialists in the field of education, as well as interesting to the general public.

Annotation. The article gives theoretical justification and algorithm of gradual designing a cause-and-effect cognitive model. The method of constructing and analyzing pedagogical situation cognitive maps is offered (analysis of the natural science and vocational training in colleges of the Republic of Tatarstan in terms of integrating new educational and professional standards), which is part of the cognitive model developed by the authors. The results of SWOT-analysis of strengths and weaknesses of developing the pedagogical state are presented on the basis of researching college teachers' survey data in the Republic of Tatarstan.

Keywords-*cognitive modeling, pedagogical situation, cognitive map, oriented graph, cognitive model*

In the last decade, pedagogy and psychology development has led to the emergence of a new direction – “cognitive pedagogy”, which is gradually being developed both in theory and in practice. This led to the existence of a new understanding of training processes and education in the context of forming a person's cognitive and personal structures. We share S.F. Sergeev's opinion who says that “cognitive pedagogy differs from classical instrumental pedagogy by paying special attention to a person's cognitive structures and tools and ways of their development, in contrast to the behavioral orientation inherent in traditional schools, which assesses the characteristics of the individual and the productive side of human activity” [1, p.70].

In cognitive pedagogy special attention is paid to educational structures, tools of perception and ways of their development. Personality solves certain problems with the help of various tools presented in the form of structures of processing and transforming information. It can be both external tools in their direct physical form (tools, machines, ergatic systems) and internal (intellect, memory, attention, imagination, etc.). Each person has an individual set, which is used with different efficiency in solving a wide range of problems.

Therefore, in the process of training and education, it is important to understand the features of the instrumental side of the individual's cognitive organization, to reflect the integral structure of human cognition system. The system of human cognition includes not only instrumental, but also substantial components of the psyche involved in the processes of human knowledge organization and self-organization. Dynamic mental structures created in the psycho-physiological structure of man to solve a specific task are called *meta-tools*. Subsequently, they are replaced by more universal and stable cognitive tools. We can say that the meta-tool is a stage of a person's cognitive ability evolution.

And although pedagogy implements a variety of technologies to improve the process of learning and education, both practitioners and researchers do not pay enough attention to the properties and features of the tools the person uses in the process of perceiving, evaluating these tools. Therefore, the process of effective human organization is directly related to creating and implementing *the instrumental sphere* of the pedagogical environment. So, for example, A.N. Dahin believes that "the cognitive approach is understood as solving problems traditional for this science by methods taking into account cognitive aspects, which include the processes of perception, thinking, cognition, explanation and understanding" [2].

Cognitive theories of learning did not appear from scratch, they were preceded by the ideas and concepts developed by Russian scientists: recommended sequence of activities (P. Ya. Galperin and N.F. Talyzina), enlargement of didactic units (M.P. Erdniev); reference signals (V.F. Shatalov), etc. Even in 1975 D.V. Vilkeev in the work "Methods of scientific cognition in school learning," examined the ratio of the inductive and deductive cognition methods in learning. He revealed psychological

background and didactic basis of the relationship of induction, deduction and hypothesis in students' cognitive activity, of which in terms of problem-based learning [3].

In modern cognitive pedagogical psychology cognitive theories of training "act as a psychological and pedagogical justification of didactic systems that implement the values of knowledge and development of students' cognitive abilities" [4], when "training is based on the students' direct experience, its expansion in the course of research and exploratory activity, dynamic development of the world" [4].

In accordance with the cognitive theory training doesn't only mean to pass a certain amount of information, it is aimed at forming a future specialist, along with the ability to perceive the training material (knowledge), to have the necessity to constantly update and use it.

The methodology of cognitive modeling is developed to improve the apparatus of analyzing and modeling pedagogical situations. At the same time, certain stages are singled out which are peculiar to cognitive analysis of any situation, for example, in the case of studying the state of natural science and vocational training in the secondary vocational education (SVE).

The first stage is forming the purpose and related objectives.

The second stage involves the collection, systematization and analysis of the existing pedagogical situation, followed by the allocation of the main factors affecting the situation development, and the definition of the relationship between them, i.e. creating *a cognitive map*.

The third stage is aimed at building a focused graph as a result of taking into account the cause-and-effect chains that reflect the system of interacting between the subjects of the educational process. They allow forming a pedagogical theory based on the key categories of human study: consciousness, thinking, cognition, understanding, etc.

The fourth stage involves combining the cognitive map and oriented graph into a single cognitive model of the studied pedagogical situation.

As a result of passing 4 stages, the cause-and-effect cognitive model of the pedagogical situation is built, which is displayed in the form of a functional graph consisting of a cognitive map and *a directed graph* (see Fig. 1).

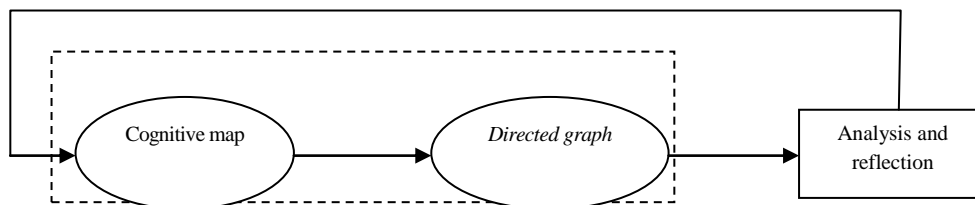


Figure 1. Scheme of building a cause-and-effect cognitive model of the pedagogical situation.

The **fifth stage** is focused on checking the adequacy of the cognitive model of the real pedagogical situation, i.e. it is focused on its verification.

The last **sixth stage** allows determining possible variants of pedagogical situation development with the help of the cognitive model, finding ways and mechanisms to influence the situation.

In this case, we consider cognitive modeling of pedagogical situations as a step-by-step process of collecting, systemizing and analyzing the existing pedagogical situation, followed by the allocation of the main factors affecting the situation development, and by the definition of the relationship between them (building a cognitive map). This takes into account the emergence of the cause-and-effect chains, reflecting the system of interacting between the subjects of the educational process, contributing to the effectiveness of forming internal tools of knowledge (consciousness, thinking, understanding) and to creating external tools of knowledge in the form of cognitive cause-and-effect model. As a result, a cognitive model of the pedagogical situation was obtained, the verification of which will determine the possible options for developing the pedagogical situation.

