Informing Science:
the International Journal of
an Emerging Transdiscipline

An Official Publication
of the Informing Science Institute
InformingScience.org

Inform.nu

Volume 22, 2019

TRAINING GENERALISTS IN HIGHER EDUCATION: ITS THEORETICAL BASIS AND PROSPECTS

Vladimir Mokiy — Institute of Transdisciplinary Technologies, Nalchik, Russian Federation — vmokiy@yandex.ru

ABSTRACT

Aim/Purpose	Absence of new scientific approaches and specialists (generalists), who professionally obtain such approaches, is one of the main reasons for an ineffective solution of complex multifactor problems of the modern society.
Background	The article briefly describes the concept of systems transdisciplinary integration of knowledge of different scientific disciplines. Also, it shows an opportunity to use this concept education of generalists in higher education.
Methodology	The article highlights the idea of gestalt of knowledge, which is based on systems transdisciplinary model of spatial unit of order. It describes the basis of gestalt-of-the-one and gestalt-of-the-whole. Also, it explains the differences and practical capabilities of holist generalists and unicentrist generalists.
Contribution	Loss of identificational attributes can take place during the process of integration of knowledge of different scientific disciplines. The article shows how to avoid this complication within a systems transdisciplinary approach.
Findings	Each type of fundamental knowledge has its own carriers, such as scientists and specialists. Therefore, direct interaction of people-carriers of fundamental knowledge has limited potential. Presently, a more practical importance is the interaction between scientists and specialists within the zones of hybridization of fundamental knowledge. Hybridization is the process of systematization of knowledge within specialized systems transdisciplinary models of unit of order. A specialist generalist's professional work is to organize scientific research, systemise knowledge of different scientific disciplines, make necessary conclusions, and suggest optimal solution for complex multifactor problems. Therefore, generalists should be considered as an important move towards the solution of complex multifactor problems of modern society.

Accepting Editor Eli Cohen | Received: July 16, 2019 | Revised: August 23, August 26, September 5, 2019 | Accepted: September 8, 2019.
Cite as: Mokiy, V. (2019). Training generalists in higher education: Its theoretical basis and prospects. *Informing Science: the International Journal of an Emerging Transdiscipline, 22,* 55-72. https://doi.org/10.28945/4431

Recommendations for Practitioners	Practitioners are barely interested in the questions of ontology and gnoseology. They are interested in optimal solution of a certain complex multifactor problem. As opined by L. Bertalanffy, one of the founders of general system theory, this solution would be possible if a generalist was present within a working group of disciplinary specialists - practitioners. As a result, practitioners should use their connections and opportunity to initiate education or preparation of generalists in universities.
Recommendations for Researchers	A new scientific approach is a way of widening scientific worldview. A new approach in inorganic chemistry made it possible to create the Mendeleev periodic table of elements. Owing to this table, researchers were able to learn the characteristics and attributes of chemical elements, which can be found in nature. Also, models of systems transdisciplinary approach allow the discovery of new elements and relations of complex multifactor problems. Its absence would, however, hinder the research and the problem description.
Impact on Society	The final document of the Summit of the United Nations with the agenda on development for the time period starting from 2015, *Transforming our world: The 2030 Agenda for Sustainable Development* (2015), contains 17 goals in the field of stable development and 169 tasks. This is the complex multifactor problem. Therefore, preparation of generalists in higher education and their inclusion in the groups of disciplinary specialists on the regional, state, and international level will make it possible to solve this problem optimally. As a result, development of society will be more manageable and stable.
Future Research	The article justifies that preparation of generalists in higher education is one of the main peculiarities of universities of the third generation. Therefore, it might be desirable for organizers of higher education and university leaders to begin speculations regarding this quest, develop educational programs for generalists, and search for optimal forms and methods of solution.

