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Article

An interdisciplinary approach to education will help solve many of its urgent problems

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Abstract: The article considers some of the challenges of our era that modern education has faced: 1) the information boom; 2) narrow specialization in many sciences and technologies; 3) deterioration of human being's and humankind's ability to understand themselves and the world; 4) insufficient use of systemic, fundamental, interdisciplinary knowledge in the educational process; 5) deepening the tendency of the profiling of education, expanding the amount of academic disciplines and training time; 6) the phenomenon of "half-life of specialist's competencies"; 7) the Dunning-Kruger effect; 8) a decrease in the level of conceptual thinking of the participants in the educational process. It is shown that these problems in modern education can be solved with the help of such methods and tools as 1) continuous (lifelong) education; 2) integrated educational technologies (STEM education, educational methods based on frame theory, etc.); 3) a fundamentalization approach in education; 4) interdisciplinary synergetic approach as well as application of interdisciplinary connections in the educational domain; 5) systemic knowledge crystallized on the basis of general systems theory; 6) a modified version of this theory developed by the author; 7) developed by the author fundamental explanatory models/principles of structuring reality that can serve as a fundamental theoretical background for any other type of knowledge when the latter is easily comprehended and acquired on the basis of the fundamental explanatory models/principles due to their universal character. Promising directions of our research are connected with the application of the obtained data in the context of the educational process due to the integrated training courses for students of different types of educational institutions.

Keywords: interdisciplinary approach; continuous/lifelong education; fundamentalization approach in education; general systems theory; fundamental explanatory models; phenomenon of "half-life" of specialist's competencies; conceptual thinking; fractal organization of reality

1. Introduction

School and family are two of the most important social institutions that ensure the transfer of civilizational information from generation to generation in the current of social time. However, modern education has faced serious challenges of our era associated with several circumstances.

Firstly, we can talk about the so-called information boom, due to which the information generated by modern civilization doubles every 5–10 months. 100–150 years ago, the process of doubling information on planet Earth took place every 50 years. Besides undeniable advantages of the mentioned process (which widens the ranges of human cognition) it has lately acquired the character of information multiplication, that is, its duplication, which reduces the level of production of objectively new information and its concentration in certain knowledge. And this

may create a certain problem for contemporary students who as the representatives of *the digital generation*, widely use the Internet resources that accumulate an ocean of diverse information.

This reveals a situation where humanity has never possessed such an innumerable amount of information, but it has never been so far from understanding its essence, the knowledge of which turned out to be fragmented in the domain of many scientific disciplines. E. Schrödinger noted in the preface of his book "*What is life? The Physical Aspect of the Living Cell*" that "We have inherited from our forefathers the keen longing for unified, all-embracing knowledge. The very name given to the highest institutions of learning reminds us, that from antiquity to and throughout many centuries the universal aspect has been the only one to be given full credit. But the spread, both in and width and depth, of the multifarious branches of knowledge by during the last hundred odd years has confronted us with a queer dilemma. We feel clearly that we are only now beginning to acquire reliable material for welding together the sum total of all that is known into a whole; but, on the other hand, it has become next to impossible for a single mind fully to command more than a small specialized portion of it".

We can provide the following scientific background to this problem: In natural science alone, with its branches (physics, chemistry, and biology), there are about 6000 specific disciplines, from elementary particle physics to cosmology, from molecular genetics to brain physiology and ecology, etc. It contains tens of thousands of theoretical concepts, of which almost half are hypotheses. (And this is quite natural: Having closed one set of problems, scientific theories immediately pose new problems.) It contains an innumerable number and variety of specific scientific results. (And this is also natural: Even in physics, not to mention biology, many hundreds of specific disciplines are in the phase of empirical-analytical maturity of their knowledge.) Let us add here mathematics as an independent and extremely complex branch of modern scientific knowledge with its dozens of areas and hundreds of specific disciplines.

In this regard, it is possible to present developed by the author a pyramid of knowledge, which reflects the gradation of knowledge in accordance with the methodological levels of cognition of reality: The level of the general (which reflects universal matrices of knowledge, i.e. a set of the most general, fundamental knowledge models/principles/laws, of which, according to our calculations, there are approximately 100), the level of the specific (here we can distinguish up to 1000 models of systemic knowledge), and the level of the single (it covers a colossal amount of fragmentary knowledge and numerous facts about reality). It is important to note (refer to **Figure 1**) that in the modern educational domain, students study/master about 1% of knowledge in zone A, up to 10% of knowledge in zone B, and about 90% of knowledge in zone C.

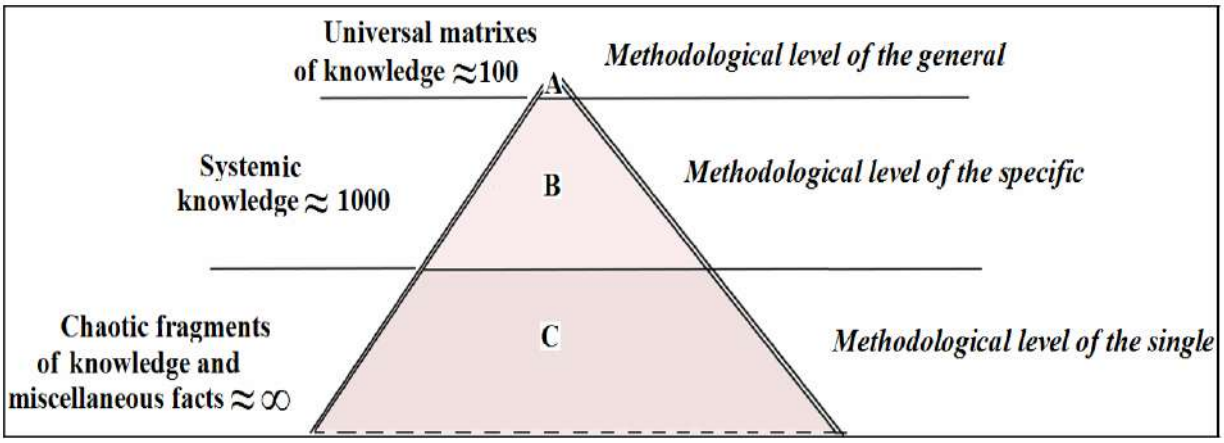

Figure 1. The pyramid of knowledge.

2. Some problematic aspects of modern education and the attempts to solve them

In the context of the educational domain, the mentioned trends are manifested in the deepening of the profilization of education [1], the expansion of a number of scientific/academic disciplines. At the same time, the share of exact sciences in education has recently exceeded that of the humanities. The training time at all levels of the educational branch is gradually increasing.

The above mentioned facts and considerations confirm the opinion of some scientists of the wide spread phenomenon of "narrow specialization": In the words of one of the thinkers, "narrow specialization is the lot of insects"; D. Epstein in his book, recommended for reading by Bill Gates, named our social world "a Specialized World" where "the Generalists Triumph" [1]. Here are some citations taken from this books:

"And he refused to specialized in anything, preferring to keep an eye on the overall estate rather than any of its parts… A Nykolay's management produced the most brilliant result" (Leo Tolstoy, "*War and World*").

"No too; is omnicompetent. There is no such thing as a master-key that will unlock all doors" (Arnold Tunbee, "*A Study of History*").

"In Range, author and journalist David Epstein exposes the fallacy behind the specialization myth and how society benefits more when people are generalists. It is those who seek broad experience in diverse fields that become innovative and creative problem-solvers, ready to tackle problems that seem unfamiliar and complex. David Epstein challenges the well-known concept that in order to perform at the highest level, you must find your niche at an early age and train for hours. While it is true that some of the best athletes and musicians began learning their craft at an early age, for example, Tiger Woods, the majority of these great individuals were actually generalists. They started out in one field, dabbled in a bunch of others, and finally settled on their true calling. Epstein states that people shouldn't be afraid of becoming generalists because the exposure will make them better abstract thinkers than narrow-minded specialists".

In general, we can talk about many watersheds separating sciences and scientific directions; and the main watershed divides science as a form of social consciousness into the humanities and exact (natural) sciences.

In addition, the information boom and the rapid development of various sciences and technologies have revealed the phenomenon of "half-life of specialist's competencies", when the technologies and knowledge acquired by students in the course of educational process become obsolete quite quickly.

This trend was revealed back in the 70s of the 20th century. In the book "*Education and Job: The Great Training Robbery*" Ivor Berg (USA) stated research results and single facts that proved that success in education was not directly correlated with labor efficiency, that is, the reasons affecting the work process should be sought not only in educational processes, but also in other factors of the person and environment [2–5].

The crisis in modern education is also revealed in the anniversary report (2017) of *the Club of Rome* (a nonprofit, informal organization of intellectuals and business leaders whose goal is a critical discussion of pressing global issues), where one can find an important conclusion about the inevitability of radical changes in the paradigm of human civilization: Rejection of financial speculation and harsh criticism of capitalism, as well as denying the primitive materialism and simplistic understanding of the world, the call for an alternative economy and "*new Enlightenment*" within a spiritual and moral worldview and harmonious civilization on our planet—such are some current imperatives of human development/evolution proposed by the Club of Rome being a reference point for the world's elite and a planetary platform where the agenda of the principles of "responsible globalism" and sustainable development of mankind has been formulated.

We should also note the so-called *Dunning-Kruger effect*, associated with metacognitive distortion, which occurs when a person with a low level of competence in a particular production or scientific field begins to imagine himself/herself an expert in this field, while he/she can make erroneous conclusions and unsuccessful decisions, but does not realize these mistakes due to incomplete knowledge, skills and abilities, thus coming to an inflated idea about his/her abilities even in unfamiliar areas of knowledge and actions performed for the first time. While highly qualified people, on the contrary, tend to underestimate their abilities and suffer from insufficient confidence in their abilities, considering others more competent. Thus, less competent people generally have higher opinions of their own abilities than competent people. Highly skilled people also mistakenly believe that tasks that are easy for them are also easy for others [6].

