

INTEGRATION OF RESEARCH PROBLEMS SOLUTION THEORY WITH THE UTILIZATION OF COMPUTER ORIENTED STUDY ENVIRONMENT

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***Abstract:** This study analyzes the main scientific methods of research problem solving, as the most important in the search of innovative research ideas with the utilization of separate components of computer oriented system in the process of teaching the natural and mathematical sciences. The structural components of solution theory of research problems are demonstrated, the examples of realization of educational material concentrated presentation are provided. All the stages of research problems solution algorithm are analyzed. The modeling of project - research work is demonstrated. The structure of project - research activity and search -algorithm of research ideas are described. The stages of research of situational problems during the process of solution of research problems are considered in the study.*

Keywords: solution theory of research problems; project-research activity; modeling; computer oriented learning system; systems of computer mathematics.

INTRODUCTION

Formulation of the problem.

Taking into account the professions that will be in demand in the future, it is appropriate to improve the training of the future professionals. In the process of education of pupils at school it is relevant to use new ways of learning, appropriate pedagogical technologies, the utilization of which will promote the pupils' personality development, their creative skills, and the ability to act independently in the modern information space. It is important to form the universal skills of

modeling and solving applied problems in the pedagogically balanced way in order to avoid numerous problematic situations in the professional activity.

It is advisable to realize the creative work process, basing on the theory of salvation of research problems. The purpose of introducing the theory of salvation of research problems in the educational process is the formation of creative mathematical thinking and educational upbringing of the pupil's personality, his / her readiness to complete the complicated life challenges.

While teaching the subjects of nature - mathematical cycle with utilization of solution theory of research problems, the pupils' worldview expands and the ability to analyze the relevant patterns improves. Also, this way of teaching develops appropriate style of thinking that helps to learn the course material, not only during the lessons, where separate aspects of solution theory of research problems are used, but also during pupils' independent work.

Analysis of recent research and publications.

G. Altshuller, V. Arnold, D. Bogoyavlenska, O. Klepikov, M. Meerovych, Ya. Ponomaryov and others examined the problems of research on pupils' creative thinking development. S. Rubinshtein, O. Leontiev, A. Ershov, V. Monahov, M. Moiseev and others investigated thoroughly the psychological and pedagogical aspects of creative personality formation. E. Kabanova – Meller, N. Menchynska, V. Reshetnykova, N. Talyzina, A. Usova carried out research into the problems of mental techniques formation, including logical activities. The research of S. Arkhangel'skiy, G. Ball, E. Zlotnykov, M. Klarin, V. Moliako, V. Uspenskiy and others is devoted to the study of the utilization of typology of tasks, as a method of goals achievement in educational process and in the formation of research skills.

The question of the methodological support concerning synergic interaction and establishment of cause and effect relationships between the separate components of computer oriented educational system and salvation theory of research problems in the educational and upbringing process is not reflected well enough.

The process of new systems and technologies creation is based on the search of innovative ideas. The creation of research ideas as a result of research and development of perspective directions becomes important nowadays. Obviously, the solution of these tasks becomes necessary in the project activity.

The process of finding ideas is the most difficult stage of the innovation process. In the educational and upbringing process, not enough attention is paid to the systematic and targeted research and development, as well as the creation of new research ideas with the utilization of research problem solution theory methods. The key problem for the organization of such education is the creation of methodological system of studying nature and mathematical disciplines with pedagogically balanced usage of separate components of computer - oriented system and the main aspects of the research problems solution.

The aim of the article. The aim of this research is the analysis and pedagogically balanced choice of educational methods of research problems solution which are considered to be the most important in the process of searching for innovational research ideas with the utilization of separate components of computer - oriented system in the process of teaching the nature and mathematical disciplines.

RESEARCH METHODS

During this research the following theoretical methods were used: analysis, comparison, generalization of materials of scientific, scientific - methodological and psychological -pedagogical literature; analysis of programming and methodological documents in the sphere of education, justification of theoretical foundations of project - research activity and main approaches of its formation in relation to utilization of separate components of computer oriented system of education.

RESEARCH RESULTS

Salvation of situational tasks in the project and research work encourages the formation of creative thinking and education of creative personality of the pupil, ready to solve complicated life challenges in different spheres. Among the main components of the research problems solution theory it is necessary to distinguish between the operators of removing the stereotypes, techniques for resolving conflicts, algorithms of research problems solution and others (Figure 1) (Altshuller 1973).

