TRAINING TECHNOLOGY IN CREATIVITY FOUND ON BASIC PRINCIPLES OF NATURAL OBJECTS

Boryana Todorova

University of Ruse, 8 Studentska Str., Ruse 7017, Bulgaria

Abstract

A system of basic principles of natural objects has been presented. The system is considered as a single, non-hierarchical, highly universal one, and those principles - as mutually complementary and justifying this universality. It outlines the links, dependences and mutual penetration between the separate principles. On this basis, groups of pedagogical approaches are derived that provide the trainees with the full knowledge of the way those principles function in the target object. At that, the study of the very principles can be made with trainees of greater age, but it can remain hidden, implicit in the very educational content and in the way it is structured and presented in the learning process. As a result of this type of training, a mastering of thought patterns and intellectual skills for creativity based on natural principles, is pursued.

Key words: *principles of natural objects, creativity, thought patterns, intellectual skills, training technology, pedagogical approaches*

1. INTRODUCTION

Training in creativity is one of the main tasks at all levels of contemporary education. A creative person is valuable for the economy, one is interesting to others and to one`s own self. He/she is useful for the community in different and unexpected ways. Creativity can be associated with originality and innovation, a high quality of achieved result, with efficiency and effectiveness of a found solution. In this sense, creativity correlates with the essential characteristics on the basis of which the perfection of natural objects, with their structure and functions, and the nature of natural phenomena and processes are appreciated. It is not a mere chance that contemporary technologies borrow ideas about structures and functions from nature.

2. FUNDAMENTAL IDEAS OF NATURAL HISTORY /FINH/

Ever since the days of high antiquity the founders of modern science have applied a holistic approach to explore the surrounding environment. They searched and formulated the basic ideas that express the most essential aspects of knowledge about the world. Over the past few centuries the brightest minds in science have developed and enriched that system we now call Fundamental ideas of natural history (Strigachev 1997). It includes:

• Idea of causality

M. Born gives the contemporary explanation of the idea of causality (Born 1977). According to him causation postulates the existence of laws that reflect the relationship between objects and their characteristics. Causality is not only a logical dependency. It means a real dependence of objects in nature one on another (Feynman, Leighton & Sands 2005).

The result follows the cause or occurs simultaneously with it. This indicates that causality is closely related both to the factor “space”, and “time” factor. From here the two attributes of the idea - contactability and determinism stem. The first of these means that the cause and the result must be within a certain spatial "contact". The second one means that events from different time points are connected by some laws in such a way that it is possible to predict unknown situations from the future (Prokhorov 1992).

• Idea of elementariness

The idea of elementariness is connected with the assumption that there are "primary" particles, unchanging and indivisible, that make up matter in all its forms. The question arises whether there is really such a "lowest" level in the structure of matter, a level of unchanging and indivisible particles, and how "deep" it is situated (Feynman, Leighton & Sands 2005).

The idea of elementariness is associated with the idea of awareness of the world (Hawking 1988, 1994). The number of levels in the structure of matter tending to infinity leads to the conclusion that the world cannot or never be fully known.

The idea of elementariness can be applied to other basic concepts such as time, space, energy, electric charge, and others which are interconnected through scientific laws and theories.

• Idea of symmetry

This is the concept by which man has been trying for centuries on end to understand order, beauty and perfection of nature.

The original meaning of the word "symmetry" is proportionality, similarity, likeness, order, rhythm, coordination of the parts in the whole. Symmetry and structure are deeply connected. If a system has a structure, it possesses some symmetry too.

In physics it is assumed (Wigner 1970) that an object is symmetrical if anything can be changed in it in such a way that after the change it looks just as before it. This symmetry reflects the symmetry in natural objects and phenomena. R. Feynman describes transformations in which the result of a given phenomenon remains. He called them symmetry operations. Symmetries arise mainly from the properties of space and time (Feynman 1967).

• Idea of conservation

The idea of conservation of some fundamental magnitudes serves as a guide in the development of knowledge in natural sciences. The very conservation laws are among the most fundamental in these scientific fields and their validity and universality are proved through numerous experiments. They bring deep philosophical charge and have a great methodological potential (Prokhorov 1992). The laws of conservation are based on some fundamental symmetries associated with space and time (Feynman 1967).