Another serious consequence of the considered problems is connected with the decrease in the level of conceptual thinking of the participants in the educational process [7–9] due to the fact that in modern conditions, humanity is undergoing a radical transformation—moving from the "*Gutenberg galaxy*" to the "*Zuckerberg galaxy*", that is, from the sphere of signs/texts and systems thinking, our civilization is transformed into a civilization of visual images and video sequences. In this context, one of the interesting points is the phenomenon of comics [10], in which the abstract-verbal (word/sign) and figurative-visual series of information are combined into a single whole. On the one hand, thanks to comics, a person gets the opportunity

to integrate two polar information spaces—abstract-logical and concrete-figurative. However, on the other hand, this fusion of a word and image complicates the development of students' ability to read literary texts. The latter ability involves the transfer of the sign-verbal information presented in the texts into figurative-emotional information. And this transpormative act is the fundamental process of thinking.

At present, the elements of the spectacular-entertaining culture are becoming excessively wide spreading, when, due to the development of the electronic/digital mass media, the number of audio-visual information signals that reach a person has increased many times. At the same time, the factor of book verbal information has weakened: According to our analysis of the reading activity of the students of physical and mathematical, physical culture and sports faculties of Zhytomyr Ivan Franko State University during 2020–2024, these students read rather little fiction. And this may lead to the primitivization of the artistic-aesthetic sphere of a student, the functional connection between the hemispheres of his/her brain may be distorted.

The mechanisms of reproductive imagination remain underdeveloped; and the highest development of these mechanisms allows the reader not only to reproduce the images of literary works, as the writer sees/feels/perceives them, but also to completely subordinate this imaginative process to a deep analysis of the text.

If the psychophysiological goal of human development can be considered the achieving the state of functional synthesis of the hemispheres (when the sign-verbal information, being perceived mainly at the functional level of left-hemispheric mental processes, is easily transformed into the imaginative-emotional sphere of the right hemisphere, and vice versa), then at present, such interhemispheric transformation processes revealing the human ability to verbalize and de-verbalize the perceived information (that is, the ability to "dress" the emotional-figurative information in sign-verbal "attire", and the opposite ability to reversely transform a sign into an image, a word—into an emotion), have to some extent decreased.

Such interhemispheric transformation needs attracting students to the artistic treasury of human civilization, which develops a persons' ability to generate figurative information in the sphere of their own artistic and aesthetic representation, and this, in turn, is a cornerstone of the development of creative thinking and implements the main mechanism of thinking as such—*diplasty* (a person's ability to combine in one logical and psyco-emotional context the opposite and mutually exclusive concepts, images, objects, states, stimuli).

The decreasing in the level of conceptual thinking of the participants in the educational process has deep civilizational background: Back in the 20s of the twentieth century, L.S. Vygotsky noted that only about 20% of the population possessed the ability for conceptual thinking [11]. Some researchers believe that at present only 20% of the population with higher education fully possess conceptual thinking, which is also stems from the widespread introduction of digital technologies in the modern educational sphere [12].

However, the above mentioned problems (which do not exhaust the range of the problems of modern education) can be solved in several ways.

On the one hand, such ways are connected with the fact that classical (traditional) education is changing radically, losing its discrete character and

acquiring a continuous one, which has many designations: "*continuous education, continuing education, continuous schooling throughout life, education throughout life, lifelong education, lifelong learning, recurrent education, out-of-school education, non-formal education, self-directing education, permanent education, adult education,"* etc. However, this type of educational activity presupposes not only *positive aspect*—continuous self-education, but also a *negative aspect*: In the process of acquiring the information generated by humanity, one has to plunge into the sea of bad infinity of the colossal agglomeration of accumulated facts and fragmentary knowledge about the world.

On the other hand, the attempts are being made to find fundamental invariants of modern knowledge. Thus, if we talk about knowledge of the most general laws and principles of science and philosophy, which cover the knowledge of zone A (refer to **Figure 1**), so we can talk about the attempts to present such knowledge in the context of frame theory [13–16] and such like theories which embody the attempts to find/built certain interdisciplinary universalia. It should be stated that the knowledge of zone A.

It should be stated that the knowledge of zone A can serve as a fundamental (and basic) theoretical background for any other type of knowledge in zones B and C when the latter knowledge is easily comprehended and acquired on the basic of cornerstone knowledge of zone A due to its universal and system-forming character.

We have to pay attention to the statement, that the development of the human personality as the main goal of the educational process presupposes that this process will be holistic, integrating the achievements of both the humanities and the exact sciences, since the formation of the personality as a holistic entity needs, firstly, the use of the achievements of both types of sciences, and, secondly, the establishment of broad interdisciplinary connections, which is manifested both in synergetics (an interdisciplinary scientific direction [17]) and in some educational technologies, for example, in STEM-education.

3. Research objectives

Accordingly, the purpose of the article is to find ways to solve the mentioned problems in the context of such aspects as a fundamental approach to education, integration of knowledge in the educational sphere (revealed so called integral education, integrative learning, describing a tendency toward integrated lessons helping students make connections across curricula), the use of an interdisciplinary approach, interdisciplinary connections in the educational domain, and a general systems theory enabling to build the basic concepts (models, frames) of integral education involving, on the one hand, all aspects of human personality (physical, emotional, cognitive, social, cultural, and spiritual), and, on the other,—presupposing applying an interdicsiplinary integration of many major areas of science and philosophy.

4. Materials and methods

In order to develop the main concepts (models, theoretical objects) of fundamental/integral education within the interdisciplinary approach, in addition to the theoretical analysis of the problematic field of the study, the general systems theory developed by Yuri Urmantsev [18], as well as a modified version of this theory developed by the author of the article have been used. The universal development paradigm developed by the author has been used, as well as the research has been based on the concept of frames, which has many theoretical and practical projections in many areas of knowledge. The research is also based on the synergetic approach being an interdisciplinary scientific tool, with the help of which the researchers seek to build "conceptual bridges" between many scientific areas. As a result, the article proposes some fundamental explanatory models/principles of reality related to zone A of **Figure 1**.

5. Results

5.1. The principle of fundamentalization of knowledge

As we have noted, in the modern educational sphere, students study/master about 1% of knowledge of zone A (being the knowledge about the most general scientific laws and principles), as well as about 10% of knowledge of zone B, which we define as fundamental knowledge, which in the context of its unification being realized due to interdisciplinary research acquires the character of integrative, systemic knowledge. The fundamental knowledge can be considered as a "universal, intellectual power that allows one to dive easily into new activities, to adopt and acquire another profession" [19,20].

In this regard, we can talk about a fundamentalization approach to education implementing the fundamental, integrative, systemic knowledge. This approach is not exhausted by the use in the educational process of the so-called fundamental disciplines [21] (such as mathematics, physics, philosophy, biology, chemistry, computer science, which interconnect and inform, enrich each other, creating a comprehensive framework for understanding the world and advancing knowledge across various fields [22]), and it has nothing to do with the consideration of fundamental education as basic education [23].

In this regard, we can talk also about the concept of integration and the integrative approach in the educational domain. This approach has its historical background.

As Y.A. Komensky (Czech theologian, thinker, teacher and writer) wrote, that the world is actualized as a whole, where everything is in mutual connection. Thus, knowledge about the world may be taught in this mutual connection, and for the formation in the students the whole system of knowledge, it is important to establish the scientific and life ties between basic educational subjects. All the more so because, as Y.A. Komensky put it, "all branches of knowledge grows from one root—the surrounding reality, revealing connections between them, and therefore must be studied in connections".

J.-J. Rousseau (a Genevan philosopher, writer and pedagogue) was looking for ways to bring together the mass of lessons scattered in many books, to reduce them to one common goal that would be easy to see and interesting to follow. And J. F. Herbart (a German philosopher and pedagogue) substantiated the psychological aspect of the relationship of different domains of knowledge, on the basis of which he came to the conclusion that under the condition of teaching the connected material, the students acquire skills faster and more fully than during isolated study of the subjects.

The analysis of scientific literature of Ukrainian educational space enables to conclude that the concept of integration and the integrative approach are based on the following theoretical and methodological foundations/prerequisites:

- Interdisciplinary principle of mutual complementarity of the natural scientific methodical tradition and humanitarian ways of cognition.
- Synergistic approach: The commonality of regularities and principles of self-organization of various macrosystems—physical, chemical, biological, technical, economic, social ones.
- System approach as a focus on systematic generalization of knowledge.
- Gnoseological approach: Integration is understood as a method and process of forming a multidimensional polyphonic picture of the world, based on the combination of different (and polar) ways and forms of understanding reality—theoretical-rational (scientific) and religious-irrational (religious-mythological).
- Hermeneutic approach: Integration is understood as a principle that manifests itself in the transformation of all components of the educational system in the direction of unification, generalization, development of integration educational programs, training courses, etc.
- Activity approach: Integration is understood as a means that provides a holistic knowledge of the world and a person's ability to think in a systemic way while solving practical problems; creation of conditions for students to develop a multidimensional picture of the world and self-cognition in this world.
- Informational approach: Integration is understood as a combination of channels of informational interaction of the learners with the world in its integrity and diversity, actualization of natural possibilities of multidimensional perception of reality.

The objects of integration in the educational process can be the types of knowledge, systems of scientific concepts, laws, theories, ideas, models of objective processes.

