

Methodology of Creativity and Creative Thinking: Structure and Content of Educational Cluster

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Abstract – The content of educational cluster based on conception of Mental Integrative Metasystemic Innovative Methodology (MIMIM) is presented. The basic elements of methodology and technology of creativity with new sense are presented.

Key words – Creativity, thinking, innovation, methodology, metasystem, integrity, creative technologies, complex systems, competency, pedagogical system

*“The world we have created is a product of our thinking;
it cannot be changed without changing our thinking”
Albert Einstein*

I. INTRODUCTION

Influence of intellectual property is rapidly growth in world economy. It is possible that the quality of our future depends, in large part, on innovative solutions to existing problems. The evolution of culture depends, in part, on creativity, also. Therefore the contemporary world society has a necessity of higher qualified, and competent specialists, who have well developed creative abilities and able to make inventive solutions in all spheres of human activity. For this purpose we need corresponding high qualified, dynamically thinking specialists in industry, economics.

Traditional higher educational system don't ready to train such specialists; but modern society needs these specialists today, tomorrow it will be late, otherwise the economy will be noncompetitive. Actually, corporations spend a great deal of time and money trying to facilitate innovation in their employees, but students are not learning how to be creative in a rapidly changing world [1]. For solving this problem it is necessary to project the integrative educational system (cluster) for training creatively thinking students.

For this objective an innovative educational model, new methodology and technology, new thinking, and higher level of consciousness become necessary. Models of contemporary engineering education and activity must be based on general models which take into consideration the unity of the world in its complex connections, and ecological, ethical, aesthetical principles. In the process of developing the model an attention was focused on the fundamentalization of education, which is based on professional flexibility, according to the permanently changing of contemporary market. At the same time the key competences, the main criteria of fundamentalization of education are in process of establishing and need the international researches, discussions, agreements. Nobody doubts that creativity and creative thinking are the key competences [2, 3].

II. MENTAL INTEGRATIVE METASYSTEMIC INNOVATIVE METHODOLOGY

The project of educational cluster of Mental Integrative Metasystemic (Transdimension) Innovative (Inventive) Methodology (MIMIM) has been developed in Kazan National Research Technological University (KNRTU, Russian Federation). The key categories of MIMIM are "creativity" and "thinking".

There are many different definitions of category "creativity", but usually, creativity is considered to be a human activity in which a principally new product is created, the most important feature being originality, which we can't reproduce and this activity and product have a historical and social importance, meaning and usefulness [4].

However, essence, mechanism, and phenomenon of creative activity up to now remain sacrament and are covered with paradigmatic (theoretical), contextual, and procedural discrepancy. It is connected with an absence of identity of views (transdisciplinarity) and highly tailored approach to the phenomenon "creativity" as well as traditions of quantitative assessments. But, Napoleon Hill noticed: "...this power can only be attained by the observance of many fundamental principles all of which converge..." [5].

In this article the following definition of creativity is formulated: "Creativity is definite quality, promoting the professional, social internal and external development of a person, self-improvement and transformation of a person and his consciousness in cognition (interaction) the higher senses of Universe, by which a person promotes his own activity for obtaining new knowledge, sense, understanding, valuable characteristics, transformation of ideal and material worlds, differing by their own uniqueness, originality, expediency, sensitivity, intelligence, consciousness and which have humanistic, transpersonal and ecological (aesthetical, ethical) orientation and don't restrain the rights and possibilities of the next, present and previous generations for the object of receiving "strong", effective solution, that is consisted in production an optimal, harmonic, self-regulated, self-organized, self-developed, self-consistent system with high level of systematization (integrality, internal self-descriptiveness), which has synergetic, dialectic, recursive, and continual interactions of holistic system with external unity (external self-description) as a result of synchronicity (self-consistency) between the structure and process of thinking and environment in temporal triune of the past, present and prospect (future)".

MIMIM is based on the temporal unity of scientific knowledge, spiritual values, art, describing the transdisciplinary character of thinking (cognition) of a person. The emphasis is put on a "strong", effective solution with the high level of novelty, patentability and reliability, funded by principle of responsibility. In this case the solution is located in the plane of the metasystemic dimension as a result of the integration (synergy) of binitarian (linear), triune (nonlinear recursive continual) and quaternary (metasystemic nonlinear recursive continual) modalities (principles, styles) of thinking. The main content of MIMIM is contemporary scientific outlook, its interconnection with goal-setting, sense, values, character, direction of life activity of a person (the essence of which is concentrated on creative activity and creative thinking), as well as filling the conception of creativity and dedicated modalities (styles) of thinking by scientific structural components, and definition the mechanism of its functioning in the unity and integrity of historical and logical approaches.