• Idea of observability

It requires that scientific explanations should comply with the experimental data. At a higher degree of quantitative explanation of phenomena, it is required that a kind of correlation should exist between what mathematical formalism and the experimental data – an experimental confirmation of the implications of the law or theory gives (Bondarev 2011; Mironov & Ivanov 2005). The idea of observability expresses the relationship between knowledge and reality. It is a powerful criterion for the truth of scientific knowledge.

• Idea of simplicity

This idea provides a direction for implementing the method of hypotheses on the development of theoretical knowledge. It has been known since the 14th century as "Occam's Razor". Its meaning is as follows: in the absence or insufficiency of experimental data for the explanation of a fact, then the simplest of all hypotheses that can give some explanation, is accepted. What is preferred is the hypothesis based on the lowest number of independent assumptions (Bondarev 2011; Ikonnikova 2008).

• Idea of relativity

Relativity is defined as a relation of an object to another one (Prokhorov 1992). The idea of relativity reflects the fact that the objects, phenomena and processes in nature are interconnected and mutually determined. The interaction between subject and object of knowledge is considered to be a particular case of the general relativity. On the whole, relativity suggests invariants and symmetry to maintain certain ratios.

• Idea of complementarity

Initially the idea of complementarity was thus formulated by N. Bohr (Strigachev 1997). It assumes that all different observations, aspects, views, etc. are needed as complementary elements to achieve an exhaustive description of the target object. In this sense, the idea of complementarity is becoming a style of thinking.

• Idea of hierarchy of natural systems

This idea assumes that every object of study in science is a complex one, i.e. it is a system. According to the idea of a hierarchy of systems, each element of a system can be viewed as a system of a lower rank to it and the considered system itself - as a part of a system of a higher rank. The Universe itself is viewed as a system consisting of a huge number of components and subsystems of different levels of complexity and order.

The systematic approach expresses the unity of natural objects because of the hierarchical inclusion of systems from different levels, one into the other, in which each element of a system is connected with all elements of the other systems. The idea of a systematic character correlates with the concept of entity of the objects. In this sense, the system is a result of the combination and the interaction among the elements forming a whole, which has new properties, that are absent in the individual elements of which it is composed. Thus, each system exhibits new, unique properties in terms of their components and their interactions (Ikonnikova 2008).

C. Bondarev treats the idea of a system also as a principle of consistency of scientific knowledge (Bondarev 2011). He attributes to it an integral character uniting the functions of the other ideas and principles, and unifies into a whole scientific knowledge, its methods and principles.

• Idea of self-organization of complex systems

I. Prigogine makes special contributions to the theory of systems (Nicolis & Prigogine 1989; Prigogine 1980). He found that the laws, which he achieved in the study of nonequilibrium thermodynamic systems are valid for systems of all kinds. In his view, matter is not a passive substance, and its intrinsic spontaneous activity, caused by the instability of non-equilibrium states in which sooner or later each system, as a result of interactions with the environment, falls into. In such crucial moments - bifurcation points, it is impossible to predict whether the system will shift to a lower or to a higher level of organization. H. Haken introduces the term “synergy” for scientific field that studies the common action of the separate parts of a disordered system, as a result of which, a self-organizing system occurs (Haken 1980, 2005). The authors relate the idea of self-organization to open, nonlinear, dissipative systems located far from equilibrium, having a high level of complexity and a large number of elements with a probabilistic nature of interaction.

• Idea of a global evolutionism

The idea of global evolutionism, formulated by N. Moiseev, originated as a natural development of previous ideas. The reason for its introduction are the results of the generalization of natural-scientific knowledge about the evolutionary developing systems, and in particular, that of the evolution theories, thus achieved in the development of all natural sciences (Moiseev 1993, 1984).

Modern science examines evolution as a global process in the universe, typical of all systems of inanimate and animate nature, in which the more complicated structures originate from the simpler ones. A process of integration of simpler elements, integrally formed with a higher organization, into more complex systems, possessing new qualities, proceeds (Bondarev 2011). B. Ebeling describes the phases of the global evolution, taking into account the importance of factors influencing its conduct (Ebeling, Engel & Feistel 2001). The idea of global evolutionism is also considered as a principle of preponderant evolution of complex systems in comparison with the simple ones.