At the same time, the problems of an integrative approach in Ukrainian education are investigated in modern pedagogical theory and practice in some directions, which, in a certain way, correspond to the conceptual aspects of STEM-education and strive to build a global, holistic, integrative education:

- methodological problems of integration;
- use of an integrative-differentiated approach to structuring the content of knowledge and education, reduction of multi-subjects, consolidation of educational branches;
- generalization of the content of educational subjects (the concept of intra-subject integration);

- formation of the knowledge system by integrative methods;
- integration of different technologies, methods, techniques within the same space-time coordinates (the concept of synthesis of didactic systems);
- consolidation of didactic units;
- interrelationship of integration and differentiation;
- structuring the integrated knowledge and integrity of the content of natural science education;
- development of integrated courses, integration of educational subjects (for example, physics + chemistry; chemistry + biology, etc.);
- integration of control elements in professional training;
- integration of technical and humanitarian knowledge;
- environmental education based on interdisciplinary research.

Regarding the psychological effect of using an integrative approach in the educational process, one should understand that integrative knowledge is not only easier to learn, but also much easier for students to apply in new life and educational situations (the case method), since the integrative approach prepares students to go beyond ordinary life circumstances thus revealing the creative potential and self-determination (inner motivation) in the students [24].

At the same time, this integrative knowledge make up generalized structures, which are characterized by a certain philosophical "charge" of paradoxicality and ambiguity, since they act as isomorphic "patterns" for a huge number of categories and concepts. This conclusion is confirmed in the research of O. V. Tretyak, the Head of the Institute of High Technologies (Kyiv T.G. Shevchenko National University), whose experiments proved that students better acquire educational material constructed from the concepts that have "fuzzy semantic contours", which enable to combine them into coherent semantic conglomerates, to establish logical connections between conceptually distant entities (facts and theoretical objects)—this operation corresponds to a creative (vague, dialectical, multi-meaning, metaphorical, multi-dimensional, non-linear, paradoxical) way of person's cognizing and mastering the world. This, in turn, actualizes the development of a system of integrative, synthetic, fundamental knowledge in the field of education, particularly in the field of professional training.

In this regard, the generalized cognitive structures express the principle of simplification in systems analysis, which, as W. Ashby believed, should be based on the method of simplification and, in essence, become a science of simplification; and the systems theorist should become an expert in simplification [25].

Thus, the integrative approach presupposes the development students' ability to comprehensively apply knowledge, reaching its synthesis, when the transfer of ideas and methods from one science to another can serve as the basis of a creative approach to scientific, engineering, and artistic human activity in modern conditions of scientific and technological progress.

The usage of integrative approach creates favorable conditions for unfolding the process of actualization of fundamental type knowledge and its implementation in the educational domain, where the fundamental type of scientific knowledge are not limited to scientific-rational knowledge—it also involves scientific intuition. At the same time, the fundamental type of scientific knowledge, revealing its

integrativeness and universality, non-classical, holistic, problematic nature, can help forming in the students the ability to the perception of the world as a whole.

In this regard, we can talk about certain features of fundamentalization of educational activity:

- it leads to a creation of an education system aimed at the development of invariant, methodologically important, long-lasting knowledge;
- it presupposes the transition from discrete of continuous (lifelong) education;
- it gives orientation towards the mastering of deep, essential connections, being the components of a holistic scientific picture of the world, as well as the ontological and epistemological unity of methodology and cognitive activity;
- it provides an access to systemic, holistic knowledge and self-knowledge, development and self-development;
- it organizes interconnection and mutual enrichment of humanitarian, cultural, general scientific and special disciplines;
- it ensures creative self-realization and intellectual growth of the student's personality;
- it creates favorable conditions for the development in the students such qualities, as scientific style of thinking, creative activity and communication, the need for continuous self-education and self-development, general and professional culture, the ability to overcome adaptation barriers when there are changes in professional functions.

The principle of fundamentalization of knowledge is implemented in the plane of interdisciplinary synthesis [26], enabling to unify the terminological apparatus of scientific areas of research, thus reaching the level of synthesis of the universal knowledge. For example, we can present the correlations of the terms of pedagogical integration and differentiation, which allows one to find a lot in common between these terms and concepts that are used in various sciences and can be systematized in a certain list:

- synthesis—analysis (philosophy, mathematics, psychology);
- generalization—personification (logic, psychology);
- abstraction—concretization (philosophy, logic, psychology);
- conjunction—disjunction (logic);
- assimilation—dissimilation (biology, biochemistry);
- combination—splitting (physics, chemistry);
- centripetal force—centrifugal force (physics);
- attraction—repulsion (physics);
- convergence—divergence (sociology, political science);
- interiorization—exteriorization (philosophy, psychology) [27].

Let us consider developed by the author several fundamental explanatory models/concepts of reality relating to sector A (**Figure 1**) [28–30].

5.2. The concept of functional asymmetry of the hemispheres of the human brain

One of the explanatory models of reality is associated with the concept of functional asymmetry of the hemispheres of the human brain [31–34]. This concept

reveals certain features/algorithms of perception and mastering of the world by the participants in the educational process in the context of hemispheres functioning. These features are to be taken into account by the world pedagogical community in the process of forming effective strategies for the students educational activities in the educational process in the institutions of various types.

Thanks to the analysis of the mentioned concept, it can be stated that the hemispheres function both in a differentiated and synthetic (holistic) modes. If the synthetic mode of functioning the hemispheres involves a unification of their psychophysical strategies for perceiving the world, then the differentiated mode reveals a certain dichotomy of the functioning of the hemispheres in the context of psychic processes.

Summarizing hemispheric functional peculiarities with a sufficient degree of simplification allows us to state that the continuous aspect of reality (continuous forms of objects, warm color gamut, melodic aspect of sound information, figurative-concrete, non-contrast aspect of visual information, emotional aspect of human interactions, etc.) is perceived by the right hemisphere; and the discrete aspect of reality (discrete forms of objects, cold color gamut, rhythm aspect of sound information, sign-symbolic, contrasting aspect of visual information, abstract-logical aspect of human interaction, etc.) is perceived by the the left hemisphere. It is interesting that visual objects located in the right field of vision are perceived by the left hemisphere, and in the left field of vision—by the right hemisphere (that is, here we have a crossed visual model of perception of the world by the hemispheres), the same can be applied to the perception of perspective—direct and reverse [31,34,35].

At large, the *right hemisphere* unfolds continuous/field processes of the world, thus revealing an ambiguous polysemantic, artistic, metaphoric context of world view that help building the sacral and religious aura of life. Just the opposite, the *left hemisphere* unfolds discrete/substance, multiple processes of the Universe, thus revealing strictly one-semantic, unambiguous, abstract, discursive and theoretical world understanding, building the rational and technocratic reality [36].

So, the hemispheric asymmetry expresses the general asymmetry of space and time in our Universe (refer to "*Gibson's law of right-side stimulation*") [36,37]).

From the point of view of the mentioned concept, it is possible to propose the following algorithm for providing educational material. On the one hand, the students are offered verbal information that explains certain educational objects on a verbal level, and on the other hand, this same information is presented in the form of a graphic images.

The information presented to students can be differentially located in the right (verbal) and left (image) visual fields, which corresponds to the hemispheric strategies of information processing and contributes to the synergistic effect of convergence of the hemispheric functions of the brain.

On this basis, it is possible to formulate algorithms for both effective (harmonious) pedagogical action and the creation of harmonious (genius) works of arts—visual, auditory, combined ones.

Let us consider these algorithms.

(1) "Blending/extinguishing" algorithm: In order for a creation of art to have a meditative-spiritual effect on a person, i.e. to simultaneously affect both hemispheres

of the brain, synchronizing their work, it is necessary to combine left- and right-hemispheric information so that the two hemispheric strategies compensate each other (as evidenced by encephalographic studies, the hemispheres are functionally synchronized in a meditative and creativity state [38,39]). The specified process implements a fundamental property of the human psyche—diplasty (a psychological and psychophysiological phenomenon of integration of two elements that exclude each other), which activates biassociation—a synergistic mechanism of human creative activity, since contrary to associative connection of concepts, which appear under the influence of deeply rooted schemes of experience (that is, based on the reiteration of concepts arising in time and space and being associated with similarity, contiguity or contrast), the biassociations appear as a result of combining ideas that do not have an obvious commonality and connection between them, when these biassociations are objectively new and sometimes seem unnatural, chaotic, paradoxical, contradictory and hence—creative.

It is possible to realize two variants of extinguishing effect:

1) Simultaneous influence on a person by right- and left-hemispheric information that level out and extinguishes each other.
2) The influence by the right hemispheric information on the left hemisphere and vice versa, when, for example, visual information located in the left field of vision (perceived by the right hemisphere) is placed in the right field of vision, which corresponds to the spatial perception of the left hemisphere.

(2) Harmonizing algorithm: In order for a creation of art, as well as educational information, to exert a harmonizing influence on a person (affecting both hemispheres of the brain simultaneously and thus harmonizing their functions), it is necessary to combine left- and right-hemispheric information in such a way that the two hemispheric strategies form a harmonious proportion (which in mathematical expression is realized through the "*golden ratio*") when the information that is intended to the right and left hemispheres must be correlated in harmonic proportion. Examples of incompatible combinations: 1) a courageous woman or a feminine man are depicted; 2) cold and warm colors; 3) continuous and discrete visual forms and motions are harmoniously combined; 4) melody and rhythm are harmoniously integrated; 5) conveying in the picture as well as in the sphere of educational materials, two slices of reality at once—in the past and in the future; 6) conveying the statics and dynamics at the same time; 7) a combination of direct and reverse visual perspective, etc.

5.3. The second fundamental explanatory model is related to the origin of the world

According to the non-classical scientific theories the world emerges due to division (splitting) of the physical vacuum (nil, ether) into the opposite parts/aspects: "plus" and "minus". The cosmological science interprets this process in the same way, when it views the genesis of the Universe as a result of "blast" from the fundamental vacuum symmetry (singular state of the substance, etc.) by means of its splitting into substance and field. As G. Naan writes, the birth of the Universe is a process of polarization of "Nothingness" into "Something" and "Anti-Something"

(being surplus and insufficient entities), that brings about the emergence of all known physical phenomena and scientific laws [40]. Eventually these polar entities are brought to mutual annihilation thus revealing physical vacuum (**Figure 2**).