Keywords	transdisciplinarity, synthesis of knowledge, generalists, systems transdisciplinary approach

INTRODUCTION

The solution to complex multifactor problems of the modern society mostly depends on approaches, methods and procedures, which implement integration and generalization of diverse opinions and knowledge. However, integration and generalization does not occur by itself. This paper argues for the formation of unique specialists to fill this need. The need for such specialists was mentioned first seventy years ago. In 1949, the journal Science published the paper called Education of Scientific Generalists. Authors of this paper, the engineer Bode, the sociologist Mosteller, the mathematician Tukey, and the biologist Winsor wrote: "We often hear that 'one man can no longer cover a broad enough field' and that 'there is too much narrow specialization.' ... We need a simpler, more unified approach to scientific problems, we need men who practice science-not a particular science, in a word, we need scientific generalists. Any research group needs a generalist, whether it is an institutional group in a university or a foundation, or an industrial group .... In an engineering group, the generalist would naturally be concerned with system problems. These problems arise whenever parts are made into a balanced whole" (Bode, Mosteller, Tukey, & Winsor, 1949).

Two years later, in 1951, Harvard University Professor K. Mather developed the idea of the need of scientific generalists. He stated: "One of the criticisms of general education is based upon the fact that it may easily degenerate into the mere presentation of information picked up in as many fields

of enquiry as there is time to survey during a semester or a year .... If you were to overhear several senior students talking, you might hear one of them say 'our professors have stuffed us full, but what does it all mean?' ... More important is the search for basic concepts and underlying principles that may be valid throughout the entire body of knowledge" (Mather, 1951).

In 1969, L. Bertalanffy cited the authors of the above-mentioned articles and stated the following: "In contrast, the educational demands of training of 'Scientific Generalists' and of developing interdisciplinary 'basic principles' are precisely those that the general system theory tries to fill. They are not a mere program or a pious wish since, as we have tried to show, such theoretical structure is already in the process of development. In this sense, General system theory seems to be an important headway towards interdisciplinary synthesis and integrated education" (Bertalanffy, 1969).

Today, the training of scientific generalists remains an unrealized idea. The practical implementation of this idea is hampered by the educational environment of modern universities. Some scientists distinguish three generations of universities. The first generation of universities, University 1.0, focused on teaching alone as did medieval universities. Modern universities typically can be viewed as Universities 2.0. These universities are aimed at both teaching and research. Humboldt University of Berlin is considered an example of a second-generation University. These universities are focused on classical approaches of scientific disciplines and interdisciplinary cooperation. The expansion of the scientific worldview in such an environment is achieved, for example, through *the philosophy of systems, the theory of General systems, and the recognition of the transdisciplinarity of science*. At University 3.0, commercialization of knowledge is added to the last two missions. The emergence of higher education in University 3.0 is associated with the development of the multicampus universities in the United States (Lane, 2013).

Solving complex multifactorial problems of society, science, and technology is one of the main tasks of Universities 3.0. Solving these problems will require new ways to expand the scientific worldview. In this case, it is not enough just to integrate existing knowledge. For example, the integration of human knowledge has made it possible to clearly understand how the human body functions. But there are still no clear answers about the need and purpose of man, about the freedom of his will. Likewise, the problem of sustainable development of human society has not been solved, and so on. Therefore, the scientific knowledge of institutions 2.0 should be generalized, and the methods by which this knowledge is obtained should be rethought in institutions 3.0. These actions can be carried out within the framework of *the system philosophy, General system theory, and transdisciplinary science (that is, a systems transdisciplinary approach)*.

Therefore, there is the need for some new structure in higher education to support the teaching of scientific generalists; they are needed to solve the complex multifactor problems of society and answer important questions, such as the following: What is the structure of interdisciplinary interconnection and interaction of opinions and knowledge that should be operated by generalists? Which identification attributes should generalists have to be different from other specialists? How to train generalists in universities?

To answer these questions, it is necessary to make use of the general classification of classical and systemic approaches, information about the nature and classification of knowledge, as well as psychological features of the perception of the world.

THE SCIENTIFIC APPROACHES

Existing scientific approaches to the knowledge of the world can be divided into two main groups. Approaches of the first group provide the formation and development of a scientific worldview. The first group of approaches includes disciplinary approaches of academic scientific disciplines. Approaches of the second group determine the expansion of the horizons of the formed scientific worldview. The second group of approaches includes interdisciplinary approaches. Let us examine these two approaches.