• Idea of compliance

This idea solves the problem of compatibility between the new and the old theoretical systems in science which describes the corresponding hierarchic levels in the structure of natural objects. It requires that a

new theory, in a borderline case, should agree with the old theory, not rejecting it completely. Thus a continuity and an upgrading of knowledge (Lihin 2011) and also a continuity among the explanations, i.e. among the elements of theories, is ensured. (Sadokhin 2009). So the idea does the part of a criterion of truth and outlines the way for the development of theoretical systems.

The idea of compliance is also applicable to different styles of thinking. The new type of thinking, characteristic of the new theories, incorporates the features of the previous stages of the development of theoretical thinking.

• Idea of overall scientific worldview /IOSWV/

This idea develops as it comprises and comes into line in itself with the other fundamental ideas of Nature History. Its evolution is a never-ending process, because natural objects are inexhaustible in their properties and the relations arising among them. It represents the ideal model of nature, which is built on the natural-scientific knowledge about its structure, principles and laws.

According to A. Sadohin IOSWV does not include all knowledge of nature. He regards it as a complete system of ideas, a special form of a systematization of knowledge, a qualitative summary and a world-outlook synthesis of various scientific theories, and of the private-scientific worldviews (Sadokhin 2009). It plays a heuristic role in the establishment and the development of scientific theories.

In conclusion, it is important to emphasize that the Fundamental ideas of nature history do not only represent the most synthesized and summarized knowledge in nature sciences, they also serve as a "programme" and a methodological base for their development. They have been serving as criteria for authenticity of knowledge and as implements for scientific knowledge and creativity since antiquity to the present.

The analysis of their content leads to the conclusion that some of them represent qualities of natural scientific knowledge only, while another part of the ideas actually represents qualities both of knowledge and the objects themselves.

The first group refers to ideas of: observability, relativity, complementarity, compliance and overall sciences worldview. The idea of elementariness may never be confirmed in its absolute sense and, therefore, it is also referred to this group. These ideas will not be a subject of our further consideration.

The second group treats the ideas about causality, symmetry, conservation, simplicity, hierarchy of natural systems, self-organization of complex systems and global evolutionism. It can be used to derive a set of principles which governs the existence and the development of natural objects or systems.

3. SYSTEM OF PRINCIPLES OF NATURAL OBJECTS /SPNO/

Nature as a whole, and in particular natural objects have the unique ability to develop and complicate, to self-organize and self-regulate. They can also repair and reproduce themselves at different degrees and in a variety of meaning of the different structural levels of matter. They remain in harmony with themselves and the world around them, seeking to stationarity with minimum energy consumption. Such a system, operating so harmoniously and "reasonably", is probably based on a kind of a fundamental set of principles of the highest level which it strictly observes.

In drawing up of such a system of principles we follow the belief that it is possible to formulate and justify the system of the general properties of natural objects which "organize" simultaneously the existence of a particular object, and at the same time, they find their expression through it. Therefore, we call it System of principles of natural objects, i.e. they are inherent, intrinsic qualities of the objects themselves, and not only of our knowledge of them.

3.1. Introduction of individual principles

I Principle of *entireness* - underlying factor "space".

This principle considers an object in its fullness and unity. It gives a "snapshot" of the object as a complete whole. That "exit" from Time defines it as an element or structure of Space, regarded as a form of existence of the known Universe.

Space expresses orderliness of existing material objects. Thus the object is distinguished from all surroundings (its environment). It reveals its essence, meaning and purpose and it allows to be noticed, identified and be given a name. A. Bogdanov expresses the opinion about the own meaning and purpose of the organization of the systems, of everything that exists (Bogdanov 2003).

The principle focuses on the concept of wholeness. In philosophy it is considered as an essential, aspect property, but also as an integrating quality of objects. These two aspects correlate with those different points of view known as "inside" or "outside" the object. When an object is viewed from "outside" this term is associated with differentiation, selfness, reticence. If the view is directed from "inside", the concept of wholeness makes sense only when the idea of externity is revealed, i.e. in openness to the surroundings (Bochkarev, Bochkareva & Saxonov 2011). So the concept reconciles in itself the opposite properties reticence and openness (essentiality and integrity) that remain in the ratio of additionality without rejecting or eliminating each other. I. Goethe wrote that when the whole reveals itself, it shows all the rest too, and this understanding presents great boldness and great humility (Bochkarev, Bochkareva & Saxonov 2011).