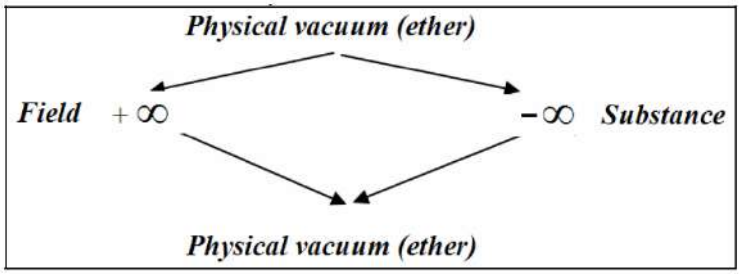

Figure 2. The process of world's genesis: Scientific approach.

The religious and mythological approach expresses the idea, that our world has been created by God from "nothingness" by means of its splitting (in the process of so called dichotomized dualization) into light and darkness (positive and negative aspects of reality) (**Figure 3**).

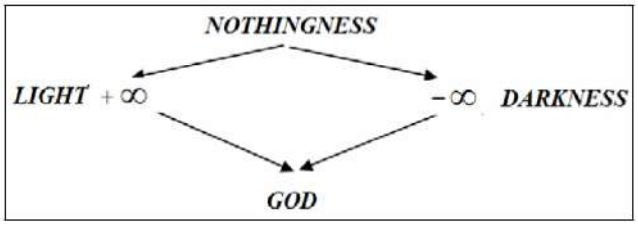

Figure 3. The process of world's creation: Religious approach.

The presented model of world's genesis plus the concept of functional asymmetry of the cerebral hemispheres enable to compose a correlation table of some important aspects of reality (**Table 1**).

Table 1. Correlation table of some aspects of reality.

Cerebral hemispheres		
Left hemisphere	Hemispheric synthesis	Right hemisphere
Elements of the triadic model of reality		
External	Border	Internal
Plural	Whole	One
Future tense	Present tense	Past tense
Chronos (linear time)	Kairos (explosive time)	Cyclos (cyclical time)
Parameters of an elementary particle		
Mass	Spin	Charge
Main types of matter		
Time	Space	Motion
Fundamental forms of matter		
Substance (information)	Physical vacuum	Field (energy)
Fundamental properties of reality, according to Yu. Urmantsev		
Quality	Relationship	Quantity

Table 1. (*Continued*).

Factors of natural evolution according to Charles Darwin		
Inheritance	Natural selection/struggle for existence	Variability
Properties of the nervous system		
Strength	Balance	Mobility
Human information processing strategies		
Induction/deduction	Insight	Traduction (transduction)
Strategies for mastering reality in society		
Praxeology	Epistemology	Axiology
Mathematical and physical parameters		
Time	Distance	Speed
Resistance	Voltage	Current
Cognition of the world in the context of associative perception		
Associations by contrast	Associations by contiguity	Associations by similarity

5.4. The explanatory model, bases on the general systems theory

Let us dwell on the third explanatory model, related to general systems theory. Due to the integral character of the Universe, the existence of the latter is regulated by some fundamental/universal laws/principles, which in the context of Yuri Urmantsev's general systems theory are revealed in the "law of system rearrangements", being a system universal that presupposes seven possible fundamental types of systems, when any systemic entity can be transformed/rebuilt in seven ways: By changing relationship, quantity and quality being designated as: A (relationship), B (quantity), C (quality). Due to them we have seven basic combinations: A, B, C, AB, AC, BC, ABC representing several basic types of systems (**Figure 4**) [18,41].

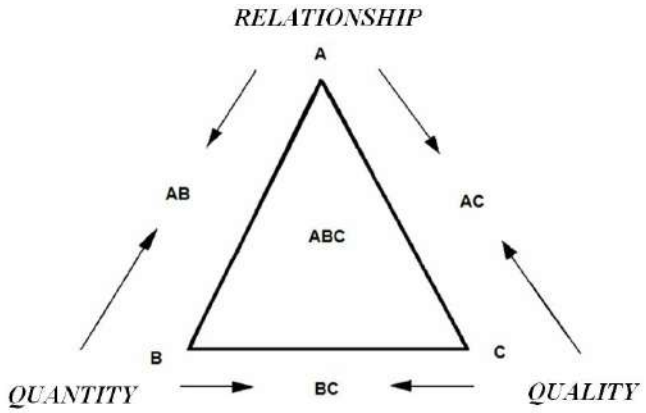

Figure 4. The representation of reality according to the general systems theory.

Color representation of the systemic organization of reality serves as a visual demonstration and definite proof of the basic model of the general systems theory (**Figure 5**).

Figure 5. Color interpretation of the systemic organization of reality.

If the elements of the model "relationship", "quantity" and "quality" are understood as fundamental categories of human cognition, then in the structure of the systemic triangle these categories determine additional fundamental categories—"measure", "sign" and "interaction". So, we have the main logical-ontological categories (universals) of reality (**Figure 6**).

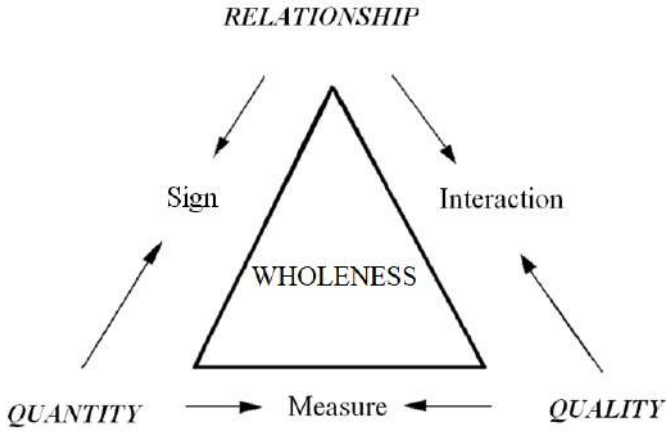

Figure 6. A fundamental model of reality, demonstrating the coordination of its major logical and ontological categories/universals.

As it is known, "measure" is a philosophical category expressing an integral and organic unity of quantitative and qualitative certainty of an object/phenomenon; accordingly, in the systemic triangle, the category of measure is actualized in the focus of the correlation of quality and quantity. In the context of types and forms of the matter, "measure" being indifferent to specific physical characteristics can be put in correlation with "space", being also an "indifferent entity" that can be understood as an extension, a certain container where the objects of reality are located and the events of our world take place.

The correlation/connection of "quantity" and "relationship" enable to appear the concept of "sign" being the category that captures the formal-logical relationships of abstract quantitative values, giving us an idea of quantitative gradation/dichotomy of different values (such as "more—less", etc.), and revealing the process of changing the parameters of the elements of this gradation. And this forms an idea of a sign and of quantitative changes, which, in turn, forms a conception of "time" being the formal and logical scale of quantitative changes taking place in the objects and

phenomena of reality (a short moment → a second → a minute → an hour → a day → a week → a month → a year → a century → a millennium → an eternity).

The correlation of "quality" and "relationship" gives us the idea of "interaction" actualized as a result of the qualitative heterogeneity of our world. Thus we have the relationship of qualitative values that form the idea of a qualitative gradation of values (such as "better—worse", "strong—weak", vlarge—small", etc.), as well as the idea of changing parameters of the objects on the scale of this gradation forming the concept of "motion/interaction" that lead to qualitative changes of the objects.

At the same time, the category "relationship" in the systemic triangle correlates with such form of the matter as the physical vacuum expressing according to its nature a relationship in its pure, real form, because the physical vacuum can be understood as an environment of the relations of virtual particles, being the material basis of the Universe.

The "quantity" in the systemic triangle correlates with such form of the matter as "substance", which due to its discrete/structural composition reveals discrete (numerical) characteristics.

The "quality" in the systemic triangle correlates with such form of the matter as "field", being realized as a qualitative entity in the process of interaction of material objects (**Figure 7**).

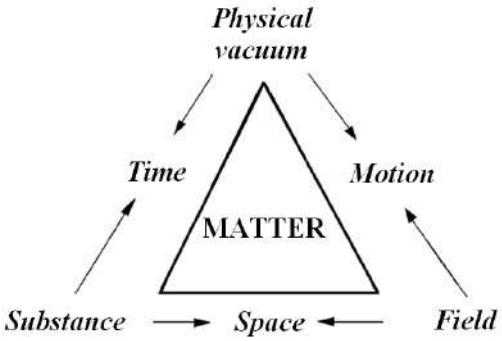

Figure 7. The composition of the matter.

The world exists, as the materialistic philosophy states, according to the four philosophical principles (1. general connection of objects and phenomena of our world; 2. unity, integrity of the world; 3. generality of motion and development); 4. system and structural organization of the world), and the three laws of dialectics (1. interpenetration of the opposites; 2. negation of the negation; 3. transformation of quantity into quality).

These determine the major tools of conceptual thinking: the diplasty (being the ability of a person to unite opposite psychological states and polar logical contents of the notions), the analysis (being the ability of a person to differentiate the constituent parts or features of objects and phenomena), the synthesis (being the ability of a person to create the combination of components or elements to form a connected whole), the comparison (being the ability of a person to compare the phenomena or events with each other), the abstraction (being the ability of a person to isolate the major features and to operate them outside the specific situation), the generalization (being the ability of a person to bring to reduction of various concepts into a single

category), the systematization (being the ability of a person to bring to reduction of some categories into a logical system).