Determining the relationship between the factors (building a cognitive map), taking into account the emergence of the cause-and-effect chains allowed us to build a focused graph, which in our case reflects the system of interacting between the teacher (master, etc.) and the student in the organization of

educational natural science education aimed at developing various methods of the student’s knowledge (deduction, induction, reasoning, etc.), i.e. at forming his cognitive tools.

Building conceptual structures of various subject areas of training courses is the result of making conceptual modeling. It happens when the first part of the oriented graph of the cognitive model will be built in the form of directed hierarchical relationships “from the didactic unit of a higher hierarchy level to the unit of a lower hierarchy level” [5, p. 374].

The second part of the oriented graph is designed in the form of appropriate cognitive profiles, taking into account the particular characteristics of different types of students’ classroom and extracurricular cognitive activity. In turn, structuring the relevant profiles should be based on a number of principles: poly-independence, cognitive complexity of perception, reflexivity, flexibility of mental processes, functionality.

As a result, it is possible to present a schematic cause-and-effect model of designing the natural science component of cognitive modeling in vocational education (see Fig. 2). It “adequately and comprehensively reflects the nature, essential qualities and components of the pedagogical system at this time, allows to obtain information on the past, present, and future state, opportunities and conditions for building, functioning and development” [6, p. 167].

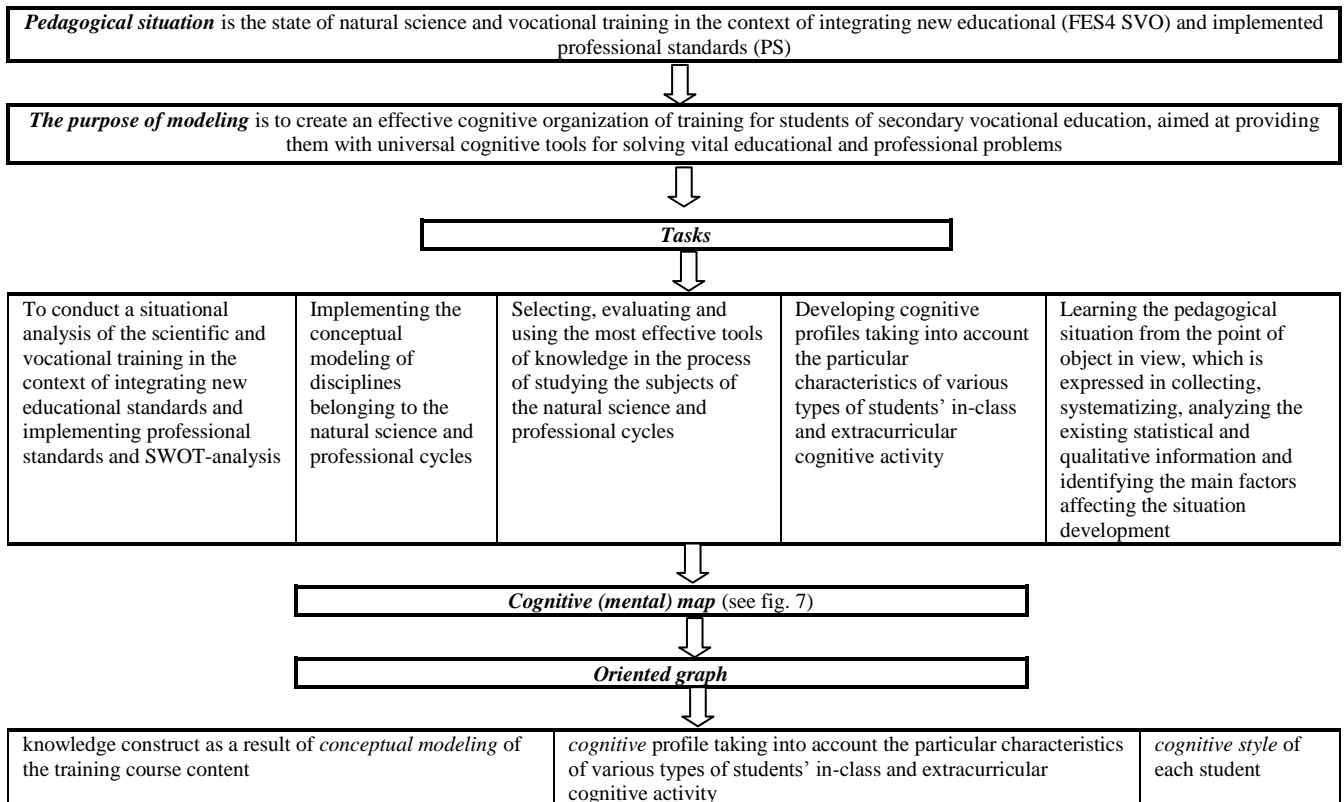


Figure 2. Cause-and-effect model of designing the natural science component of cognitive modeling in the vocational education

Studying the situation (the state of natural science and vocational training in terms of introducing and integrating new educational (FES4 (Federal Educational Standard) SVE and professional standards) took place from the position of the goal. It consisted of collecting, systematizing, analyzing existing statistical and quality information. SWOT-analysis was used to find out the strengths and weaknesses of the pedagogical state. N.V. Sofronova, R.I. Gorokhova propose to use this method for the objective determination of the problem field of the object under study. They believe that it allows laying the foundation “to determine the goals (directions) of development ..., preparation of alternative solutions to reduce the risk in the selected problem areas of forecasting possible events” [7].

SWOT-analysis involves the selection of the main factors affecting the situation development. If this impact is positive in nature (increasing, reinforcing), the connection is attributed to the “+” sign, if the impact is negative (reducing, weakening), the connection is attributed to the sign “-” [8]. So to determine the factors affecting the development state of natural science and vocational training in SVE, a didactic tool (questionnaire) was used. The latter gives the information on the state of designing curricula and their educational and methodological support, implementing interdisciplinary connections, etc. This made it possible to graphically form a cognitive map of the pedagogical situation, designed to adequately and holistically reflect the essence, the most important qualities and components of the pedagogical system (in particular, the condition of the natural science and vocational training of secondary vocational education students) at a given point in time, which allowed to obtain information on its state and capabilities.