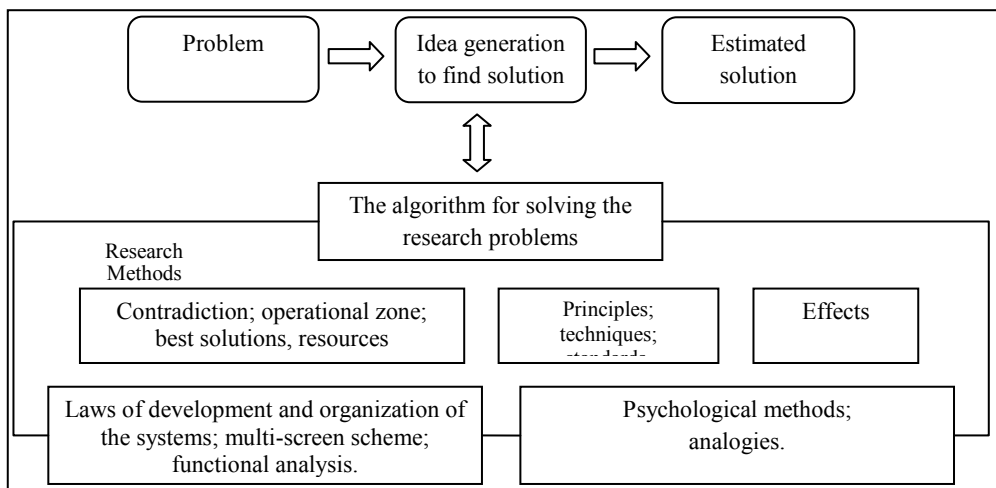


Figure. 1. Structural components of the research problem solving theory

In the process of solution of research problems, the main moments of solution of complicated non - standard problems with pedagogically balanced usage of

separate components of computer oriented educational system are described (Hrybiuk 2015). One of the examples of the realization of the idea of the concentrated presentation of educational material is schematically described in Figure 2.