MIMIM includes the principles based on the cognition of universal character as deductive elements:

- *Formal logic (Aristotle)*: law of identity, law of noncontradictory, law of excluded third.
- *Classic science*: the principle of universal determinism, the principle of reduction, that consists in knowing any complex form from only the knowledge of its basic constituting elements, the principle of disjunction, that consists in isolating and separating cognitive difficulties from one another, leading to the separation between disciplines, which have become hermetic from each other, the principle of relativity.
- *Dialectic*: the law of the unity and conflict (interaction) of opposites (ancient Ionian philosopher Heraclitus); the law of the passage of quantitative changes into qualitative changes according to measure (Aristotle); the law of the negation of the negation (Hegel) (or author interpretation – the law of the reflection of the reflection of the reflection), principles of historicity and futurism.
- *Modern Physics*: uncertainty principle, correspondence principle, principle of complementarity.
- *Synergetic*: order-parameter concept, enslaving-principle, mutual responsibility.
- *Fractal geometry*: principle of self-similarity;
- *Chaos theory*: nonequilibrium, decentralization, symmetry and asymmetry;
- *Conception of sustainable development*: network character of interactions, responsibility, integrality of ecologic, ethic, aesthetic characteristics, subject-subject approach;
- *Postmodernism*: logic of sense through archetypes, pluralism, multilayer instead of hierarchy, subjectivism, spontaneity, narrative, simulacra;
- *Innovative economics*: principles of network structures, informational technology, psychology of evolution;
- *Aesthetic, ethic, ecologic principles*.
- *Methods of scientific and technical creativity*: «brainstorming» (A. Osborn), synectics, (J. Gordon), mental cards (T. Buzon), lateral thinking method (E. de Bono), and TRIZ (Teoriya Resheniya Izobretatelskikh Zadatch - TRIZ in Russian, "the theory of inventing problems solving" (TIPS) in English – G. Altshuller) [6, 7].

Brainstorming is the most used group creativity technique being used to enhance idea generation in organizations and industry. Brainstorming is a group process of generating ideas in which there is no criticism. A. Osborn claimed that interactive groups could generate more ideas than individuals working alone. He also claimed that the creative process involved two steps, idea generation and idea evaluation. In the idea generation step, the object is to produce the greatest number of ideas. According to A. Osborn, the more ideas that are generated in the first step, the more opportunity there will be to evaluate one as being useful in the second step of the creative process. The success of brainstorming is often measured by the quantity of ideas generated about a heuristic task. Therefore, the brainstorming technique for generating ideas is one step in the creative process, and Osborn recommends group interaction for the facilitation of creativity.

Optimal method of a solution of problems includes the principle of feedback between mental work and an object of inventive activity. TRIZ gives an opportunity to obtain an effective almost ideal solution of the appeared problem taking into account a multiple-factor optimization. It comprises methods of imagination and fantasy activation of an inventor in combination with algorithmic approach to the solution. It includes as well methods of arrangement and formulation of the inventive problem that is in fact halfway of a solution. TRIZ rests upon a principle of subjection of the development of any systems (technical, biological, social) to objective laws which could be cognized and then used for deliberated and task-oriented (without a plenty of hollow trials) solution of complex problems, for obtaining a “strong” solution. “Strong” solution at first approximation is a creation of holistic, optimal, harmonic, self-regulated, spontaneous system (approaching the ideal – ideal mechanism, ideal result, ideal thinking, etc.) in combination with hypersystem. Attention at ideal (“strong”) solution contribute qualitative component to the methodology of thinking and creative activity [6, 7].

In MIMIM the instrumental level of thinking process is underlined. There are three fundamentally different modalities of thinking – binitarian (linear), triune (recursive continual) and quaternary (metasystemic). Modality of thinking is characterized by the principle of organization (pattern) of thinking, as manifested in its internal condition, contained in a specificity of connected configuration elements making up its structure and method of their operation (internal informativity) and interaction of internal unity with the environment (external informativity).