SWOT-analysis of the studied situation was carried out by us according to certain positions (factors) (by colleges of the Republic of Tatarstan (RT), the number of respondents was 88 people):

Block № 1. Data on the respondents’ teaching staff that design and improve curricula.

Block № 2. Designing curricula.

Block № 3. Implementing interdisciplinary connections.

Block № 4. Accounting for the graduates’ future professional activity.

Block № 5. Educational and methodological support of designing curricula.

Block № 6. Difficulties experienced in curriculum design.

Data on the respondents’ teaching staff that design and improve curricula – block №1 (see Fig.3)

Data analysis of the respondents’ teaching staff engaged in designing and developing curricula shows that a significant percentage of teachers surveyed are teachers of general educational and general vocational disciplines (43% and 39%, respectively), more than 80% of whom have a full academic workload. However, there is a threat of staff shortage – the proportion of teachers aged 50 and 60 is more than 66% compared with the 2013 survey data when this portion was

59.3%. At the same time, an increase in the share of young teachers aged 20 to 30 was recorded from 4% (according to 2013 survey data) to 33% and proportion of teachers aged 30 to 40 is from 22% (according to 2013 survey data) to 41%. This testifies to the reserve of the staff potential of the vocational education organizations of the RT.

Block № 2 Designing curricula

According to the results of analyzing the second position, it can be stated (see Fig. 4) that in the context of integrating new educational and implemented professional standards, the majority of teachers prefer the joint form of the curriculum design ($\approx 60\%$).

Data analysis shows that when designing the curriculum using modules allocated on a procedural-organizational basis, the following average distribution is observed: for practical classes – 41.46%; for studying new material – 39.02%; for individual work – 27.83%; for lectures – 21.85%; for assessments – 12.2%. At the same time, the majority of respondents use modules formed according to the sections of the training course (58.54%) and core competencies (48.78%).

The respondents’ opinion about the meaning of the taught discipline for students to perform the graduation qualification work (GQW) (or to pass the state examination) was distributed as follows: applied – 46.32%; fundamental – 39.02%; technological – 9.46%. At the same time, 2/3 of the respondents consider the content volume of the discipline taught by them to be sufficient both for mastering general cultural competencies (GC), professional competencies (PC) and professional qualification (PQ) (65.85%), and for the overall development of the modern student’s personality as a whole (43.9%).

Block № 3 Implementing interdisciplinary connections (Fig. 5)

The curriculum design of disciplines using a modular competence-based approach, as shown by the survey, is focused on taking into account interdisciplinary connections. They are most actively implemented in selecting methods and forms of education (91.12%), which corresponds to the unity of requirements for organizing certain methods and forms of training in colleges, especially of technical specialization. They are used quite fully in forming GC, PC and PQ (80.49%), which meets the requirements of educational and professional standards. The specific character of each discipline affects the decrease in the use of interdisciplinary connections in designing training courses (68.29%).

Block № 4. Accounting for the graduates’ future professional activity (Fig. 6)

In the context of introducing professional standards, studying respondents’ opinions of the quality of students’ preparedness in the taught discipline (within the specialty) reveals that about half of the number of teachers rate it at a sufficient level, both for future professional activities (51.2%) and for further education (48.7%). At the same time, teachers state that it is possible to improve the quality of the disciplines taught by them (taking into account the employers’ requirements) if the practical focus of the subject is

strengthened (63.41%) and the number of hours for professional practice is increased (31.71%).

Block № 5. Educational and methodological support of designing the curricula (Fig. 7)

Modern educational and methodological support of designing curricula cannot be imagined without the use of information and communication technologies. A survey reveals the following distribution of using various types of technical equipment: computer – 97.56%, multimedia projector – 78.05%; audio-visual equipment – 31.70%; interactive whiteboard – 29.27%, etc. These figures are correlated with the data on using electronic manuals as a method of assessment (80.79%). However, ≈5% of the respondents do not use this technique as they don't have it.

Analysis of the data also allows establishing the shortage in certain educational and methodical literature, namely:

- on the taught discipline – 78.00%;
- on the rational use of information and computer technologies in their discipline – 63.40%;
- on competence-based assessment of learning outcomes – 48.70%;
- in pedagogical literature – 31.70%.

The marked shortage is covered by teaching aids, which are of:

- substantial nature – 58.54%;
- evaluating nature – 58.54%;
- applied nature – 48.78%.

These figures indicate that the library stock is not able to be updated during the period of repeated reforming of standards, which leads not only to the required changes in the content of the courses taught, but also in the system of evaluating the students' learning outcomes.