Definitions of the Scientific Approaches

Monodisciplinary Approach. A disciplinary approach has shaped the scientific worldview. The linear logic of disciplinary approaches corresponds to a certain process. In the course of this process, knowledge is successively added to the objects of the research, to a disciplinary image of an object, and then to a local picture of the world. Therefore, disciplinary approaches are designed to perform several basic actions: obtaining the maximum amount of knowledge about the object; highlighting the subjects of the study in the object; and the forming of theoretical principles and techniques of disciplinary research.

The increasing complexity of the disciplinary approach creates the conditions for the emergence of the second approach which acknowledges the interdisciplinary interactions in science. Such interactions are carried out in the framework of interdisciplinary, multidisciplinary, and transdisciplinary approaches.

Interdisciplinary Approach. An interdisciplinary approach is a way to expand the scientific worldview in the direction of enriching the knowledge, methodology, and language of one scientific discipline at the expense of knowledge, methodology, and language of another scientific discipline. The presence of similar subject areas allows the researcher to use the methodology of one discipline to solve the problems of another discipline. The main identification of interdisciplinary approaches is the establishment of subordination between the interacting disciplines. The "leading" discipline shapes the major issues and main tasks of interdisciplinary research. The final results of interdisciplinary research are described in the language of the leading discipline. "Subordinate" discipline submit for interdisciplinary research only its own methodological apparatus (Mokiy & Lukyanova, 2017a).

Multidisciplinary Approach. A multidisciplinary approach is a way of expanding the scientific worldview in the direction of a holistic image of the studied object. Multidisciplinary approaches allow the researcher to search for a combination of different subject areas that are important for the object under study. Multidisciplinary research is defined as research conducted in several disciplines and pursuing several independent goals. At the same time, they are united by a common target context. The main identification features of multidisciplinary approaches are the presence of a target research context that does not belong to any single discipline, as well as consensus and compromises, resulting in an intersubjective (accepted by most people) research result (Petts, Owens, & Bulkeley, 2008).

Transdisciplinary Approach. A transdisciplinary approach is a way of expanding the scientific worldview, which consists of examining an object outside any single scientific discipline. In the absence of strict identification signs, the transdisciplinary approach today is perceived as a special type of scientific research that crosses the boundaries of many disciplines, going beyond them, and hence the prefix "trans" (Knyazeva, 2011). In this sense, transdisciplinarity is to be understood as being complementary to monodisciplinary and interdisciplinary research (Kastenhofer, Steininger, Omann, & Stagl, 2015).

For a long time, monodisciplinary experts tried to determine the essence of transdisciplinarity. They have insisted that it should not be at predominance in the scientific society, but it should allow all disciplines to unite beyond their own frontiers (Nicolescu, 1994). Under these circumstances, the incipient transdisciplinarity was forced back to the use of the synthesis of linear logic inherent in disciplinary approaches and interdisciplinary techniques. Subsequently, the idea of a transdisciplinarity is broken down into several types and species of transdisciplinary approaches (Brenner, 2014). Also, they admit a subjective interpretation of disciplinary knowledge and the results of the practical use of disciplinary techniques. Such transdisciplinarity stands in as a weak transdisciplinarity. Its de facto methodology came close to the methodology of interdisciplinary and multidisciplinary scientific studies (Max-Neef, 2005). Some scientists believe that transdisciplinarity is in danger of becoming used increasingly in an inflationary manner for labeling any interaction taking place between scientists and practitioners, including consultancy, participatory research, and even interviews with prac-

titioners. Thus, transdisciplinarity is in danger of losing its strength as a powerful approach (Scholz & Steiner, 2015).

A profound development in our understanding of transdisciplinarity occurred at the end of the 20th century. The participants of the International Transdisciplinarity Conference, held under the auspices of UNESCO in Royaumont Abbey (Paris, France) in May 1998, adopted a resolution concerning the need for the existence of strong transdisciplinarity (transdisciplinary science) in science and education (Kim, 1998). A scientific approach, which represented the strong transdisciplinarity or transdisciplinary science, was found in the classification of the systems approach types. This is the systems transdisciplinary approach.