The modalities of thinking

Binitarian modality of thinking is constructed on a binary principle (the antithesis of the dichotomy, the dilemma of "bad" - "good", "right" - "wrong" or how it can be seen from the laws of formal logic of Aristotle - law of excluded third) scheme ("source - drain", "transmitter - receiver") and is characterized by a linear character.



Fig. 1. Semantic formula of binitarian modality of thinking

Binary scheme is one-dimensional and generates a linear representation of the relationships between objects and phenomena (fig. 1). Binary thinking modality, contrasting science and religion, science and art, substance and field, body and consciousness, being and thinking, knowledge and faith, person and nature, good and evil, reason and feeling, subject and object, divides parts of a coherent and unified essentially semantic space into isolated, often completely unrelated (or related eclectically) with each other part. It leads to the thinking according to the principle of alternative "OR1-OR2".

Polyunified modality of thinking is based on the operability of "polyunity" and "recursive relations" and has nonlinear character (interaction and interrelation of objects, entities, and phenomena, circular causality, networking principles of system organization). It is based on understanding any object, process as a functionally entire, in which individual parts are

interrelated and at the same time correlated with environmental, social, and world media at the level of a wider and deeper penetration into the understanding (awareness) of a pattern of organizing the complex structure of living and nonliving systems and their unity. The simplest form of polyunity is triune (fig. 2). Triune is the structural and the substantial unity of thinking process (consisting of three elements, each of which is comparable, equivalent, of equal size, an equal part of the same level and can be used as a measure of unity of two others), which is a simple (elementary), internally coherent through negative and positive feedback, active (dynamic), i.e. variable and contains the idea of infinity.

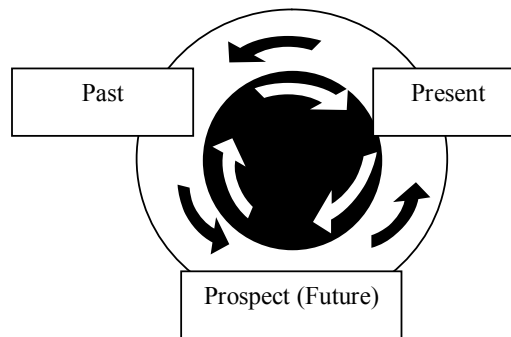


Fig. 2. Semantic formula of polyunified modality of thinking

It represents an elementary cell of synthesis. The third element in the trinity is a necessary measure to solve the problem of binary contradictions. In the triune each pair of components are in the ratio of complementarity, where the third element specifies the measure of correspondence (complementarity and correspondence principles of Niels Bohr). Such principle of thinking as "AND-AND-AND" is here realized, as an analogy by creative method of aircraft designer Roberto Bartini (Soviet Union) "AND-AND" – the common principle of the connection (unity) the opposites.

Pay attention to such opposites as, Man – Woman; Physics – Lyrics; Order – Disorder, etc. For example, K. Jung in "Psychological Types" [8] in obvious view presented such opposites:

Nominalism – Realism
 The Idealist – The Realist
 The Introversion – The Extraversion
 Rationalism vs Empiricism
 Intellectualism vs Sensationalism
 Idealism vs Materialism
 Optimism vs Pessimism
 Religiousness vs Irreligiousness
 Indeterminism vs Determinism
 Monism vs Pluralism
 Dogmatism vs Skepticisms

These opposites can be leaved as binary system, or can be resolve into triune (polyunity).

Quaternary modality of thinking (fig. 3) is based on the methodological principle of the universal nature, which was introduced into practice by K. Jung, and which has roots in four principles or causes of Aristotle, who defined them as interdependent sources of all

phenomena, namely the external and internal causes. Internal causes are the content and the form. External causes are: the initial (active) cause, generating the consequences, and the final reason that forms the objective or purpose.

In MIMIM the fourth component (the final reason) is the solution of a problem, i.e. a "strong", an effective solution; it is the attractor of resolution (removal) of contradictions of triune, which lies in another plane (another dimension). Thus, the quaternion has fourfold structure in the form of 3+1, where the triune defines a dynamic system, and the fourth component, complementing and completing the triune, and has the meaning of sense. In this case we have a Tetrahedron. This principle of thinking has such semantic formula as "AND-AND-AND-AND".