In formulating the Principle of entireness we mean the first of the reviewed aspects of the concept. The second aspect is related to the third principle.

II Principle of *change* (movement, development, evolution) - underlying factor "time".

Time reflects order with the change of phenomena. In this sense, the principle examines the movements of the object, the changes that occur in its qualities and characteristic magnitudes in the course of time. Some trends towards development and evolution of the object, emerge and the end of its existence in time is thus marked too.

The principle is related to the idea of global evolutionism, thus uniting the systemic approach and the evolutionary theory.

With introduction of synergetics and the study of complex dissipative structures, the understanding of evolution suffers a change too. It turns out that the linear nature of evolutionary processes is not obligatory. So, it can be observed only in the periods between two abrupt changes in the structure and properties of the object (points of bifurcation). The direction of evolution in these points is influenced by the existence of sustainable structures-attractors in the system as the trend of change is realized towards the qualities and properties of these structures (Ikonnikova 2008).

III Principle of *polarity* - underlying factor "systematic/duality."

Natural objects have a complex structure and exist as systems. Considering the factor Simplicity, we assume that of each hierarchical level in the systems, it is most likely for the binary (dichotomous) structure to occur.

Dichotomy, resulting from factors systematic and simplicity, has no clear link with the principles that have been formulated so far. In order to achieve consistency among the concepts of systematic, entireness and evolution of objects, it is assumed that the whole or the object itself splits into two parts of equal value (polarities) according to a single quality (quality of wholeness) which helps to the utmost of the evolutionary purpose of the whole. Thus, the object turns into the simplest type system - a binary system. The polarity of the object generates the interaction within the whole, its movement, development and evolution.

This principle is relevant to the integrity of the object concerning its wholeness.

Examples: both sexes with living organisms; positive and negative electrical charges; substantial and field forms of matter, acids and bases, electric and magnetic field.

Qualities of polarities:

• They form a perfect whole without a surplus and/or a deficit.

• They make sense only together; when separated they lose the brightest of their "individuality", their most typical kind of interaction, their evolutionary purpose.

• They complement each other just in one sign - the one that separates them.

• They are attracted to one another (they affect each other and are interactive).

It is not always easy for polarities to be distinguished from ordinary oppositions. Oppositions:

• They do not form a whole.

• They can exist by themselves.

• Accidentally they complement partially, and vary in many and in different signs.

• They repel each other more actively than attract and there may be a struggle for dominance and elimination of the opposite side.

Oppositions can easily be found among objects that have no natural origin - economic, social, religious and political structures.

IV Principle of *rhythm* - underlying factor "interaction (between polarities)"

Objects exist in a constant interaction among themselves - they are not isolated from one another.

The principle is manifested in a temporary and a recurrent predominance of one polarity over the other one (tides of polar structures and/or qualities) as a result of their_interaction. And if the Principle of change is related to the trend of the evolutionary process, the Principle of rhythm shows the way to carry out this process, it draws the spiral of evolution.

If the periodic motion or amendment is being made within a quality, that is not characteristic of the entireness of a system, it is more correct to name it oscillation or vibration. This type of movement is considered by Principle II. (For example, the changes of anthropometric indicators in the course of evolution with humans.)

V Principle of *causality* - underlying factor "causation"

Causality expresses the interconnection of objects in space and time. It carries in itself the idea of interaction among natural objects.

So the object, its structure, qualities and properties, their stability or modification is assessed as a unit of a series of objects; it originates from the previous one and it alone generates the next object. Causalities of the object with other objects reflect in the interactions among them.

On the other hand, the link cause-and-effect, cannot occur outside of Time and certainly of Space. It is the connecting element between objects and events in the Universe, and through them to Space-Time itself.

VI Principle of *analogy* (compliance) - underlying factor “simplicity (economy)”

With this principle the simplicity of natural systems is considered in the sense that each object has the simplest possible structure, i.e. nothing is more complicated, than being simpler if possible. Each natural object possesses the lowest level of complexity, which allows it to show certain qualities and to function in a certain way. Its existence and functioning is provided by the required minimum material, energy and information.

Even at this basic level, we find embedded duality - permissible complexity, which provides diversity of natural objects occurring in the conditions of maximum simplicity.

The principle that if one thing can be simpler, there is no need to be more complicated, leads to the realization of identical models (analogies) for different objects.