For us it is very important to place in a systemic sphere the peculiarities of the development of human intellect. J. Piaget understands the intellect as a system of logical operations being the realization of mental actions, possessing the property of reversibility, due to which the main properties of the objects are preserved. J. Piaget defines the process of intellect development in the form of different groups being similar to mathematical groups. The grouping is understood by J. Piaget as a closed and reversible system being a logical/axiomatic model that the scholar can use to interpret certain facts. All operations in the grouping are organized according to certain criteria [42]:

1) Combinability/transitivity [A + B = C]: boy and girl = children.
2) Reversibility [C − B = A]: 3 + 2 = 5, but 5 − 2 = 3.
3) Associativity: [(A + B) + C = A + (B + C)]: (1 + 2) + (3 + 4) = (3 + 1) + (4 + 2).
4) Identity [A − A = 0]: 3 − 3 = 0.
5) Tautology [A + A = A]: A > B, A > B = A > B.

   Further we have two more additional criteria.
6) Reflexivity expresses a person's ability to correlate the logical actions with himself/herself.
7) Universality of thinking tends to exhaustive coverage of all logical/mental cases both in the sphere of actual and potential reality.

   The analyzed entities can be put into systemic correlation (**Table 2**).

Table 2. Systemic correlation of important entities of philosophy and natural science.

Forms and types of matter	Logical and ontological universals	Principles and laws of dialectics	Criteria of cognitive operations	Conceptual thinking tools
Physical vacuum	Relationship	Interpenetration of opposites	Identity (inversion)	Diplasty
Substance	Quantity	Structural organization of the world	Reversibility	Analysis
Field	Quality	Generality of movement	Tautology	Synthesis
Motion	Interaction	Transformation of quantity into quality	Associativity	Comparison
Time	Sign	Negation of the negation	Reflexivity	Abstraction
Space	Measure	Integrity and unity of the world	Combinability (transitivity, composition)	Systematization
Matter	Wholeness	General ties/connection of objects and phenomena	Universality	Generalization

5.5. Some other generalizations in the context of general systems theory

Let us consider developed by the author some other generalizations in the context of general systems theory (**Figure 8**).

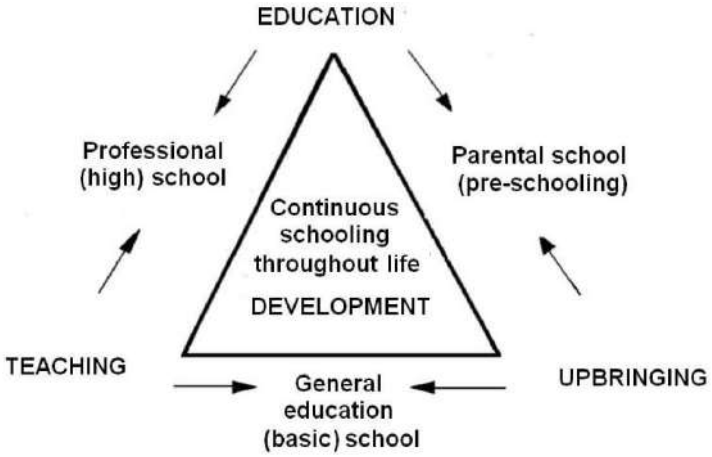

Figure 8. Systemic model of the school as a social institution.

As we can see, here we differentiate such concepts as education, teaching, upbringing. In the pedagogical literature of English-speaking countries, the concept of "upbringing" is practically not used being included in a more general concept—education [43].

Let us consider the systemic model of pedagogical space (**Figure 9**).

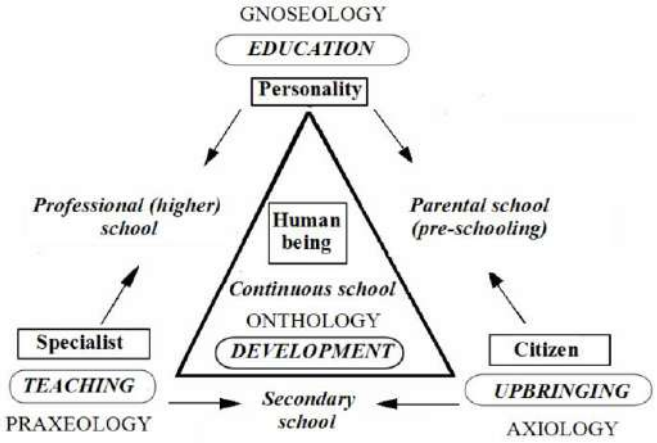

Figure 9. The systemic model of pedagogical space.

The systemic principle can be applied to the model of a personality being the subject of psychology (**Figure 10**).

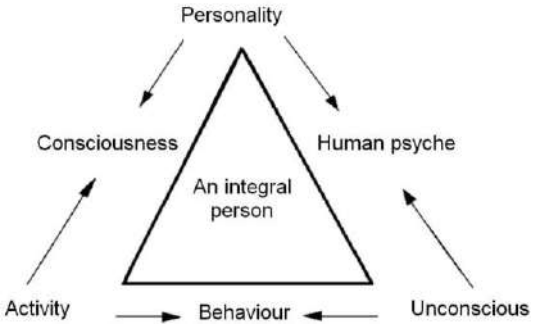

Figure 10. Systemic model of a personality being the subject of psychology (source: Author's research).

The above mentioned systemic model of a personality can be put into correlation with the structure of the personality developed by a Ukrainian scientist H.S. Kostyuk [44] (**Figure 11**).

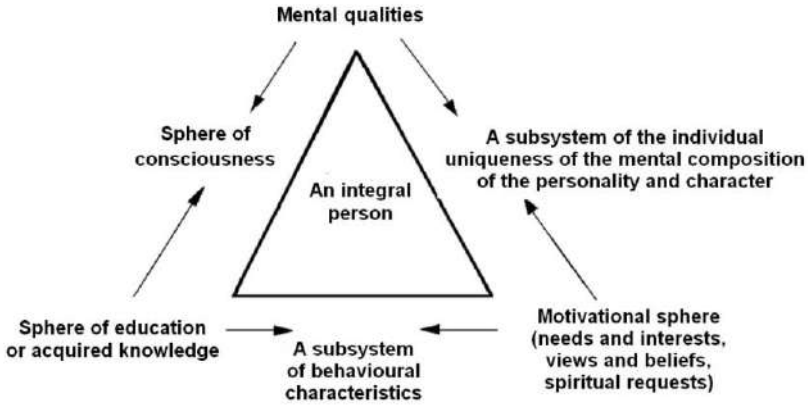

Figure 11. Systemic model of the personality (source: Author's research).

It should be noted that the presented systemic view of reality can be deepened thanks to fractal modeling (a fractal is an object in which the parts are somehow similar to the whole, that is, separate constituent parts are self-similar), which can be illustrated by the fractal triangle of V.F. Serpinsky, revealing the fundamental geometric principle of the fractal structure of the universe (**Figure 12**).

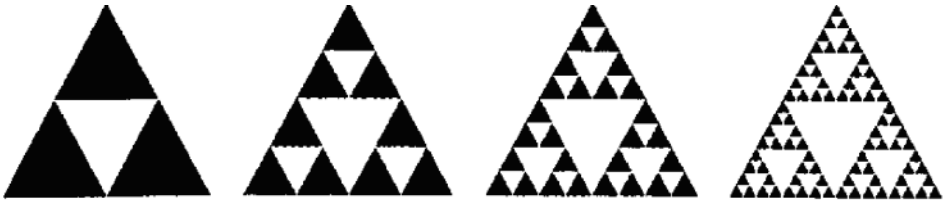

Figure 12. V.F. Serpinsky's fractal triangle.

On this basis, it is possible to analyze the competencies of a modern teacher, which can be represented in the form of three spheres, which reflect three aspects of a person being the subject of 1) communication; 2) cognition; and 3) work (B. Ananiev), when the person is realized in the system of relations 1) with society and other people; 2) to oneself; 3) to work (V. Myasishchev): 1) the competencies relating to the person as a personality, as a subject of life activity; 2) the competencies related to human interaction with other people; 3) the competences related to human activity, manifested in all its types and forms.

Thus, we can talk about the classification of competencies according to three principles: 1) subject-personality; 2) subject-subject interaction; 3) activity.

Therefore, universal aspects of a specialist as such find a place in the systemic model of the competencies of an educator (**Figure 13**).

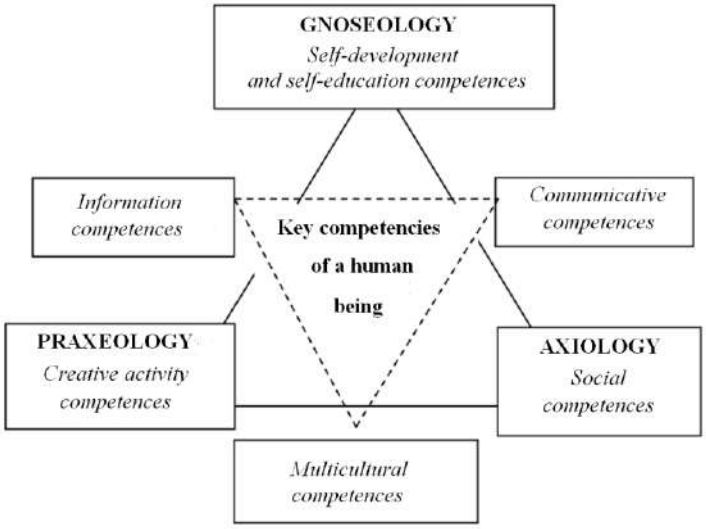

Figure 13. Systemic presentation of the competencies of a universal specialist.

5.6. The explanatory model associated with the universal development paradigm

Let us consider the fourth explanatory model associated with the universal development paradigm [29,45].