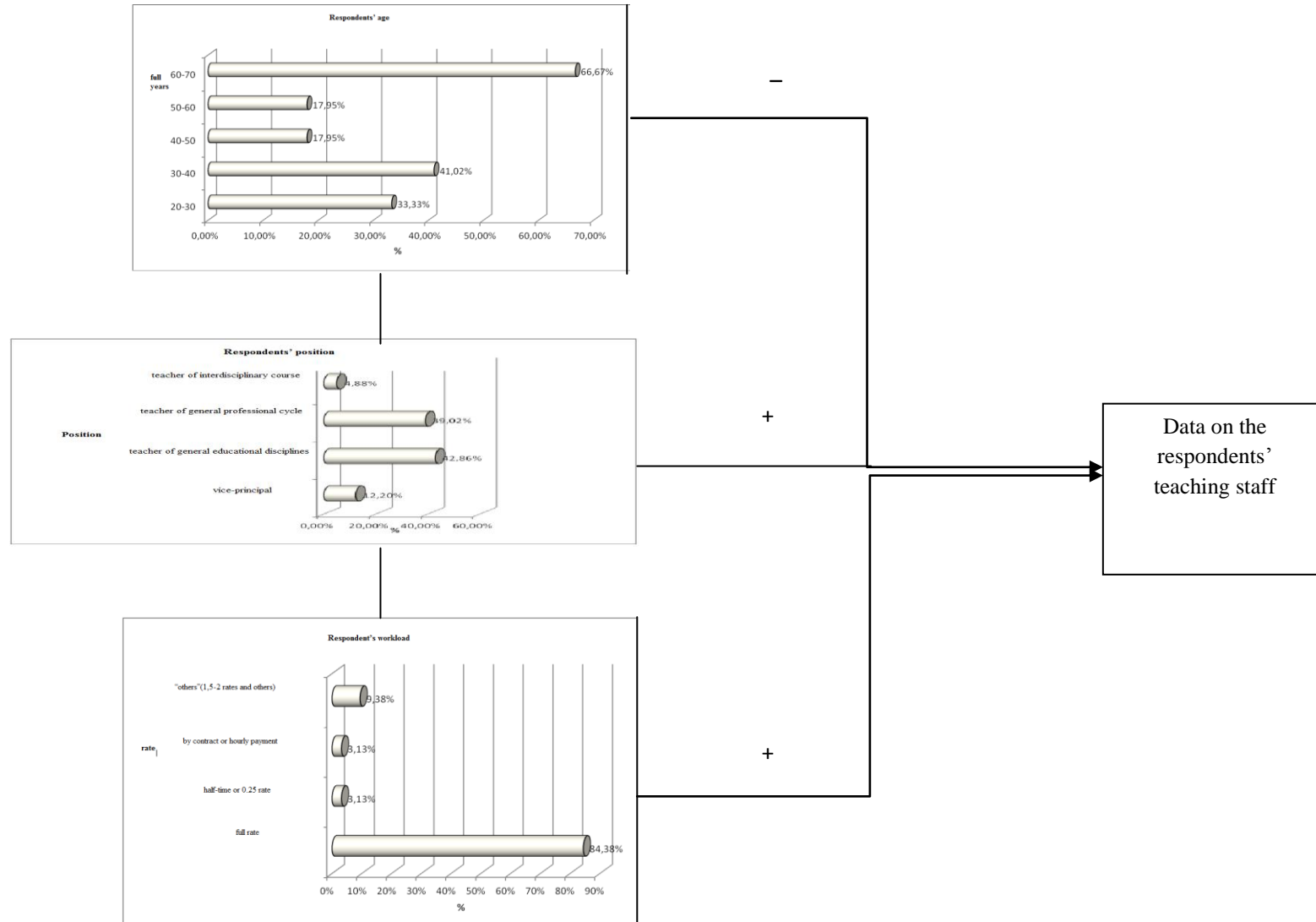


Figure 3. Fragment of the cognitive map of the natural science and professional components of the cognitive model (position № 1. Data on the respondents' teaching staff involved in designing and improving curricula)

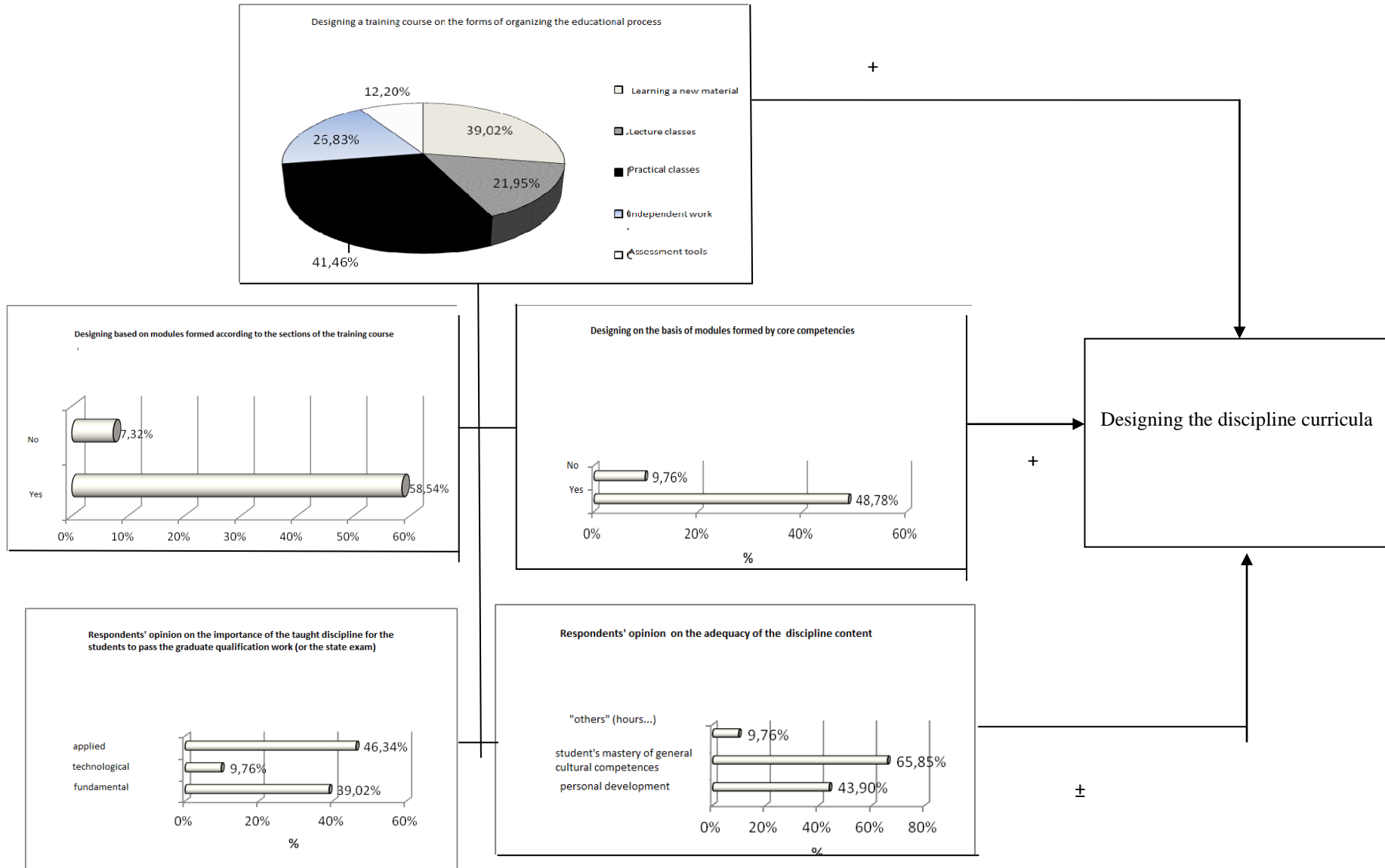


Figure 4. Fragment of the cognitive map of the natural science and professional components of the cognitive model (position №2. Designing the discipline curricula)