So the analogy is not just about knowledge transfer from one object to another one based on a kind of resemblance. The analogy is a combining quality of a group of objects from different levels in the structure of matter, that can be very different from one another. They can participate as components in different types of systems, and they can carry out a different type of interaction, but nevertheless they can show the same pattern of structure, function and/or interaction.

The factor "simplicity/economy" that lies at the heart of this principle limits the varieties of models of natural objects. In this sense, a model is not just an element of our knowledge of objects, it is not only a result of applying of idealization and abstraction. It reflects the real unifying quality of natural objects.

VII Principle of *interconnection* of objects in the Universe - underlying factor "unity"

Natural objects exist in unity.

This principle again gives an expression of the idea of wholeness in the aspect of integrity. It is with a Third principle that we apply this idea to a specific structural level of the object, looking for its sub-structures and their possible unification, it is here that we appreciate the place, the role and the importance of the object for the whole, i.e. for the upgrade systems of higher hierarchical levels. Words to this effect and sense that one cannot pick a flower without upsetting a star, are unforgettable.

The proposed principles can be considered as interrelated, complementary and elements passing one into another of a comprehensive non-hierarchical system. We derive the wholeness of the system itself and a complementarity of its elements as main qualities of the system of principles of natural objects.

As the principles are presented in this way, they carry a universal character, and they are equally applicable to various types of natural objects at different hierarchical levels in the structure of matter. The level of generalization, which they reach, proves the growing trend to synthesize knowledge and an interpenetration of scientific fields and their derivative subjects nowadays.

3.2. Ties and relations among the principles of the system

The principles, thus suggested, can be interrelated, complementary and elements passing into each other of a comprehensive nonhierarchical system (Figure 1). An integrity of the system itself and complementarity of its elements are derived as main features of the system of principles of natural objects.

Figure 1 shows graphically the relationships among principles examined above. Semantic interpretation of these relations is done according to their numbering on the scheme:

(1) Every object and its characteristic essential quality varies and evolves until a new essential quality is achieved, which means a new object. This attitude is uniting for the category "Space-Time".

(2) The cause-effect relationships among objects are at the heart of their differentiation and distinction. They are manifested through the quality of Space.

(3) The cause-effect relationships among objects and their interactions, as well as those among their elements, define movements, set the direction of the current changes and the trends in the evolutionary processes. They are shown through the qualities of Time.

(4) The First and the Third principles correlate with each other through the two aspects of the concept of "entireness" - materiality or distinction and integrity. Reaching a new substantial quality means and the emergence of a new, different polarity of the object too.

(5) The polarity of the object follows, but it also sets the direction of development and evolution.

(6) The principle of polarity is closely linked with the principle of rhythm. It is the interaction between polarities that creates rhythm.

(7) Each pole is a cause, and at the same time, is due to the other pole. The dichotomy of the object is causally determined by the nature and evolutionary purpose of the object.

(8) The Principle of rhythm is the highest manifestation of the Principle of change. It outlines the way significant changes of objects are carried out.

(9) The analogies occurring in the nature of causal relationships, including analogies in natural laws that express them.

(10) There are occurring analogies in the dichotomous structure, properties and functions of objects.

(11) Analogies in the nature of rhythmic manifestations.