One of the most important discoveries of modern science is related to the understanding of the world as an integral whole. One of the consequences of such an understanding lies in the plane of the fractal/holographic nature of the Being, which reveals the triadic principle of the space-time (structural-procession) organization of the Universe as a scientific universal and the principle of self-similarity, which is embodied both at the level of any integrity (system) and at levels of its elements. As it is known, a fractal is an object in which the parts are similar to the whole in a certain way revealing the phenomenon of self-similarity. An example of such a self-similarity may be a triadic tree-like branching: While each branch and each successively decreasing branch is different, they are qualitatively similar in structure to the whole tree; such an object has a fractal dimension (**Figure 14**).

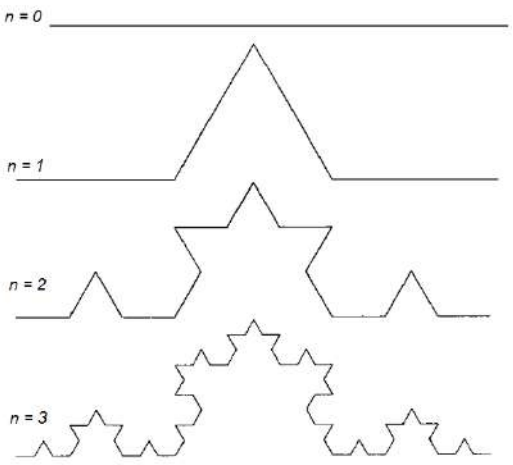

Figure 14. Construction of the triad curve (which was first investigated by Helge von Koch in 1904).

The constructed curve has no length, as its length tends to infinity as the number of generations increases. In addition, it is impossible to construct a tangent to this curve, since each of its points is an inflection point (a specific point or singularity) in which the derivative does not exist. Traditional methods of geometric analysis seem to be unsuitable for Koch's triadic curve.

The triad curve provides the basis for Hegel's principle of development (**Figure 15**).

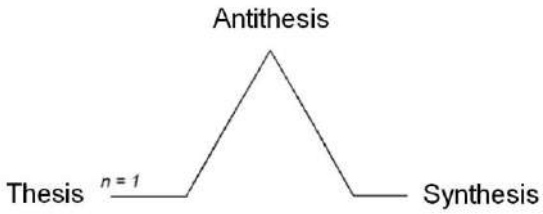

Figure 15. The interpolation of the fractal triad curve on the triad scheme of Hegel's mechanism of development.

The three universal stages can be explained by the dialectical philosophy of Hegel, who divides any concept (and, accordingly, the phenomenon behind this concept) into three moments, each of which is also divided into three (and so on). Schematically, the movement in the triad is possible as follows (**Figure 16**).

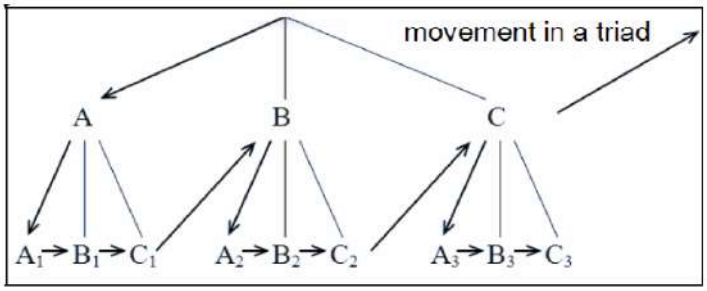

Figure 16. Hegel's triad: Implementation of the triadic principle of development.

Thus, the development of the triad of the first concept from A to C and then the transition to the next level is carried out through three subsequent triads formed by moments/points A, B and C, fixed as independent concepts. But this means that somehow the third moment of the first member of the triad (C1) turns out to be practically identical to the second member (B), and the third moment of the second member (C2)—to the third member (C). This scheme of the development of dialectical contradiction, which captures the reiterated (cyclical) change of two opposite states—integrity and discreteness (reflected in the categories of the single and the multiple), —is universal.

At the same time, the universal developmental model reveals "the law of threes", or the law of the distribution of random variables, according to which the distribution of events does not depend on the nature of the random series itself. This law fixes the invariant distribution on the numerical continuum: If one take a table of random numbers and examine it more closely, one can see that the random numbers are located not at random: If you divide the numerical series into three digits, you

can see that the average digit is generally larger than the two adjacent ones. Therefore, Ivan Aivazovsky's picture "*The Ninth Wave*" turns out to be factually correct, since it is the ninth wave that is the highest, which is explained by the effect of the aforementioned digital series. This conclusion is confirmed by the research of S. E. Shnoll, who for several decades carried out measurements of processes of various biochemical and physical nature, investigating oscillatory processes in biological systems, the aspects of the theory of evolution, cosmophysical correlations in biological and physico-chemical processes. These studies proved the high probability of the similarity of oscillatory regimes of physical and chemical processes [46].

The mechanism of periodization/repeatability of the phenomena of nature and the cosmos was revealed, and a large number of experiments (measurements) proved that there is a synchronicity of events and processes of a completely different nature in the world, which is explained by the fundamental scheme of fluctuations, which have a "subtle structure", when, in Plato's words, each phenomenon in nature, that is, each idea-form has its own lifetime. It is shown that this synchronicity depends on certain cosmological factors. Here we can refer to the phenomenon of synchronicity revealed by Wolfgang Pauli and Carl Jung who understood the synchronicity as the coming together of inner and outer events being meaningful to the observer/participant in a way that cannot be explained by cause and effect connections [47–49].

As we can see, the logic and philosophical substantiation of the triadic structural-dynamic principle of world's organization, according to Hegel, shows that any developmental process is connected with the mentioned triad (thesis → antithesis → synthesis being the so-called universal model/paradigm of development), expressing an elementary nature, which means fundamentality. This can also be illustrated by the S-shaped law of development discovered by a Belgian mathematician Pierre Verhulst (who introduced the logistic equation, which is a kind of generalization of the equation for exponential growth) due to construction of a model of population growth (K) under the condition of external limitations. The proposed function of two variables is an analytical description of the process of the development of objects of any nature (**Figure 17**).

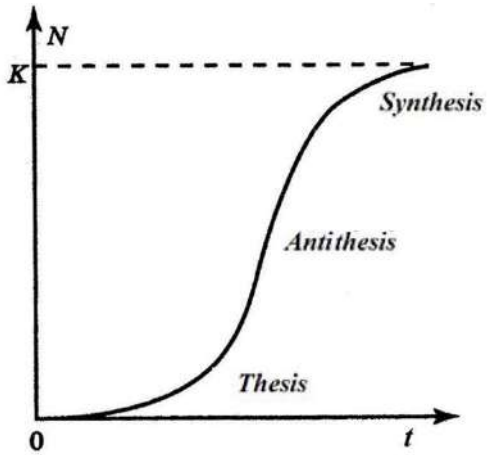

Figure 17. S-shaped law of development.

The triad model of movement appears as a universal model of reality, the fundamental characteristic of which is motion, a change being carried out as an oscillatory-wave process, the analysis of which at the level of the simplest sinusoidal model of the motion as a triad entity allows us to build a "universal language", which, according to Academician L.I. Mandelshtam, enables synthesizing "universal knowledge".

From the point of view of scientific analysis, the change of interacting objects reveals a neutral/boundary phenomenon: Any change is realized in the form of a wave/vibration, and any wave structurally has "zero functions" ("0") being the points equidistant to all "sections" of the wave, since relative to zero all numerical expressions are equally uncertain. At the same time, zero as an expression of a critical physical state expresses a critical (neutral, calm) phase of development, in which all kinds of transformations and changes take place (**Figure 18**).

At the same time, the wave model expresses a universal development paradigm in the context of three methodological levels of the analysis of our reality—the single, the specific and the general.

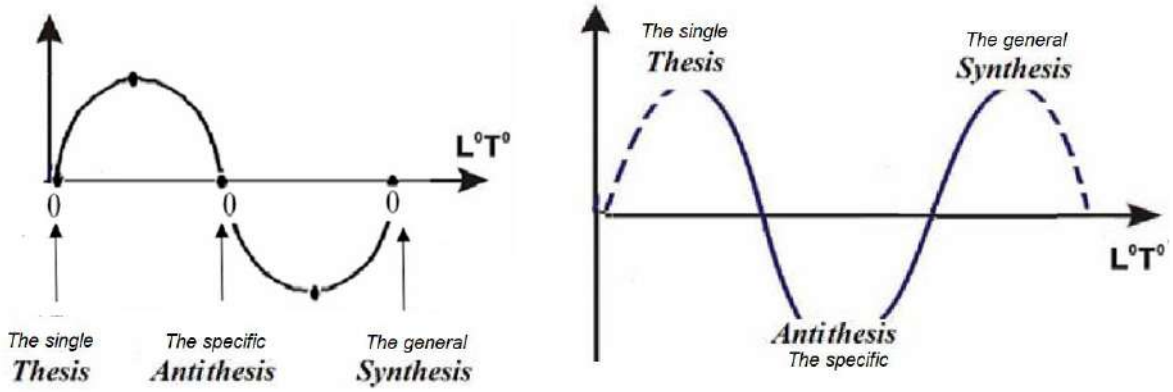

Figure 18. The wave model of reality in the context of the universal paradigm of development and three methodological levels of analysis of reality.

The wave being a generalized form of realization of any movement, development, change, combines the diachronic and synchronic aspects of the world since, on the one hand, a sinusoidal (conical spiral), representing the wave in the most fundamental way, reflects the linear-sequential processes, and, on the other, — it reiterates the same process pattern due to its constant return to the maximum (or minimum) points (**Figure 19**). This embodies the phenomenon of a particle-wave dualism, regulated by N. Bohr's principle of complementarity and expressing the integration of the wave and corpuscular. So, any pair if opposites can be viewed as not polar, but complementary, thus representing oneness.

The structure of the wave correlates with the Hegelian triad developmental model: thesis → antithesis → synthesis.