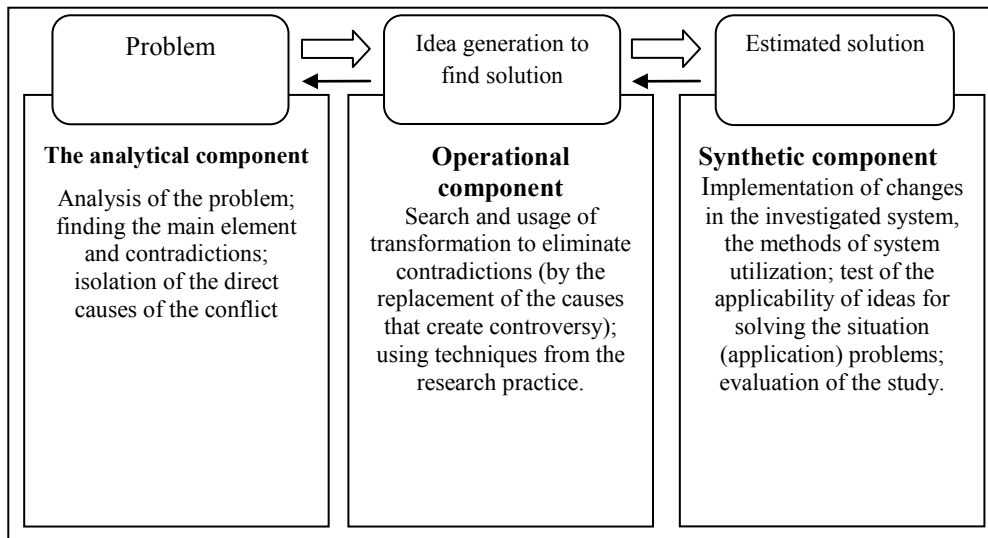


Figure 2. Component approach in the context of solving the research problems

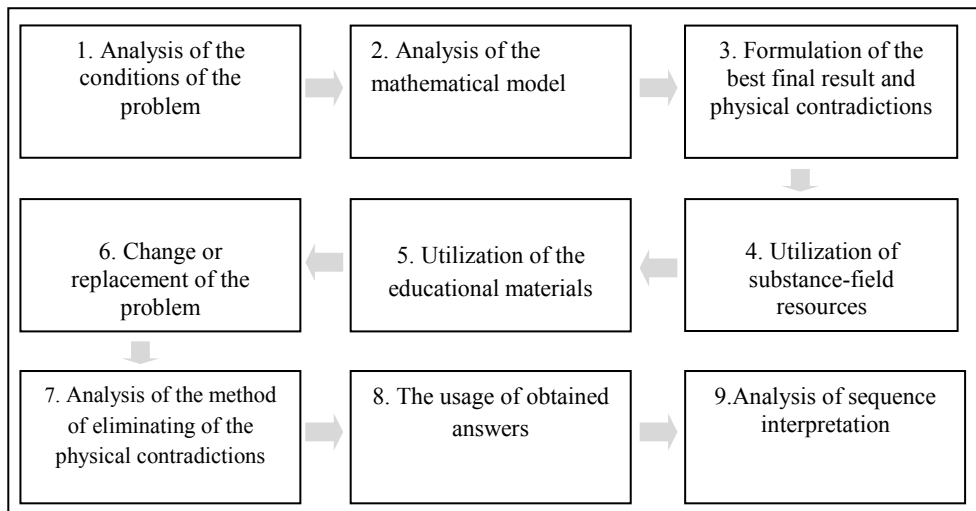


Figure 3. The algorithm for solving the research problems

Education of creative personality of the pupil can be possible only in the condition of the goal-oriented, motivated activity of the pupils in the process of salvation of research problems with the utilization of oriented rules and relevant algorithms (Gin 2015): analysis of the problem, model analysis of the problem, formulation of perfect end result and physical controversy, monitoring and utilization of material

and field resources, utilization of educative and reference materials, modification or replacement of the problem conditions, analysis of removal methods of physical controversies, utilization of obtained results, sequence analysis of proposed problem (Figure 3).

The processes of extraction and reinvention play an important role in the research, as it is necessary to train the creativeness of the child through the project and research activity and proficiency of the pupil in order to repeat standard and non - standard processes (Orlov 2006). Accordingly, the utilization of reinventing modeling (reconstruction, renovation, reproduction) of the research process with the utilization of the main components of the research problem solution theory is presented in Figure 4.

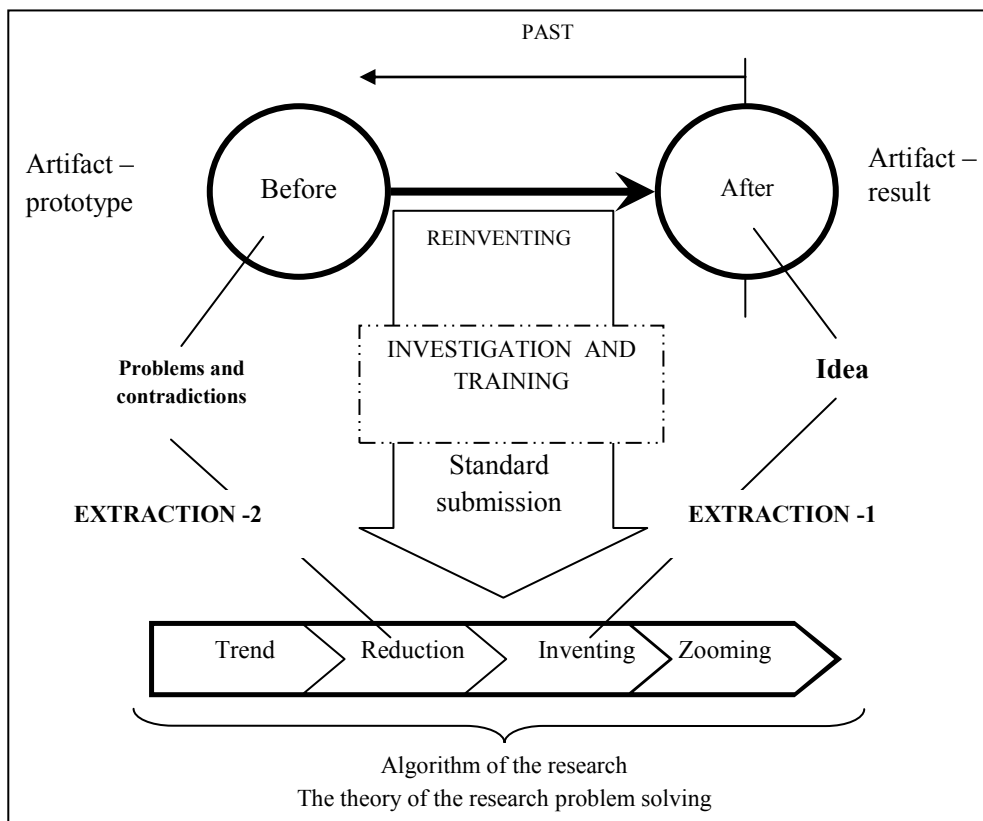


Figure 4. Simulation of the project-research work

Correlation between the process of inventing and reinventing in the process of utilization of research problem salvation theory is presented on the figure 5.