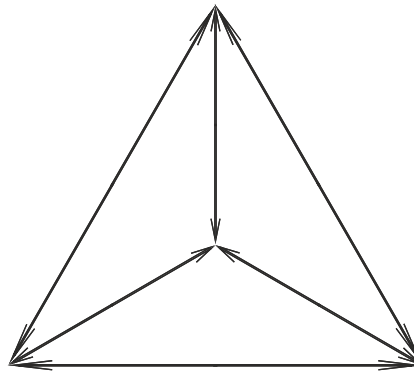


Fig. 3. Semantic formula of quaternary modality of thinking

Structure of Educational Cluster

The deductive approach as a cognition of universal principles (transdisciplinary approach) was taken as a basis for projecting the creative educational cluster. The main chapters (modules, elements) of educational courses of this cluster, which form its sense, are:

1. Creative (innovative, inventive) activity and contemporary paradigm.
2. Creativity and creative thinking: categories and phenomenon.
3. Science of thinking: logic, dialectic, synergetic, their unity and principles.
4. Ethics and creativity.
5. Aesthetics and creativity.
6. Ecology and creativity.
7. Economics and creativity.
8. Psychology of creativity.
9. Methods of scientific and technical creativity.
10. Project approach.
11. Management of intellectual property.
12. Leadership.
13. Human resource management.
14. Managerial decisions.
15. Economy, Trade Policy, and Law of World Trade Organization.
16. Estimation of the creative development level.

Fundamentalization of education includes principles of interdisciplinarity and transdisciplinarity and enhances the interpenetration of natural sciences, technical, technological, socio-economics and humanitarian sciences, thereby exerting an active influence on the radical changes in economics, engineering and technology, stimulating the development of applied research programs. In this case clusters become concentrated with interconnected particular disciplines with high level of systemic interconnections. Level of systemic interconnections implies the degree of informativity of any element of the system about a state of other elements of the system. The high level of systemic interconnection is supplied with a principle of transdisciplinarity [9].

The content of all sixteenth educational courses is projected in their unity. First of all, emphasize is made on the necessity of paradigm shift [10], basic scientific principles, which have universal (transdisciplinary) meaning, definition of the category “creativity” and its elements [3], transition from linear to nonlinear thinking [11], mutual roots of ecology, ethics, and aesthetics and their meaning for thinking formation, actual transfers in economics from linear (rational) models to nonlinear (irrational) ones, theory of complex systems [11], models of emotional, motivational, cognitive resonance [12] in psychology of creativity, rule of intellectual property in contemporary and future economics [13, 14], problems of formation, development, and estimation of creative abilities in education [15].

Approbation of MIMIM

In Institute of Additional Professional Education (KNRTU) in framework of the Program «Lecturer of Higher Education» for students (who desire that qualification):

- ◆ Methodology of Creative Activity,
- ◆ Innovative Processes in Professional Activity,
- ◆ Methodology and Technology of Competence Formation ,
- ◆ The Culture of Logic in Professional Activity,
- ◆ Methods of Scientific and Technical Creativity,
- ◆ Psychology in Engineering Activity,
- ◆ Method of Project in System of Specialists Preparing,
- ◆ Aesthetics in Professional Activity.

For Students, Master-students, and PhD. Students:

- ◆ Methods of Scientific and Technical Creativity,
- ◆ Technical Aesthetics (Design) in Technology of Industry,
- ◆ History and Methodology of Science, Industry, Chemical Technology, Ecology,
- ◆ Mental Integrative Metasystemic Inventive Methodology and Creative Activity.

Approbation in foreign universities:

- ◆ International Educational Project Erasmus Mundus - University of Genova (Italy)
Masters Program: “Research Methodology”
- ◆ Embassy CES (London, Great Britain): “Effective Communication Technologies”

III. SUMMARY

Fundamentalization of education includes principles of interdisciplinarity and transdisciplinarity. These principles are concentrated in categories “creativity” and “creative

thinking” and change the pedagogical interpenetration of natural, technical, technological, socio-economics and humanitarian sciences. Elaboration of new ideas in the unique cultural, technical, and historical context seems to be very important for expanding new details in their content: additional unique consequences could be inferred. Inferring new consequences from new ideas allows disclosing the hidden essences, i.e. such essences that have not been reflected (revealed and explored). It is open a road to new solutions, new constructions, new products, and new sense. Contemporary world is in need of it, so we have to train students to be a creative specialists.

“All this will not be finished... perhaps in our lifetime on this planet. But let us begin” (John F. Kennedy) [16, p. 27].

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