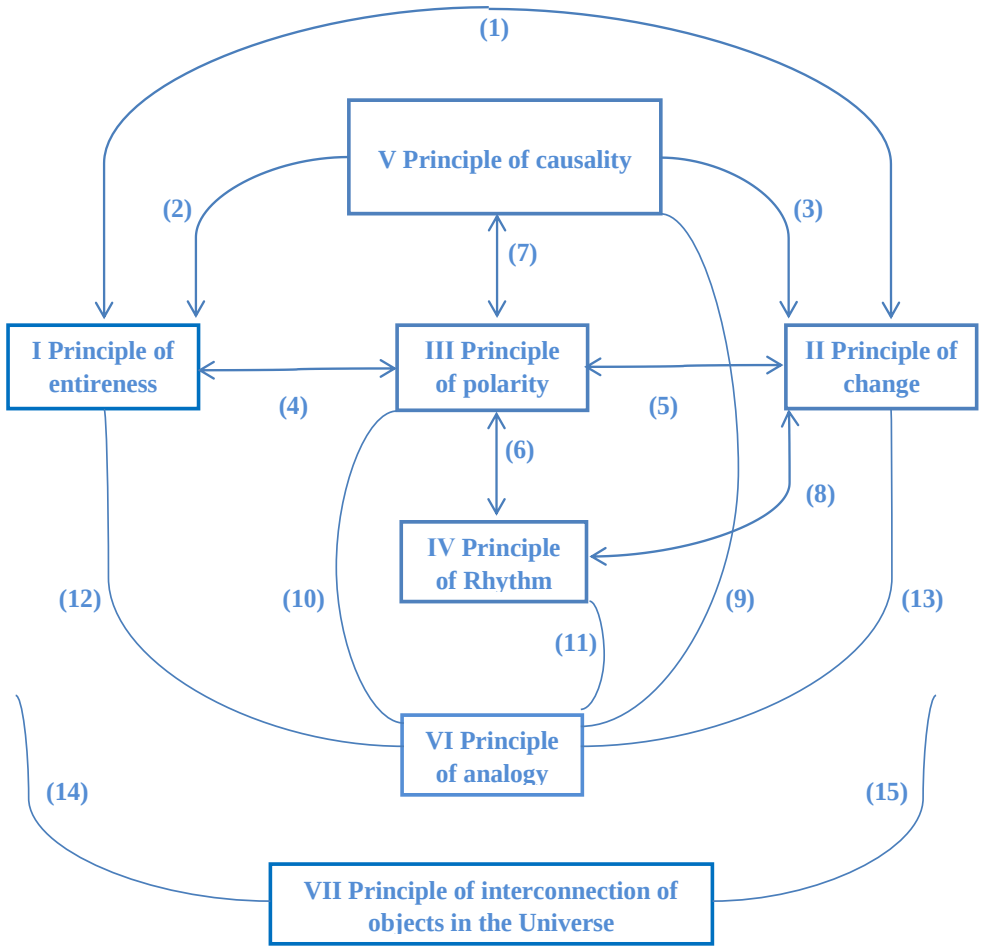


Figure 1. Interconnection and relations among individual principles in the system

(12) Analogies among the essential qualities of objects of different levels of matter organization.

(13) Analogies in the way the processes of different levels of complexity proceed.

(14) and (15) Summary of all ties and relationships listed here.

When analyzing the chart, the following conclusions can be drawn:

• There are formed some structures, often triangular, by which the joint operation of three or more principles are manifested. For example, the first, the second and the fifth principle; the first, the second and the third principle or the second, the third and the fourth principle.

• The sustainable configuration among the first five principles stands out.

• The principle of analogy permeates, with equal weight, into any of the foregoing.

• The Seventh principle holds, in the highest degree, an integrating and summarizing function.

Presented in this way, the principles carry universal character. They are equally applicable to various types of natural objects at different hierarchical levels in the structure of matter. The level of generalization, which they reach, proves the growing tendency to synthesize knowledge and interpenetration of scientific fields and their derived subjects of nowadays.

4. COMPARISON BETWEEN THE PROPOSED SYSTEM OF PRINCIPLES AND FUNDAMENTAL IDEAS OF NATURE HISTORY

The second set of fundamental ideas of nature history /FINH/ relating to causality, symmetry, conservation, simplicity, hierarchy of natural systems, self-organization of the complex systems and global evolutionism, have much in common and can be compared with the System of Principles of natural objects /SPNO/ which is displayed below (Table 1).

№	Principles of SPNO	Fundamental ideas of natural history
I	Principle of entireness	The idea of systematic (an essential aspect of wholeness)
II	Principle of change	Idea of a global evolutionism (trends of evolution) Idea of self-organization of complex systems
III	Principle of polarity	The idea of systematic (integrative aspect of wholeness)
IV	Principle of rhythm	The idea of systematic Idea of a global evolutionism (a way to achieve evolution)
V	Principle of causality	Idea of causality
VI	Principle of analogy (compliance)	Idea of simplicity Idea of symmetry Idea of conservation Idea of invariance
VII	Principle of interconnection of objects in the Universe	Idea of hierarchy of natural systems

Table 1. Comparison of Principles of SPNO and Fundamental ideas of natural history

Conclusions that follow the comparison:

• The meaning of each principle corresponds to one of the FINH, with some of its aspects or it is unifying a few closely related ideas.