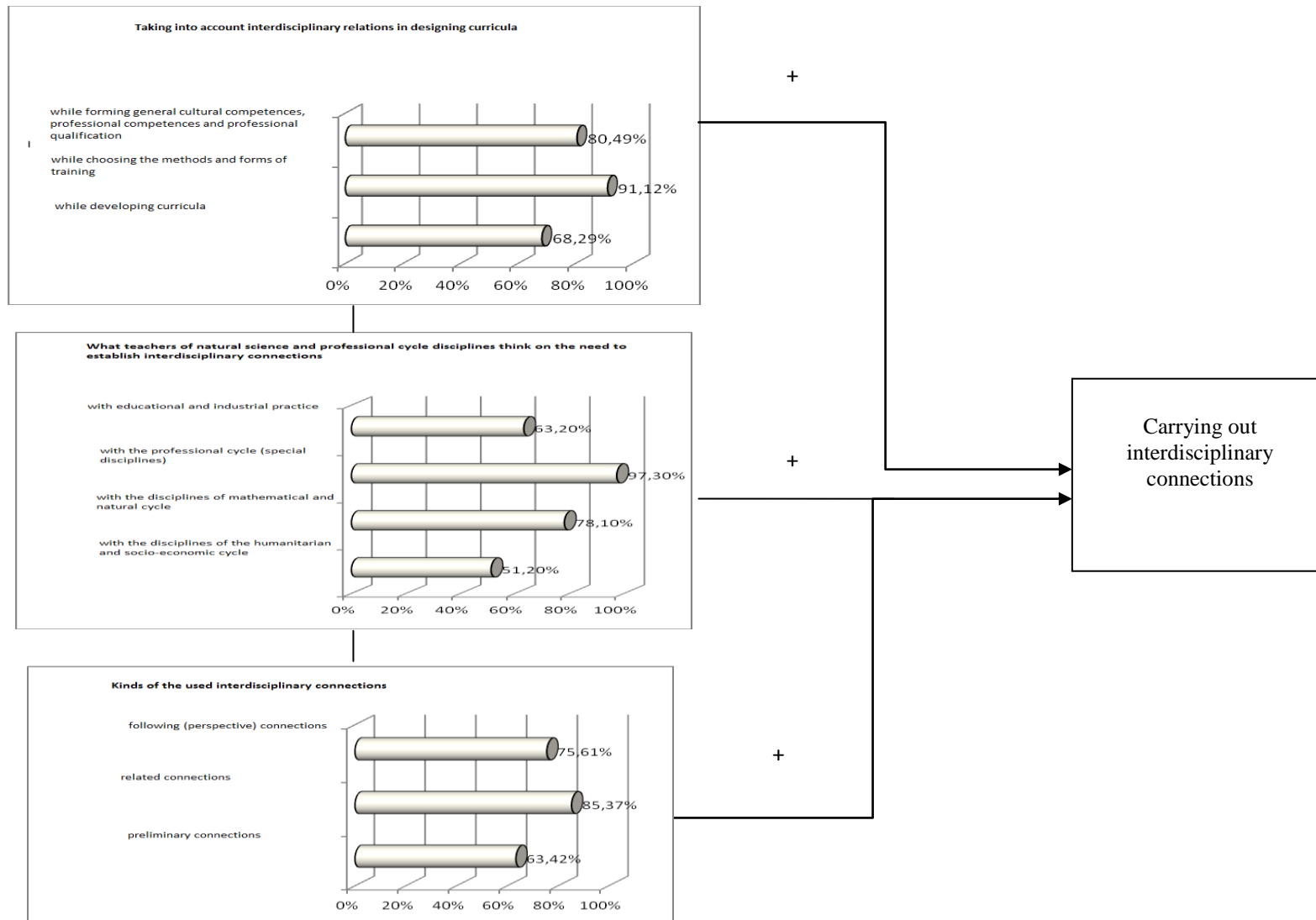


Figure 5. Fragment of the cognitive map of the natural science and professional components of the cognitive model (position № 3. Carrying out interdisciplinary connections)