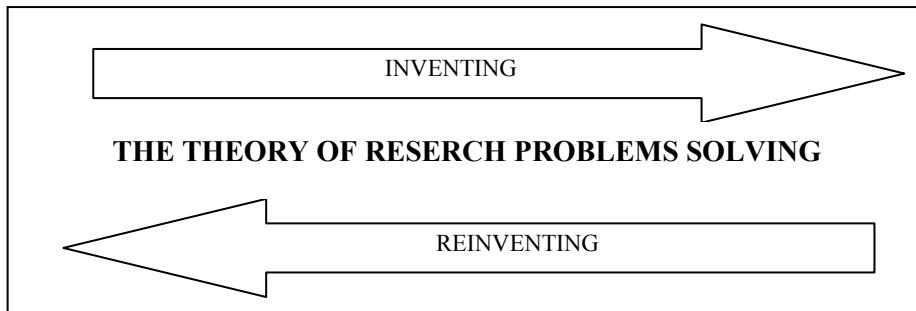


Figure 5. Inventing and reinventing in the process of research problems solving

Initially, the essence of scientific experiments is about the following factors (Hrybiuk 2013):

- 1) identification of the main problem that requires solution in the proposed research;
- 2) identification of research method with the help of which it is planned to solve a research problem.

The main methodological means are the following (Hrybiuk 2015):

- 1) generalization and classification of models of the main problems and methods of problems salvation in the process of research;
- 2) establishment of laws in the context of problem appearance, monitoring, forecasting and systematicity concerning the problems solution.

Utilization of operational reinventing from the position of acceptance and consolidation of research skills and solution of the problems, as well as relevant demonstration of the research process of the well-known principles and methods of research problem solution by the pupil, encourages the formation of the important skills during the work of the pupils with prototypes, using the appropriate software for the effective solution of the existing problem situations.

Such a methodological approach stimulates associative thinking of the pupils and active perception of educational material. With the utilization of intuition, the pupils independently find interdisciplinary relationships, at the same time obtaining the experience in the project - research activity.

The process of solution of research problems consists of (Figure 6) (Grybyuk 2014):

- a) functionally perfect model – the foreseen functioning of the system during the perfect solution of the research problem;
- b) contradiction model – model of systematic conflict that reflects inconsistency of the requirements to the system;

- c) transformational model – model of changes in the system that are necessary to eliminate contradictions and achievement of precise functionality of a perfect model.
- d) resource model – a multidimensional model of system characteristics that demonstrates its aim, functions, composition and structural correlation between elements, relationships, educational and reference materials, form and spatial location, temporal parameters of functioning, efficiency and other efficiency performance indicators.

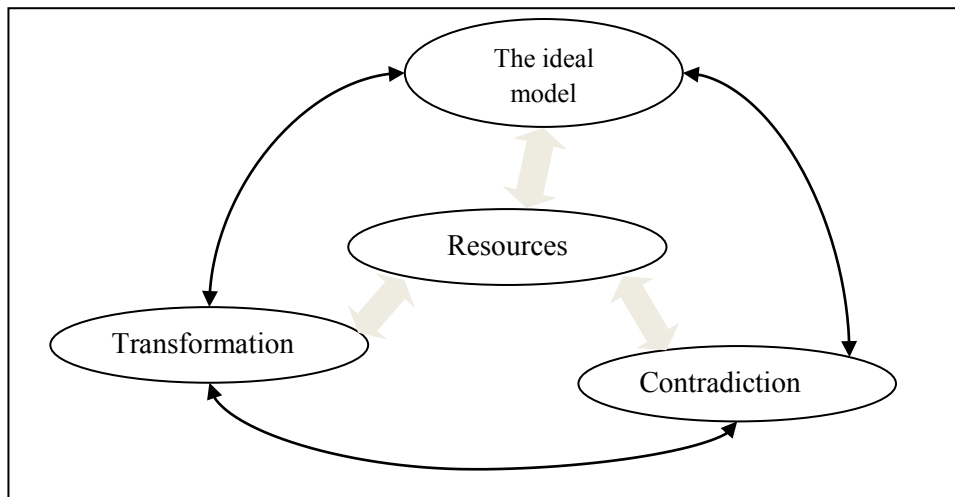


Figure 6. The main components of the research problems salvation theory

The aspects that are proposed above are fundamental, they accumulate the necessary scope of educational material that represents the most important part of creativity in solution theory of research problems, enforcing cognitive and instrumental components.

Undoubtedly, the researched systems (not only technical) are created for realization of a certain function and develop according to certain laws that can be used to control other systems.