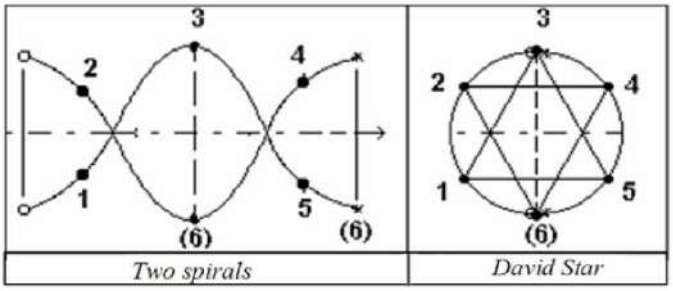

Figure 19. The principle of the identity of the dynamic (two spirals) and structural (the David Star) representation of reality.

So, we can conceptualize the universal model/paradigm of development/motion, the idea of which can be found in the works of many famous thinkers. Aristotle, Kant, Hegel maintained that life's essence should can be revealed in a certain goal, being the cause of any existence and development. Hegel wrote that the end, or result, is in the same way the beginning, with which the motion starts. This creates a situation when the starting and ending points of any process are necessarily bound with each other, like the Northern and Southern poles.

In the context of synergistic knowledge, the development/change of objects can be presented in the form of a synergistic scheme of alternating hierarchical and dehierarchical phases of systems development, when systems pass the neutral/boundary/transformation point of their development (**Figure 20**).

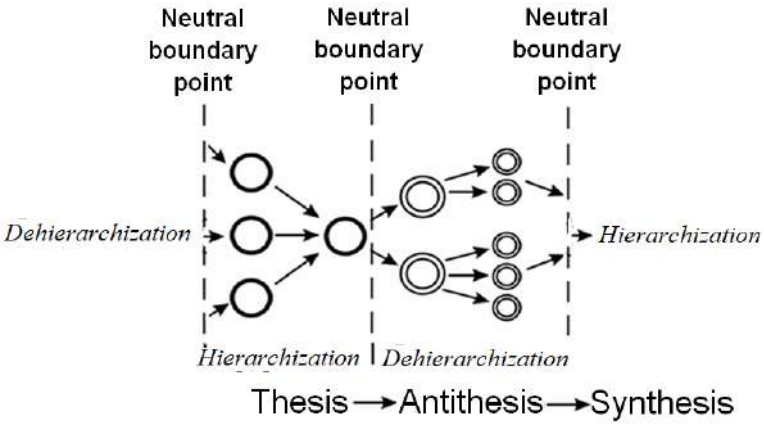

Figure 20. Alternating processes of developing system's hierarchization and dehierarchization: A synergistic "bead game".

The considered models are implemented in the phenomenon of fractal-holographic nesting of various historical cycles of development of various objects and phenomena and their correspondence to methodological levels of analysis of reality (the general, the specific, the single):

The fractal-wave trajectory, due to nested triadic cycles of different dimensions, reveals complex fractal scenarios of cosmo-social-nature dynamics, when one cycle of these dynamics may contain cycles smaller in chrono-vibrational scale, characterized by their own features (**Figures 21** and **22**).

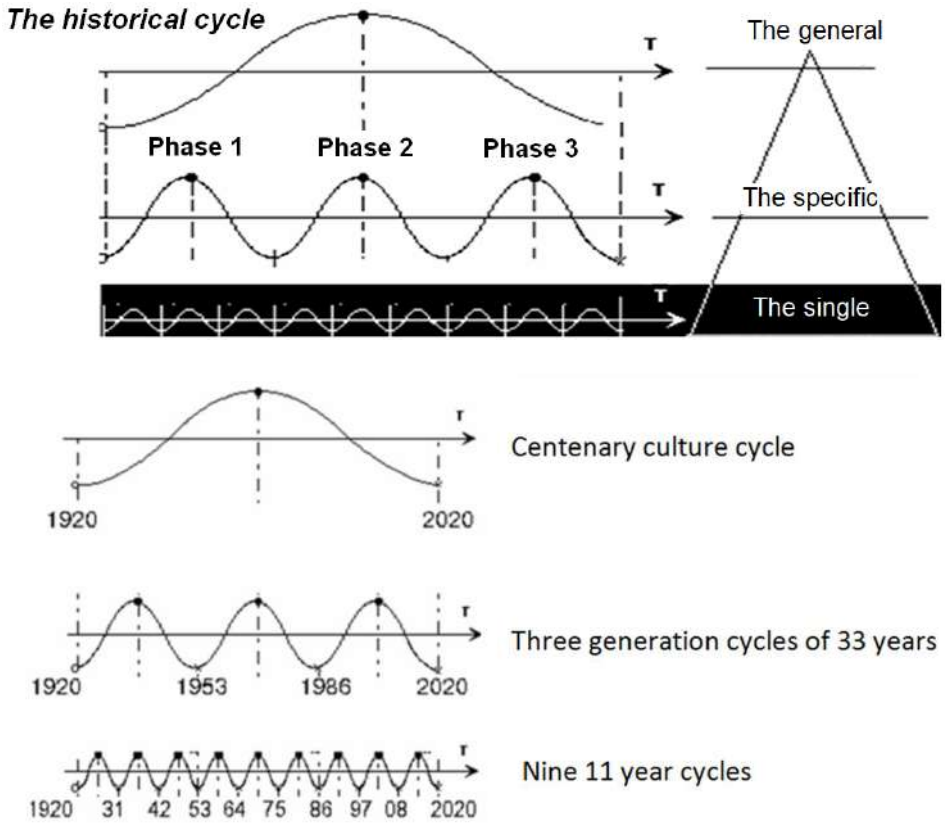

Figure 21. Illustration of the fractal-holographic phenomenon of nesting of different cycles of development.

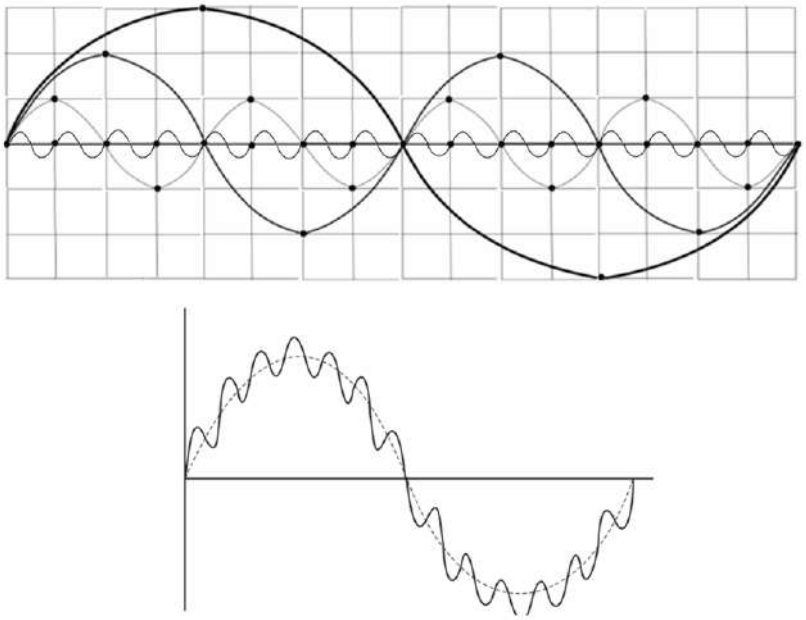

Figure 22. Complex structured fractal-wave models of cosmo-social-nature dynamics.

Let us illustrate the structured fractal-wave models of some authors (**Figure 23**).

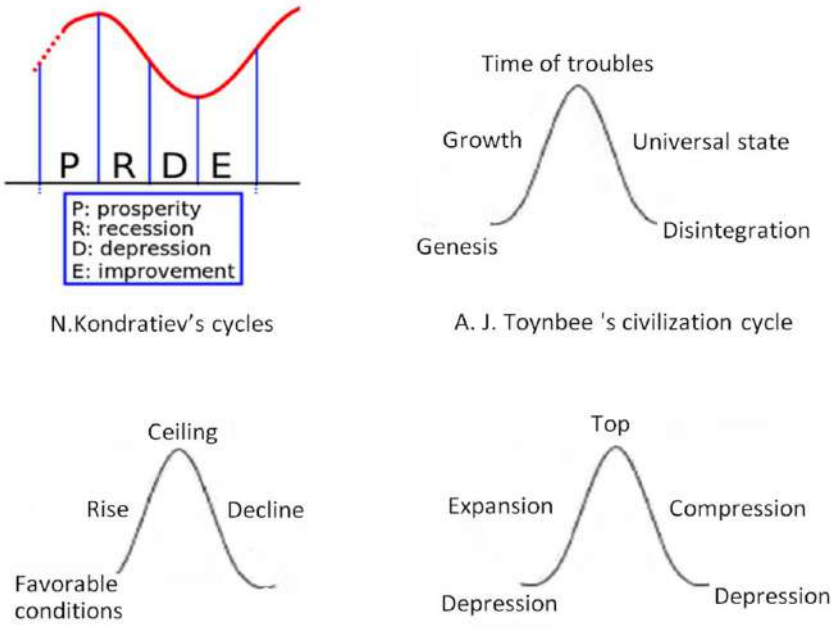

Figure 23. Some renowned cycles of social and economic development.

5.7. The content of the universal developmental paradigm

Let us consider some triad structures expressing the content of the universal developmental paradigm

Aristotelian dialectics

1) Thesis: Energy
2) Antithesis: Possibility
3) Synthesis: Entelechy

Development of logics in the context of the functions of the hemispheres of the human brain

1) Right hemisphere, polysemantic logics
2) Left hemisphere, unambiguous, classical (abstract-logical) logics
3) Hemispheric synthesis, paradoxical (dialectical, polysemantic) logics.