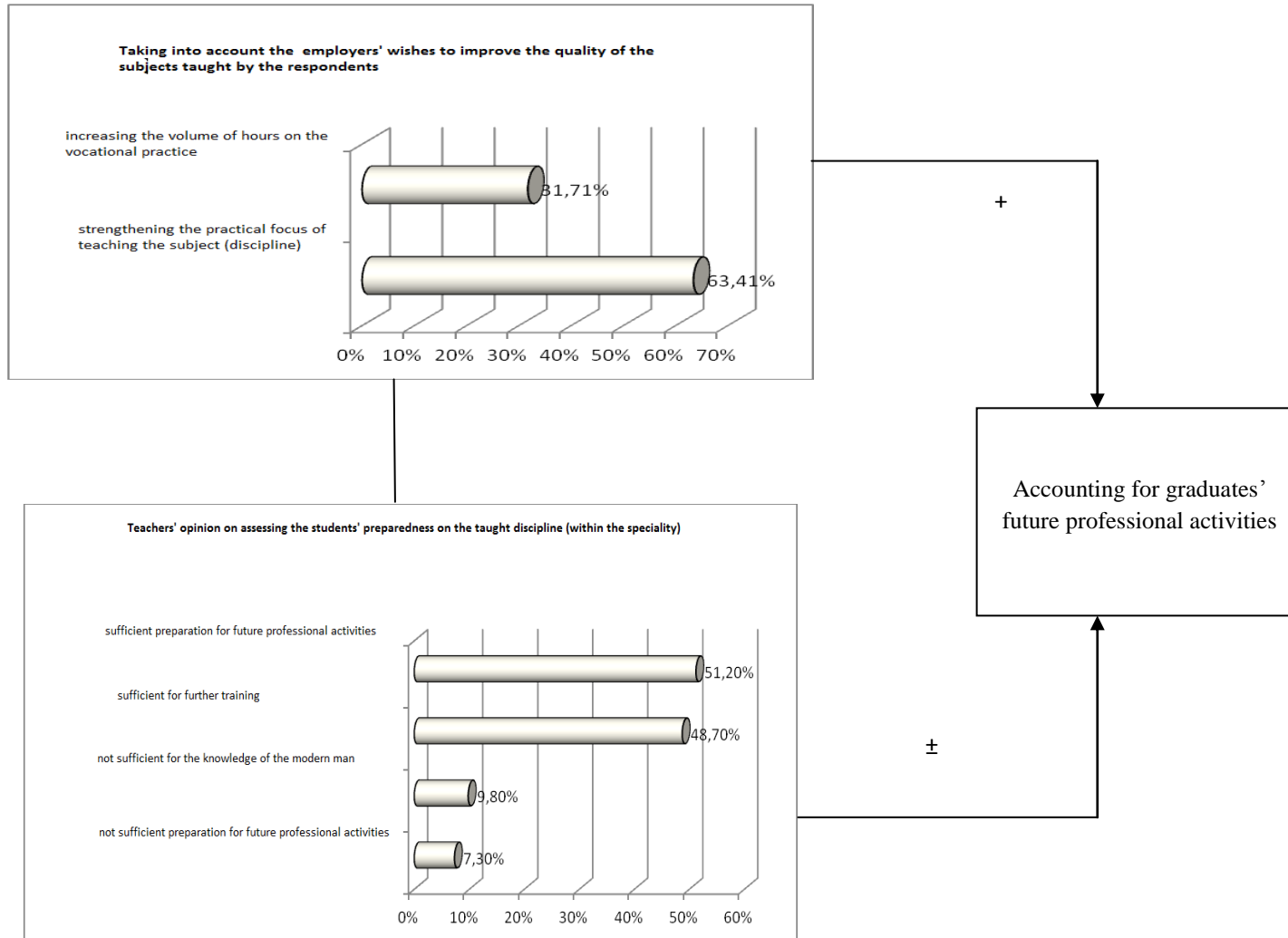


Figure 6. Fragment of the cognitive map of the natural science and professional components of the cognitive model (position № 4. Accounting for graduates' future professional activities)

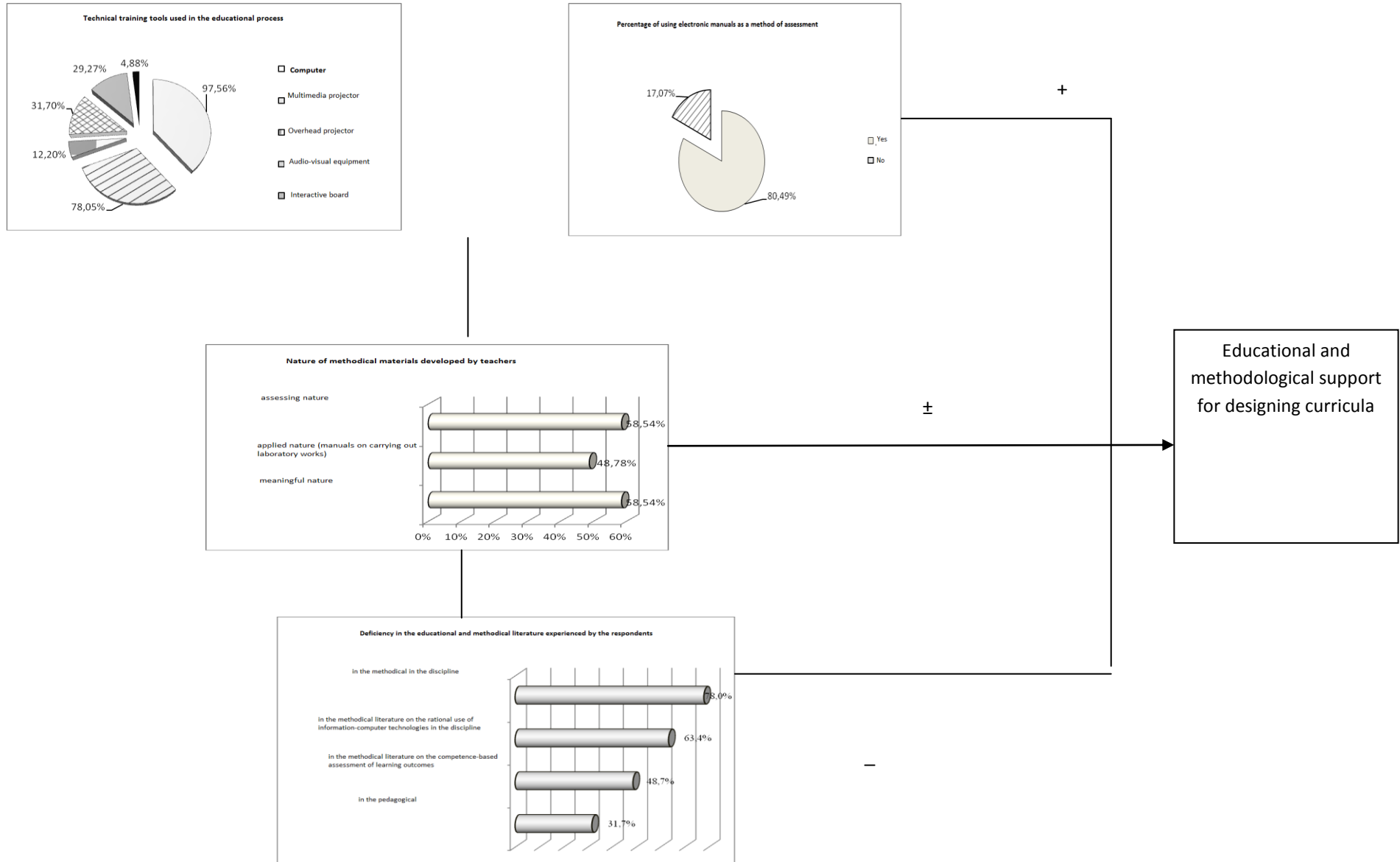


Figure 7. Fragment of the cognitive map of the natural science and professional components of the cognitive model (position № 5. Educational and methodological support for designing curricula)