During the life cycle of the system, its efficiency increases in the correlation between efficiency of the positive factors concerning the realization of the main functions of the system to the evaluation of the negative factors, that are related to expenses on the creation, exploitation and utilization of the relevant system.

Systems and their respective components are developing unevenly, it is the main reason of a slow increase of new systems efficiency, that causes appearance of technical problems (Hrybiuk 2014).

The contradiction between incompatible properties and requirements, necessary for the realization of functions of relevant components and the system as a whole is put in the basement of a certain life problem. The appearance of conflict contradiction

with the utilization of technical means is accompanied by the creation of the research. The amount of types of conflict contradictions is limited and opens possibility of their clear recognition in real life situations, in order to use appropriate methods of technical problems solution. The relevant methods of contradictions solution are chosen during the project - research of the certain model. Among the research methods in our research, it is necessary to distinguish: the focal object method, brainstorming, synectics, and a method of morphological analysis (Orlov 2006).

Methods of problems solution are used together with other methods of complicated systems development control (economical, systematic and technical, cultural and educational, and even political), appropriate methods of development and stimulation of memory, attention, associative thinking, creativity, intellectual capacities and psychological development of the human as a whole.

The sense of focal object method is about positioning of attention on a certain perfect object; after that this object is compared with other randomly chosen objects. The combination of characteristics of two objects – focal and random, causes the appearance of creative ideas for the specification of the focal object. The main peculiarities of this approach are presented below (Figure 7).

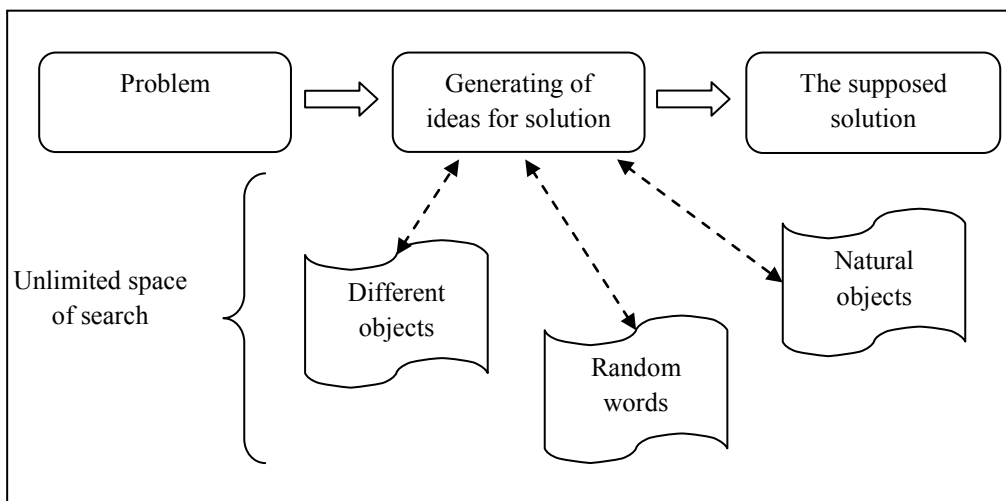


Figure 7. The method of focal objects

The proposed method is successfully used in the research (Hrybiuk 2015) for the development of associative thinking and skills of comparative analysis. As a result, a new point of view about the solution of the problem appears, it simulates the creative thinking. However, the negative aspect is the significant influence of random factors, absence of limits concerning the process of search, lack of resources for the realization of educational process.

The goal of brainstorming is about previous significant analysis of the situation through the list of control questions, and the presence of two phases during the research - idea generation, analysis and critics of the ideas by the pupils.