Development of the psychosexual aspect of humanity

1) "Divine androgyne", synthesis of male and female principles. Psychosexual androgynous unity.
2) Stage of sexual dimorphism—the "sexual split".
3) Blurring of psycho-sexual roles, going beyond rigid sexual differentiation, bringing together the male and female sexual scenarios.

Development of the language

1) Undifferentiated (nonlinear) state of the linguistic matter of ancient languages, in which spatio-temporal phenomena are merged.
2) Splitting of the linguistic matter, differentiating of language, as a system of signs, and speech—as a linguistic activity.
3) Restoration of nonlinear forms of writing, actualization of extraverbal suggestive means of communication.

Sociogenesis

1) A holistic symmetrical state of society operating with mythological thinking, equal distribution of social wealth and power (high level of social synergy [50,51]), the unity of leisure and labor, the synthesis of production and consumption.
2) The state of socio-economic stratification, polarization of wealth and power, leisure and labor, production and consumption, decrease in the level of social synergy.
3) Restoration of the state of social symmetry, increase in social synergy, equal/harmonious distribution of power and wealth.

Development of literature as a cultural essence

1) Mythoepic, intuitive literature.
2) Splitting of mythoepic literature into lyrical (right-hemispheric) and dramatic (left-hemispheric).
3) Intuitive literature of the "stream of consciousness".

Development of the sphere of sensations

1) The presence of a single tactile-kinesthetic complex, formed in a child at the level of intrauterine development.
2) The single complex disintegrates into visual and auditory components.
3) Merging of the spheres of sensations, reaching an integral kinesiological level of perception—synesthesia.

Development of spatial-architectural concepts of humanity

1) The mythological state of society is characterized by radial-ring planning. The construction technology was combined with the worldview of people (in particular with their cosmogony), when the moral and the factual are united. Thus, in primitive communities, the architectural structures of mankind, firstly, had radial forms, and, secondly, were integrated into the surrounding natural environment.
2) In the Middle Ages and in Modern times, architectural forms in various modifications expressed straight lines, cubes, parallelepipeds, in the spirit of which, for example, Le Corbusier works. Integral-ring development is replaced by rectangular, discrete-multiple one. In the Renaissance, mankind returns to symmetrical forms. Then there is a reverse movement—to pragmatic-rational asymmetrical forms of development, which are a reflection of the simplified, machine rhythm of life (expressed in the term "design").
3) Nowadays, angular architectural forms are being step-by-step replaced by natural biospheric structures. The idea of "round" cities is taking on new meaning, when humanity is returning to symmetry in the field of architecture.

Development of the concept of space and time

1) The unity of space and time in primitive societies.
2) Its division in the language and culture in modern society.
3) Modern attempts to connect space and time in the context of the ideas of quantum/relativistic physics about the integral complex "space-time".

Development of physical science

1) Synthetic empirical science of the ancients, operating with the integral elements (water, air, fire, wood, metal, etc.).
2) Classical Newtonian analytical physics, operating with discrete, atomic entities.

3) Relativistic and quantum physics, operating with integral, continuous entities, with coming to integral phenomena—physical vacuum, ether of the ancients, torsion fields, etc.

Development of mathematics

1) Development of synthetic (right-brain) mathematics of ancient people (embodied in so called "folk mathematics".
2) Establishment of classical mathematics, operating with abstract discrete values.
3) Development of "fuzzy" mathematics of modern times: From the standpoint of classical mathematics, all provisions of higher "fuzzy" mathematics, which uses operations with continuous, "fuzzy" transfinite quantities, turn out to be, strictly speaking, incorrect. Fuzzy mathematics is capable of carrying out mathematical modeling of nonequilibrium, nonlinear systems, fulfilling the order of synergetics to create generalized mathematical models of the development of systemic formations of nature and society.

Development of psychology

1) At the initial stage of human development, the principle of participation, the psychization of being, connected the subject and the object of psychological (magical) research.
2) Then we can talk about the psychoanalytic stage, where the separation of the subject and object, the fragmentation of a human being, is observed, which we find in Z. Freud, who understood a human being as a conglomerate of "personality instances" being constantly at odds with each other.
3) The era of the development of synthetic psychologies is coming, in the sphere of which the principle of mental and spiritual unity is embodied. Humanistic psychology has shown that the integrity of human being, the presence of subpersonalities (in Gestalt psychology) or "alienated experience" does not carry a fundamental insurmountable contradiction.

Development of forms of person's activity

1) play (the activity not aimed at achieving pragmatic goals and existing for its own sake as a subject-subject phenomenon, like the esthetic principle "art for art's sake")
2) work (purposeful activity aimed at achieving certain pragmatic goals, which reveals a subject-object instrumental character)
3) creativity (subject-subject phenomenon—the activity that has much in common with play, but at a higher level of development, since it has the characteristics of both play (spontaneous, self-determined activity), and work (the activity that reveals a certain practical result).

Development of pedagogy and world education as a social institution

1) Primitive communities. Subject-subject state of integration of teacher and student, "direct" transfer of knowledge through a spontaneous act of mystical initiation or joint activity; value-dominant type of social consciousness, revealing the predominant role of symbols, rites, rituals, initiating forms of education, which was built on bright, long-remembered images, mythologemes, actualizing the emotional-symbolic nature of education.
2) Societies of modern times. Subject-object state of differentiation of teacher and student; the transfer of knowledge by a ratiocratic teacher is mediated by

subject-object relations; cognitively dominant type of social consciousness, characteristic of the Enlightenment era, the culture-defining mythologem is the maxim "knowledge is power" (F. Bacon), when natural sciences, humanitarian and technical disciplines come to the forefront.

3) Information society (knowledge society). Subject-subject state of integration of teacher and student (teacher and student are in an equal position with respect to the Truth), the transfer of knowledge is initiated as the disclosure to students of the very process of knowledge generation; a return to the subject-subject principles of ancient education, the need for nature-consistent education is realized. Noospheric education and new non-traditional forms of education are developing.

6. Conclusions and research prospects

The conducted analysis has elucidated some rather serious problems that contemporary education has faced. The general ways to solving these problems (and many other specific educational problems which have not been mentioned in this article) are reflected in the jubilee report of the Club of Rome, where the formation in young people of "literacy for the future" was proclaimed as major goal for the education. To achieve this goal, as the members of the Club of Rome believe, the educators and all persons concerned should focus on certain educational prerequisites when the educational process

- be based on "connectedness": The relationships have been and will be the essence of learning; the use of information technology is "valuable and effective only when it promotes communication between people"; therefore, education should "arouse interest, release energy and actively use each student's ability to learn for himself and help others learn";
- has a value character, be rooted in universal values and respect for cultural differences; "values are the quintessence of human wisdom that accumulates over the centuries", at the present stage they are embodied in the well-being of all living beings and the world as a whole;
- focuses on sustainability since much of the knowledge about ecology, systems interconnection and sustainable development has emerged recently and has not yet become part of the overall cultural baggage; therefore, the training of new generations in relevant disciplines and the formation of relevant skills is of fundamental importance;
- cultivates integrated thinking, not limited to analytical thinking, when the teaching of systems thinking is insufficient, because "systems thinking tends to consider reality in rather mechanistic categories, unable to capture its organic integrity" whereas integrated thinking is able to "perceive, organize, coordinate and connect individual fragments and achieve a true understanding of fundamental reality"; it differs from systems thinking in the same way as integration differs from aggregation;
- proceeds from the pluralism of content, since many universities implement specific schools of thought, instead of "giving young minds a full range of conflicting and complementary perspectives"; today's students need inclusive

and comprehensive, interdisciplinary education, in which some forms of knowledge should complement others, not exclude and reject them; while cultural diversity is also necessary for social evolution, just as the genetic is necessary for the biological, and the material for the ideal.

Thus, the considerations of the Club of Rome reveal the paradigmatic aspect of education, expressed in the idea of the "new Enlightenment" as a fundamental transformation of thinking, which should result in a holistic worldview—humanistic but free from anthropocentrism, as well as open development, but one that values sustainable development and care for the future [52, 5].

It should be emphasized that the problems of education can be solved by such modern means/ways being mentioned in the article, as 1) continuous (lifelong) education; 2) integral educational technologies and theories, such as STEM-education, frame theory, etc. [53]; 3) a fundamentalization approach in education that allows achieving integration of knowledge through the use of an integrative approach in education, consolidation of didactic units, development of integrated training courses; 4) an interdisciplinary synergetic approach applying interdisciplinary connections in the educational sphere, allowing to build "conceptual bridges" between many scientific fields.

The novelty of our article lies in our proposition to solve the mentioned educational problems through the integrated training courses we are developing, which can be taught to students of all specialties with the aim to mold a holistic worldview in all the participants in educational process. The content of the courses is determined by systemic knowledge that is based on developed by the author modified version of the general systems theory enabling to build the fundamental explanatory models/principles of reality that can serve as a fundamental theoretical background for any type of specialized knowledge being easily comprehended and acquired by students due to its universal background.

At large, the fundamental explanatory models/principles can be considered as philosophical universals the ancient philosophers were eager to found (refer to: Moreland, J.P. (2001). Universals. McGill-Queen's University Press).

Author's universals covering the static and dynamic aspects of reality are based on the concept of functional asymmetry of the hemispheres of the human brain, expressing the most general strategies of perception, cognition and mastering of reality by a human being. Besides the general systems theory, revealing the fractal/hologram nature of reality, the author's universals are associated with the origin of the world (in this we support the ancient thinkers' opinion: "knowing an object means knowing its origin"). Author's universals cover the synergetic paradigm of development, enabling to reveal a universal algorithm of the wave-like unfolding of any process (thesis—antithesis—synthesis), which made it possible to formulate a lot of models of development.

Promising directions of our research are connected with the application of the obtained data in the context of the educational process due to the integrated training courses for students of different types of educational institutions. Our further publications, as we hope, will be devoted to outlining the content of some of these courses.

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