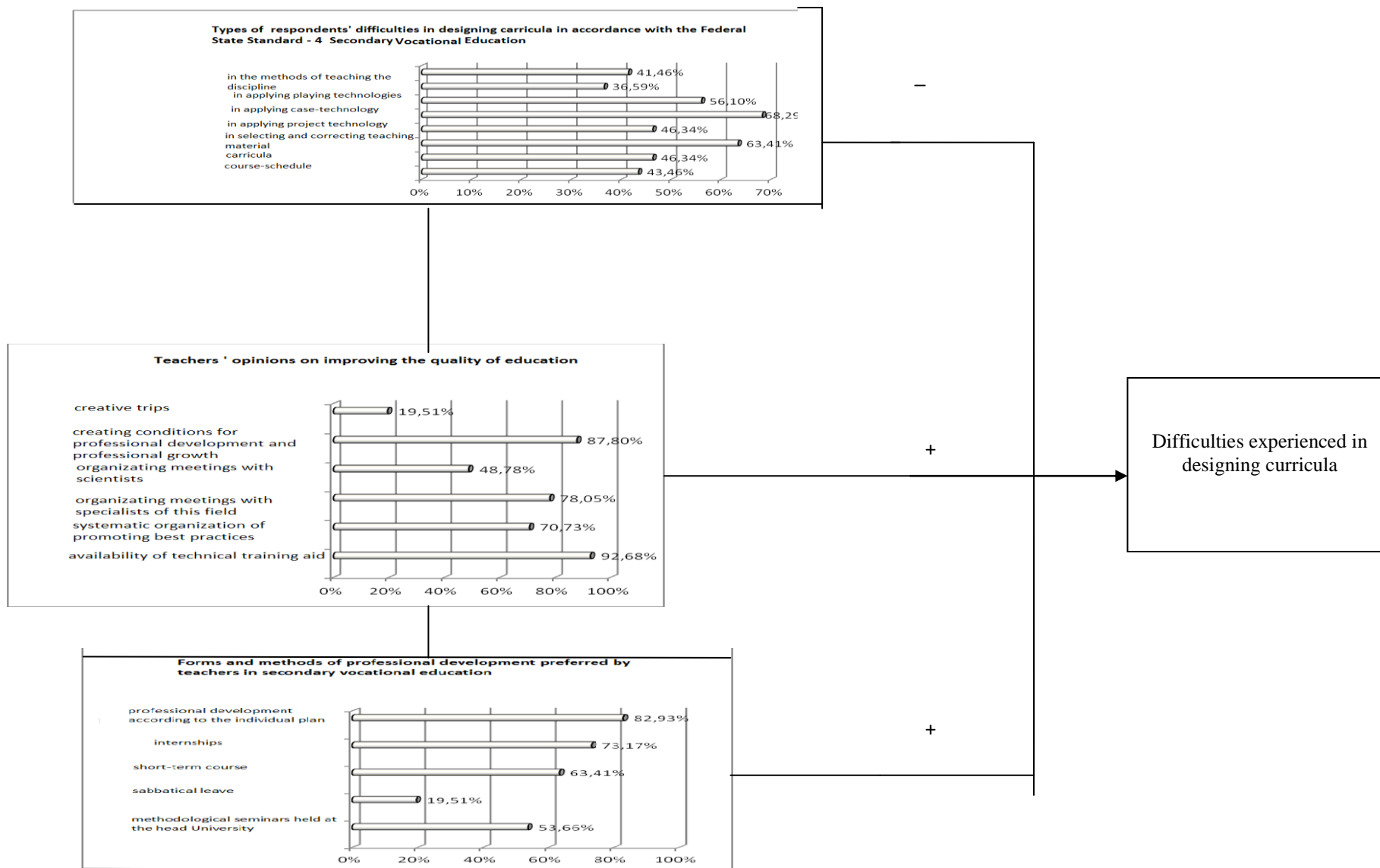


Figure 8. Fragment of the cognitive map of the natural science and professional components of the cognitive model (position № 6. Difficulties experienced in designing curricula)