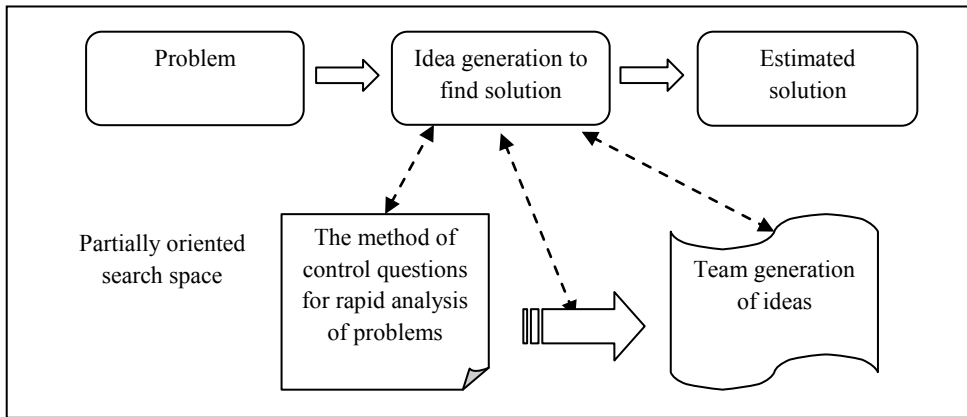


Figure 8. The method of brainstorming during the research

The proposed method is used for the quick (generational) thinking, it is aimed to overcome the negative stereotypes of pupil’s thinking. Obviously, this universal method does not require large expenditures of time on generation of research ideas, however, it does not offer a clear direction concerning the search of project ideas, it is complicated in particular individual situations and it does not offer the way to transfer the practical experience to pupils.

Synecotics is a method, oriented on the team realization of research ideas, it is also connected with the ideas of brainstorming (Figure 9).

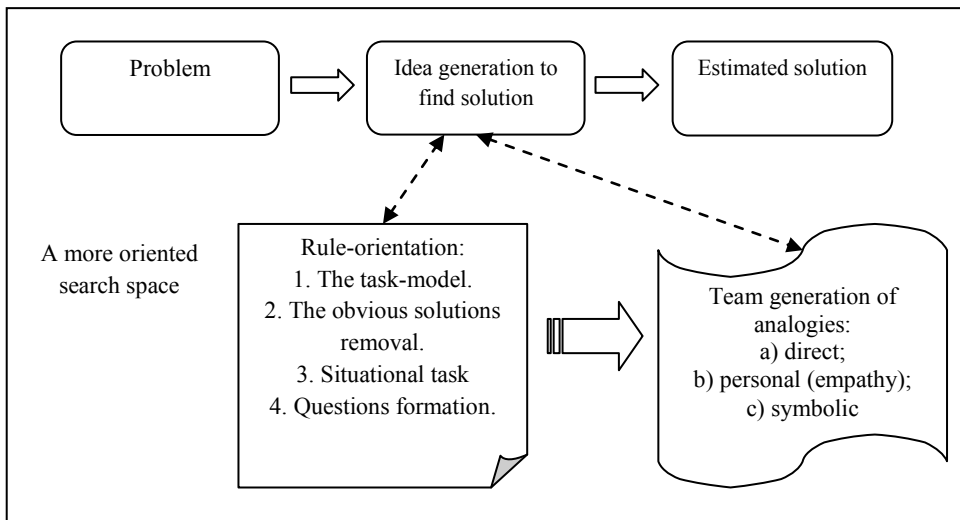


Figure9. Synectics in the project - design work

Synecytic method is quite universal, as it offers comprehensive utilisation of pupil’s personality resources and realisation of ideas in a team – the characteristics which are necessary for the development of pupil’s creative skills. The method of morphological analysis is used in the process of search of limits of systems solutions and for the realization of systematical analysis of perspective directions of problem solutions.

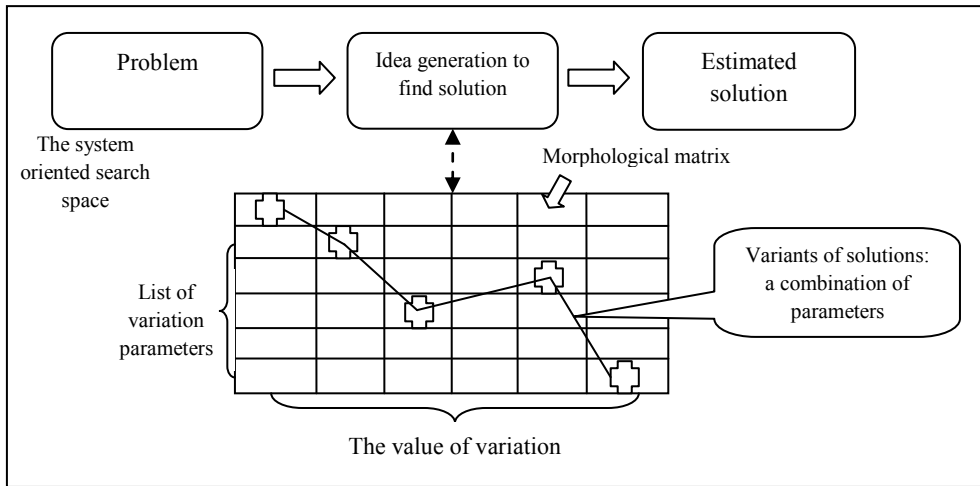


Figure 10. The method of morphological analysis in the research - design work

The proposed method is used effectively during the computer analysis of data in the process of search of alternative solutions and realization of logical analysis of educational materials, etc. The utilization becomes complex only if the matrix will increase in the dimensions. The process of project-research activity can be described in 5 problem levels that consist of 6 stages: selection of problem, choice of search conception, data collection and analysis, search of solution ideas, transformation of ideas in the construction, and perspectives of ideas further implementation (Table 1) (Altshuller 1973).