CLASSIFICATION OF THE SYSTEMS APPROACHES

Russian philosopher V. Sadovski writes: "The arsenal of modern tools for understanding was created mainly by classical science. It has an analytical nature and is unsuitable for the analysis of integrity, hierarchy, and complex organization. At the same time, systems thinking can be developed by modifying the existing cognitive means of classical science. At present, to describe systems thinking, systems research methods, we are forced to use non-systems in its essence concepts and methods. This, ultimately, is the general basis for the emergence of systemic paradoxical situations" (1974). It is logical that such a modification of scientific approaches will consist of system approaches similar to those of classical science. It is important to decide how to determine the solutions of the worldviews. As Martin Hall explained, the power of systems methodologies is derived from taking into account worldviews. This is because worldviews create the context both for adequate modelling of problems and for appropriate selection of solutions (Hall, 1995). Therefore, system approaches will interpret the term "system" in different ways. Such approaches are as follows: systems disciplinary, systems interdisciplinary, systems multidisciplinary, and systems transdisciplinary approaches.

DEFINITIONS OF THE SYSTEMS APPROACHES

There are four distinct systems approaches to understanding: the disciplinary, interdisciplinary, multidisciplinary, and the transdisciplinary. The definitions of systems approaches differ in how to correctly select and model an object in the image of the system. The paper now explores each.

Systems Disciplinary Approach: Classic. The systems disciplinary approach is a method of highlighting and modeling an object in the image of a local monodisciplinary system. The systems disciplinary approach demonstrates a special way of integrating disciplinary knowledge. Such knowledge is specifically selected by the researcher according to certain criteria when modeling an object as a system. The systems disciplinary approach, in essence, is a form of perception of the methods and principles of classical systems research.

Systems Interdisciplinary Approach: Complexity. The systems interdisciplinary approach is a method of highlighting and modeling an object in the image of a local interdisciplinary system. Systems interdisciplinary approaches demonstrate ways to integrate the disciplinary knowledge of similar subject areas of objects within the framework of modeling their relationships as a system. In their highest form, systems interdisciplinary approaches are able to form the so-called interdisciplinary system paradigms.

Systems disciplinary and systems interdisciplinary approaches are more dependent on the empirical description of system research procedures. The success of these approaches determines the modeling of the object in the image of the system, supported by its strict mathematical expression. The principle of simplifying the image of an object during its systems modeling is transferred to the formation of local pictures of the world. Subjective relief of the world picture from non-essential characteristics can be accidentally excluded from the field of view of the researcher in regard to those characteristics that, under certain conditions, can play the role of factors that determines the development of an object.

The following two approaches from the classification of systems approaches allow one to eliminate this circumstance. These approaches include the systems multidisciplinary and the systems transdisciplinary approaches. These approaches are more dependent on the existing general philosophical concepts and on the image of the world picture, which influence the content of the ontological and epistemological aspects of the study of systems. The following are important for the development of these types of systems approaches:

- Heuristic, systematizing, and ideological functions of the world picture.
- Concepts of space, time and information, as philosophical categories that are directly related to fundamental objects (world, universe).
- The definition of the concept of a "categorical imperative" in a subjective and objective context, determining, respectively, the integrity or unity of the object as a system.

Systems Multidisciplinary Approach: Holism. The systems multidisciplinary approach is a way to correctly isolate and model a complex object as a holistic multidisciplinary system. The image of a holistic multidisciplinary system is associated with a set of objects that are combined to achieve a specific goal. To discover the order that determines the integrity of an object as a system, this approach uses an appropriate set of systems disciplinary methods. The whole world consists of parts. These parts outside the entire are of independent sense. The concept and the view of the whole world do not forbid the existence of other entire worlds, of other entire objects. For this reason, it is necessary to justify the completeness of a set of object parts as a system in each specific case within the framework of systems multidisciplinary approach, and then to identify or subjectively establish the order that determines the interaction of these parts. Integrity implies a unique combination and consistency of parts. This circumstance sets the vector of search and description of a hypothetical (subjective) imperative in a specific scientific study of a specific set of objects.