• The ideas with a more specific content relate to only one principle (ideas of causality, simplicity, symmetry, conservation, invariance, self-organization of the complex systems as well as the hierarchy of natural systems).

• Two of the FINH, namely, the systematic approach and the global evolutionism, are characterized by a higher degree of generalization and fundamentality. They are just the ones, regarded in different aspects, that we link, above all, with natural objects. The idea of systematics is manifested, most frequently, but this is quite natural, because our research is directed towards natural objects that have a complex hierarchical structure.

• The meaning that we attach to the principle of analogy, namely the development of uniform patterns with objects of different hierarchical levels in the structure of matter, does not demonstrate the idea of simplicity only, it is embodied in the idea of symmetry too, and it is embodied in the ideas of preservation and invariance which are linked with it genetically.

The developed system of principles of natural objects in a greater degree correlates and it is consistent with the nature and the manifestations of natural objects, therefore, it can serve as a basis for building a technology for training in creativity, based on the deductive approach.

5. TECHNOLOGY FOR TRAINING IN CREATIVITY

5.1. Drawing of Systematic procedures for knowledge and creativity based on SPNO

Four levels of learning are accepted in didactics - a level of recognition, reproductive, applicative and creative one (Lehner & Cekov 1986; Razumovskiy 1984). In the process of training these levels build up gradually. Learning at a higher level means that students have already mastered the previous levels satisfactorily.

The proposed so far technology for training in creativity is directed precisely to achieving the highest level, i.e. the fourth or the creative one by mastering mental patterns and intellectual skills for creativity based on SPNO.

Modern non-classical philosophy considers knowledge to be a creative activity, and the application of semantic approach transforms it into a process of making good sense (Khomich 2003).

A setting of "marking structures" in the work is typical for the creative process through which the latter makes some sense. The role of such "marking structures" may adopt the basic principles which serve as internal regulatory mechanisms with the existence and the development of natural systems. Thus natural principles are transformed into principles of human thought, and through it, of all created by man.

These reflections are used as a base for building systematic procedures for knowledge and creativity based on SPNO.

The full cycle of scientific knowledge allows it to be reduced to a simple cycle expressing the rhythm in the manifestation of processes of learning and creativity. What is to be understood by "knowledge" means the formation of a maximum accurate and true mental image or model of the target object, its qualities and properties, and by "creativity" we understand transformation of the constructed mental image, in an original way at that, into a product of creativity or work (scientific theory or real object).

So certain the processes of knowledge and creativity appear as two polarities in the overall process of accumulation of new knowledge about the world around us and they close a round of the spiral. As knowledge cannot but go into creativity so a work cannot but become a support for a new cycle of knowledge.

The ultimate aim of knowledge is Truth and of creativity – positive and Good results. So it turns out that this wide-known and detailed formalized cycle of scientific knowledge is based on moral categories - Truth and Good. We can continue the interpretation: if the starting point is Truth, then the result will be Good or on the road to Good we reach Truth.

The developed system of principles has a significant methodological potential. Following the deductive approach, each of the principles of SPNO can be deployed in a stage (an operation) of an overall procedure of a cognitive or a creative activity. Since they are based on a system of principles, so the procedures, thus formulated, are considered as a system too. We call them respectively a Systematic

procedure of knowledge /SPK/ and a Systematic procedure of creativity /SPC/. Each procedure includes seven operations so as there are principles.

By the systematized procedures the fundamental principles of natural objects can be treated as principles of knowledge and creativity too.