Table 1

The structure of the research - design work

Levels	A	B	C	D	E	F
5-th	Finding the new problem	Finding the new method	Getting the new data of the problem	The formulation of the new principle	Creation of new design principles	Change of the whole system, where a new design is introduced

4-th	Finding the new task	Finding the new search concept	Getting the new data of the task	Finding the new solution	Creation of new construction	Applying the new construction
3-rd	Changing the primary problem	Changing the search concept concerning the condition of the task	Changing the collected data concerning the condition of the task	Changing of the known solutions	Changing of the initial construction	Introduction of new construction
2-nd	The selection of one task from the several tasks	The selection of one search concept from the several search concepts	Collecting information from several sources	The selection of one solution from several solutions	The selection of one construction from the several constructions	Introduction of modifications of the finished construction
1-st	Utilization of the current task	Utilization of the search concept	Utilization of the current data	Utilization of the current solutions	Utilization of the current construction	Implementation of the current construction
Stages	Selection of the task	Selection of the search concept	Collection and analysis of the data	Search for salvation ideas	Transformation of idea into design	The prospect of the implementation

In the process of project-research activity, it is necessary to use different creative ideas in order to find the perfect final solution. The process of research ideas search consists of several stages that cover different variants (Figure 11). The strategy of algorithmic search is built, basing on the creation of procedural characteristics of the research in the form of algorithm that has certain sequence of operations, actions, data processing. Such strategy is based on the specification and utilization of research stages for the successful salvation of relevant tasks of the project. Also, it foresees the strengthening of the components of system analysis with a clear formulation of the study goal (Chyapyale 1990).

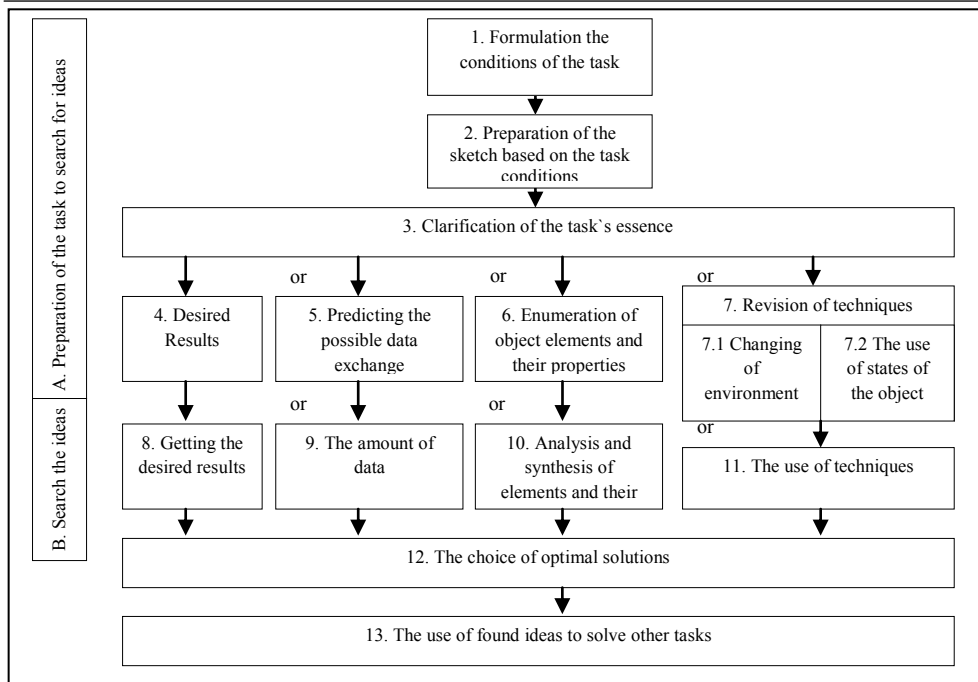


Figure11. Block - diagram: Search of the research ideas

The following research stages of situational tasks are considered in the research, during the solution of research problems (Table 2).