The philosophical basis of the systems multidisciplinary approach is holism. Holism, in a broad sense, is a position in philosophy and in science regarding the problem of the relationship between part and whole. In ontology, holism is based on the principle that the whole is always more than the sum of its parts. The epistemological principle of holism stated that the knowledge of the whole must precede the knowledge of its parts. In a narrower sense, holism is understood as the "philosophy of integrity". Please note that attributes of the whole world are not compared with attributes of its parts. The whole world is not subject to dismembering, fragmentation, or partition. However, this image of the world does not require its uniqueness and oneness. Therefore, the whole world does not interfere with existing of other whole worlds practically or theoretically. Other whole worlds may have their own laws, attributes and, as the most important, their own inner order of interaction between the parts. The idea that attributes of the whole world are not the same as attributes of its parts suggests that the whole and the parts have a strong predisposition of having different goals of their existence. Such point of view shows that relation between combination of parts of the whole and objective connection that unifies them represents a compromise. As result, existence of this compromise may be the most probable version of developmental nature of the whole world. Also, its future may be blur and unknown. Applied to scientific researching this circumstance may lead to the following results. On one hand, it will interfere with usage of universal methodology. On the other hand, it will provoke endless process of creation of narrow and limited methods. Namely these issues are dominant in modern science.

Systems Transdisciplinary Approach: Unicentrism. The systems transdisciplinary approach is a way to correctly isolate and model a complex object as a single transdisciplinary system. At the same time, a set of objects pursuing a common goal is associated with a functional ensemble of objects. The image of the transdisciplinary system in this case is associated with the general order, which determines the unity of the functional ensemble of objects. This approach allows the use of a special transdisciplinary concept, philosophical basis, and methodology in the study. All this can be found in the Russian school of transdisciplinarity (Rimondi, & Veronese, 2018).

The systems transdisciplinary approach is based on the philosophic principles of unicentrism. In a broad sense, unicentrism is a position in philosophy and in science that is based on the problem of the correlation between the single and its fragments. This position assumes the isomorphism of the universal order of the structure of fragments of space, the attributes of information, and the periods of time that determine the one and only world. In ontology, unicentrism is based on the principle that the one and only world is represented as the sum of ordered fragments of space, attributes of information, and periods of time. In turn, they determine the unity of goals and results of the development of phenomena and processes of reality. The epistemological principle of unicentrism states that the knowledge of the one and only world must be preceded by the selection of appropriate models of spatial, informational, and temporal units of the universal order. In a narrower sense, the unicentrism is understood as the philosophy of unity, developed by the Russian philosopher, Vladimir Mokiy. Also, he introduced the term "unicentrism" in 2009 (Mokiy, 2009). The united world is the one and only world. Any objects at all levels of the reality of the one and only world are its natural elements and fragments. Therefore, the main condition for the existence of the one and only world is the existence of a universal order in it. As the name implies, it follows that this objective order must manifest itself everywhere: in every element and fragment of this world and in every interaction of these elements and fragments at every level of reality. As a result, the same order should ensure the achievement of activity goals and results of all these elements and fragments. In addition, it should synchronize these goals and results. For this reason, a single world is a One Orderly Medium.

The major attribute of this One Orderly Medium is the potency, which is naturally present in it. Potency is the prospective futurity of the One Orderly Medium. Within the framework of the unicentrism concept, the definitions of fundamental philosophical categories are as follows:

Space – as a form of existence of potency of One Orderly Medium;

Information – as a form of manifestation of potency of One Orderly Medium;

Time – as a form of transformation of potency of One Orderly Medium.

However, the universal order plays the role of a transdisciplinary system in relation to the forms of potentiality of a single world. This particular universal order manifests in the forms themselves, in the interaction of these forms, as well as determines their unity.

The status of a single object within a One Orderly Medium indicates the need for directive placement of monodisciplinary knowledge in accordance with the structure predetermined by the general order for fragments of space, attributes of information, and time periods. Therefore, the order determining unity is not revealed in the course of systems transdisciplinary research of a complex object. It is not formed subjectively as it is done in the systems multidisciplinary approach. It is postulated through systems transdisciplinary models of spatial, informational, and temporal units of order. The model of spatial unit of order provides ground for the physical and/or logical object boundaries and the nature of relations between elements within these boundaries. The model of informational unit of order provides ground for the necessary and sufficient amount of information on the object, and it describes the overall condition of this object. The model of temporal unit of order show the organization of conversion the internal potency of object from the original volume to the results that will be used in the subsequent processes of its conversion (Mokiy, 2019a).