Principles of SPNO	**Operations of SPK**	**Operation of SPC**
Principle of ***entireness*** factor "space".	***Differentiation***, defining the target object. Awareness of its purpose, meaning and sense.	***Differentiation*** - clarifying the purpose, meaning and sense of the work being created.
Principle of ***change*** factor "time".	***Changes*** - understanding about the "movement" of the object, its development path, its evolution.	***Changes*** - foreseeing the "movement" of the work, its development path, its evolution.
Principle of ***polarity*** - factor "systematic/duality."	***Polarity*** - understanding of the evolutionary purpose of the object, a corollary of this objective prime quality and differentiation of both polarities in it according to this quality.	***Polarity*** - determining of the evolutionary purpose of the work, the corollary of this objective prime quality and differentiation of both polarities in it according to this quality.
Principle of ***rhythm*** factor "interaction"	***Rhythm*** - understanding of the interactions of polarities inside the object (its functioning).	***Rhythm*** - foreseeing the interactions of the polarities within the work (its functioning).
Principle of ***causality*** factor "causation"	***Causality*** - understanding of the reasons, which determine the object and of the consequences that it causes itself.	***Causality*** - reasoning of the causes that account for the work and of the consequences which it may cause itself.
Principle of ***analogy*** factor "simplicity/economy"	***Analogy*** - reasoning of analogies with certain models for structure, movement, interaction. .	***Analogy*** - applying of analogies with certain models for structure, movement, interaction.
Principle of ***interconnection*** of objects in the Universe factor "unity"	***Importance for the whole*** - reasoning of the place and role of the object in the overall picture of the world.	***Importance for the whole*** - foreseeing the place and role of a work in the overall picture of the world.

Table 2. Comparison of the system of principles with procedures of knowledge and creativity

5.2. Applying the systematic procedures in teaching nature sciences

Applying of systematic procedures in the processes of scientific and educational knowledge and creativity can be accomplished by:

- We seek and outline a manifestation of the principles in the object of our knowledge, that leads to its quicker, full and true learning.

- We think about and introduce a manifestation of the principles in a work we create by which it becomes beautiful, useful and of high quality.

Objects, processes, phenomena in nature can be explored thoroughly and in detail according to these procedures in the process of learning or teaching them. Each object of natural sciences can undergo the most complete research or study as:

• its nature and structure,

• its existence and evolution,

• its qualities and properties,

• its interactions and links with other objects,

• the processes and phenomena in which it participates,

are followed according to the systematic procedure of knowledge.

The first principle and the cognitive operation related with it, can be applied in lessons presenting new knowledge with introducing new concepts, definitions, magnitudes. The usage of different teaching materials that promote the visual idea of the studied object and its location, relative to its environment, is in the context of this principle.

The second principle and its corresponding cognitive operation have a place in the studying of processes, of qualitative changes of a different character, as well as with laws and regulations, which represent the changes of the studied magnitudes in time. The using of empirical methods of knowledge in demonstrations, practical tasks or laboratory exercises correlates with this cognitive operation.

The place of a Third principle and a cognitive operation is in studying of the structure of the object and in the disclosure of existing polarities in it. Using of visualization means and demonstrations is suitable.

The fourth principle and the relevant cognitive operation are important for the explanations in studying of rhythmic processes. Visualization and demonstrations are again basic didactic resources.

The fifth principle and cognitive operation are closely related to logical or, the so called, linear thinking. The search for causes or anticipating the consequences through logical operations analysis, synthesis, comparison, induction, deduction, etc. are key ones to drawing of regularities and laws, in solving qualitative and quantitative tasks, problems and cases. They are an essential part of the process of mental experiment and the creation of theoretical and material models.

The sixth principle and operation correlate with the lateral thinking. Using associations and analogies helps to find unconventional creative solutions to educational problems and cases. Since it takes more time, it is proper to stimulate its implementation by the trainees in the preparation of assignments such as creating models, in extracurricular activities, in work projects. Some laboratory settings, and some models to visualize the structure or processes with the objects, being studied, are created on the principle of analogy. They are particularly suitable for the learning of the sixth principle and operation.

It is quite natural for the Seventh principle and its corresponding cognitive operation to find their place in the study of applied aspects of knowledge, being learned, in lessons for systematization and summary, as well as in the revision lessons of a subject.

The study of the very principles, the cognitive and creative operations can be carried out directly with trainees of greater age, but those can remain hidden, implicit in the very educational content and/or in the way it is structured and presented in teaching process.

CONCLUSION

As a result of this type of training a mastering of thought patterns and intellectual skills for creativity is achieved, which is a prerequisite for a more successful integration of humans into their natural environment, to put under control the crisis relations Man - Nature.

The Systematic procedures for knowledge and creativity presented above can be used and applied consciously in every human activity, relevant to nature. The proposed procedures can be interpreted and applied equally with success in the processes of both scientific and educational knowledge and creativity.

Their highly generalized and universal character allows their application in researches, analyses, development of models, programs, and systems for evaluation and control in various areas of human activity. Thus human creations would acquire, even to some extent, the high quality of natural objects and in society relations of harmony should get their priority.

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