Table 2

Components	Levels of research				
	Rationalization	Modernization	Principle	Synthesis	Research
The initial condition	Condition with one parameter	Multi - parameters condition; direct structural analogues	Unstructured tasks; only functional analogues	Not many facts are known; No functionally structured analogues	Uncertainty is the main target factor; there are no analogues
Resources of the problem and researcher	Resource is obvious and easily accessible; Basic professional training	The resource is non-obvious, available in the system; Standard professional training	The resource often does not function with other systems and levels; Combination thinking is developed	The resource is from previously acquired knowledge; associative thinking, thorough erudition, ability to overcome stereotypes	Unknown resource and / or its usage; exclusive, selective motivation, lack of stereotypes

The complexity of the task	Tasks without controversy	Standard tasks	Non standard tasks	Experimental tasks	Research tasks
Rules of transformation	Engineering optimization solution	The engineering solution based on typical (standard) analogues	Research solution by using combined methods	Research solution by using integration scientific and technical elements	Scientific and technical discovery
The level of innovation	A small parametric replacement of elements	The functional structural solution without changing the principles of functioning	Research with the system effect of replacing the functioning principle	Prominent researches with systemic effect of significant changes in the surrounding systems	The largest study with systemic effect of radical changes in the surrounding systems

All theoretical and practical instruments of research problems solution are structured (Figure 12) taking into account the administrative, technical and physical components. All the below presented components are the instruments of the operational level, as they are used even if research project is realized on tactical and strategic levels. The proposals, presented below are used for the better understanding of its peculiarities (Altshuller 1973).

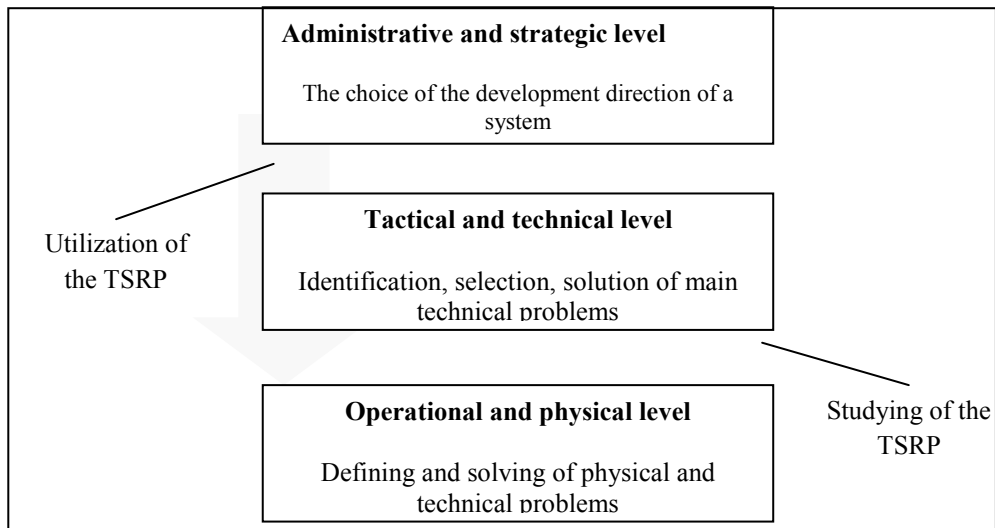


Figure 12. The process of analyzing and solving of research problems

Procedure, recommended in the research (Figure12), for selection and analysis of instruments during the salvation of situational problems has the following advantages:

1. Methods of operational level are mostly based on practice that is why their priority exploration allows starting faster the utilization of instruments of the research problems solution theory for the salvation of situational tasks.
2. The operational level knowledge of project and research work is the basement for understanding the ideas and methods of higher levels, as education of pupils is usually organized from simple and practical to more complicated and abstract.
3. The following education of tactical and strategic levels on the examples of the projects allows development of operational instruments skills.
4. On the operational level, the project can be studied in more details. It accelerates the formation of certainty in the constructiveness and effectiveness of research problems solution theory as a whole.

CONCLUSIONS AND PROSPECTS FOR FURTHER RESEARCH

Multidimensionality and feasibility of research problems solution theory is based on the formulation of problem structure, its reduction about thoughtful and simplistic forms as a binary controversies that are determined by the diagnostics of the problems and identification of their real essence; formulation of ideal goals, modeling of necessary functions, which correspond to the desired solutions of research problems that enables removal from stereotypical influence of usual solutions in the objects of environment; utilization of experience of effective research creation for finding solutions of situational tasks; utilization of development laws of the proposed systems for the strategic search of direction search of relevant ideas of salvation, using independent components of computer oriented educational system and methodology of the step by step analysis of practical problem and synthesis of solution idea with the utilization of the proposed guidelines and algorithms of project and research tasks solution.

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