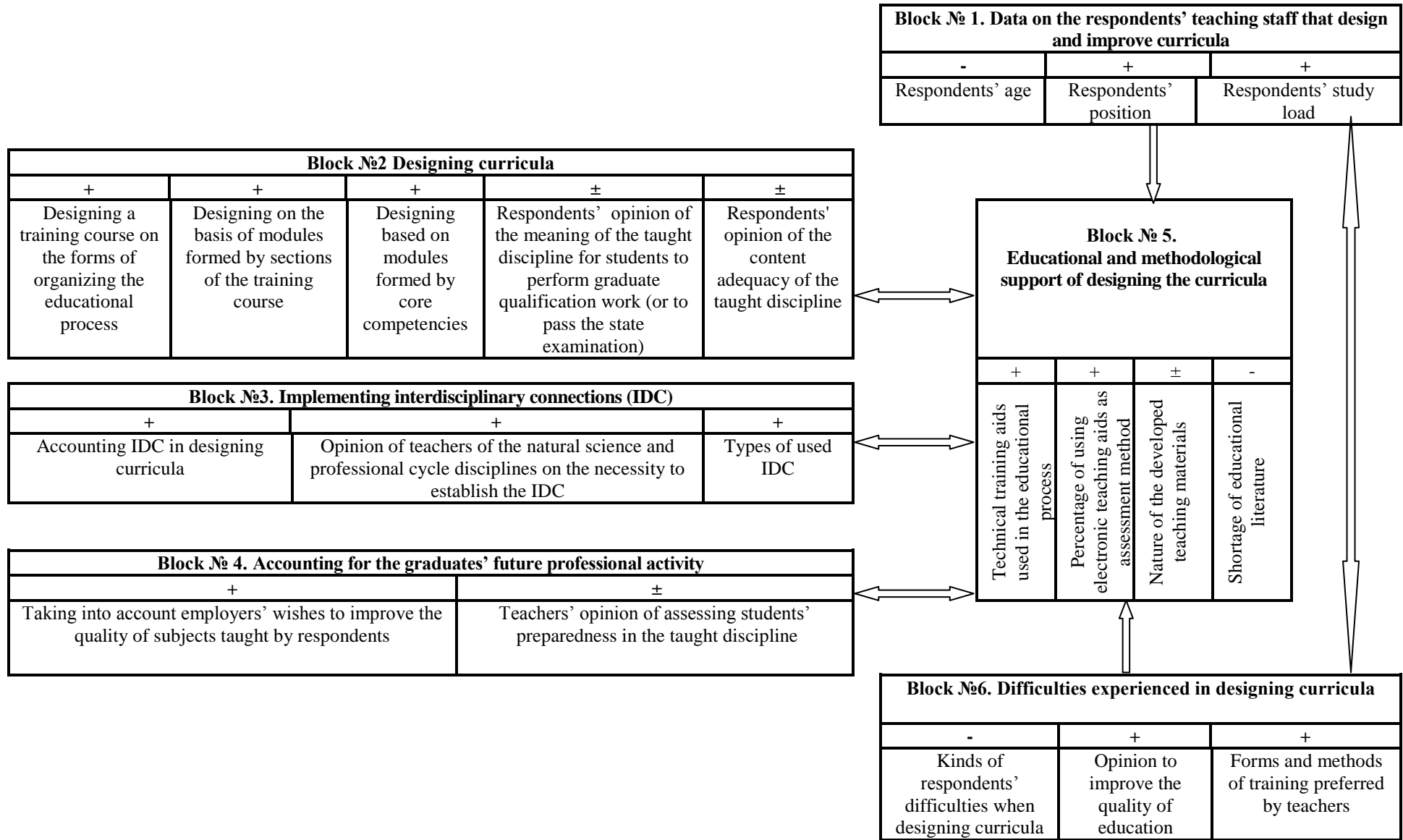


Figure 9. Cognitive map of the state of the natural science and vocational training in the context of integrating new educational (FES4 SVE) and implemented professional standards (PS)

New educational and introduced professional standards dictate other requirements for using modern educational technologies, teaching forms and methods, which causes certain difficulties for teachers. It has been established that among the interviewed respondents the greatest difficulty in designing training courses is the selection and correction of educational material – 63.41%. Difficulties in choosing new approaches in presenting educational material are associated with the use of case technology – 68.29%.

Thus, the SWOT-analysis of the situation under study which is the state of science natural and vocational training in the context of integrating new educational (FES4 SVO) and implemented professional standards (PS) can be represented as a scheme – a cognitive map (see Fig. 9), which made it possible to identify its strengths and weaknesses, drawbacks, possible threats.

As a result, the main factors (blocks) that influence the development of the situation were distinguished and the interrelations between them were identified (see Fig. 9): data on the respondents’ teaching staff that design and improve curricula (block № 1); designing curricula (block №2); implementing interdisciplinary connections (IDC) (block №3); accounting for the graduates’ future professional activity (block №4); educational and methodological support of designing the curricula (block №5); difficulties experienced in designing curricula (block №6). Each block contains from 2 to 5 indicators reflecting its particular characteristics element by element. The characteristics of positive and negative effects of each block indicator are reflected in summary table 1.

TABLE 1. CHARACTERISTICS OF THE POSITIVE AND NEGATIVE EFFECTS OF THE UNIT INDICATORS FOR ANALYZING THE STATE OF NATURAL SCIENCE AND PROFESSIONAL TRAINING

Block № (number of indicators)	Characteristics of indicator impact		
	+	±	-
Block №1 (3)	2	-	1
Block №2 (5)	3	2	-
Block №3 (3)	3	-	-
Block №4 (2)	1	1	-
Block №5 (4)	2	1	1
Block №6 (3)	2	-	1
Total:	13	4	3

It can be stated that the SWOT-analysis of the state of the natural science and vocational training in the context of integrating new educational (FES4 SVO) and implemented professional standards (PS) allows us to conclude that against the background of the generally positive pedagogical situation at the time studied, a number of shortcomings were identified:

- the proportion of teachers with an average age of 50 and 60 is more than 66%;
- shortage of the educational and methodical literature;
- difficulties in designing curricula in accordance with the FES4 SVO, namely in selecting and correcting educational material; in applying project technology, case-technology, playing technologies; in organizing independent work with students.

So, we can state that:

1. In the last decade, the development of pedagogy and psychology has led to the emergence of a new direction – cognitive pedagogy, special attention is paid to cognitive structures, tools of knowledge and ways of their development;

2. One of the directions of developing the methodology of cognitive modeling is a phased analysis and modeling pedagogical situations. At the first stage, goals and tasks are formulated; in the second stage, the existing pedagogical situation is collected, systematized and analyzed, highlighting the main factors peculiar to the situation, i.e. developing a cognitive map; at the third stage, a directed graph is created; at the fourth stage, the cognitive map and the oriented graph are merged into a single cognitive model of the pedagogical situation under study; at the fifth stage the adequacy of the cognitive model to the real pedagogical situation is checked and, finally, at the sixth stage possible options for developing pedagogical situation are determined with the help of the cognitive model, ways and mechanisms to influence the situation are found;

3. Using the SWOT-analysis of the strengths and weaknesses of developing the pedagogical state in the process of creating a cognitive model map allows describing both quantitative and qualitative characteristics of the factors identified in the process of developing a cognitive map and identifying strengths and weaknesses, drawbacks and possible threats of the pedagogical situation under study.

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