Due to these models, the researcher operates with available knowledge of similar and dissimilar subject areas, which is their interaction. These models initially determine their number and types, as well as the nature and consequences of such interaction. Thus, they initially form the content of an objective categorical imperative, which can be spoken of as a system analogue of D.I. Mendeleev's periodic table. The new 'periodic table' might enable the discovery of hitherto unknown and unsuspected kinds of systemic structures, behaviors or capacities existing in nature, opening the way for more effective systems methodologies (Rousseau, Billingham, Wilby, & Blachfellner, 2016). The world in

the form of vertical functional assembly and the system in the form of the universal order, which makes condition for the unity of this assembly, are close to the vision of L. Bertalanffy with respect to the general systems theory. That is to say that within the framework of systems transdisciplinary models of the unit of order, disciplinary knowledge with regard to the world, various study objects, their similar and dissimilar subject areas, as well as functional assemblies of objects was able to be located without strict boundaries between disciplines.

IDENTIFICATION ATTRIBUTES OF OPINIONS AND KNOWLEDGE

Russian philosopher A. Nikiforov (2015) wrote: "Nature has no opinions, knowledge, and systems. All possible opinions, knowledge, and systems are results of cognized interaction of man and the ambient world. These results are shown in schemes, words and logical sentences (conceptions). Since the senses of all people have the same structure and the ambient world affects human senses of different individuals in the same way, all information about each element of the world should be considered as a heritage for everyone".

However, taking into consideration the sameness of human senses it is necessary to pay attention to the individuality of every person. Human individuality is a combination of particular attributes and features which condition peculiarity of his or her psychic state and personality. An attribute is defined as a quality or characteristic of a person (Examples of attributes, 2018). Personal qualities of a person, his habits and interests, the manifestation of experiences and moods, abilities and inclinations - all this is an integral characteristic of the personality, making it unique.

This individuality is shown through sensual interpretation of the content of data perceived from the ambient world. As a result, such data transforms into subjective opinions about the world. The existence of a multitude of subjective opinions has important practical meaning. Subjective opinions are distributed in accordance with the "law of normal distribution" of K.F. Gauss. The result of distribution is illustrated in a bell-shaped model – Gaussian curve (chart of normal distribution) (Gauss, 2008). Fields of opinions of subjective content, FOSC, and field of opinions of intersubjective content, FOIC, are shown by a Gaussian curve. Opinions of subjective content are distributed at the periphery of the Gaussian curve. Opinions of intersubjective content are distributed at the center of the Gaussian curve. Opinions of intersubjective content play the role of knowledge for most people. In this case, an attempt is made to show the principal possibility of applying the Gaussian to the organization and interaction of opinions and knowledge. Due to various circumstances, the state of society may deviate from the historical norm. Therefore, the areas of the tails and the central part of the Gaussian, respectively, can increase and decrease under real conditions. Thus, this will not change the very principle of organization and interaction of opinions and knowledge. Perhaps, these characteristic changes can play the role of objective indicators of the state of society (see Figure 1).

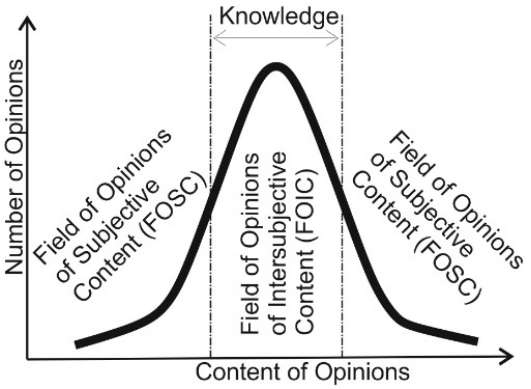

Figure 1. Normal distribution of subjective opinions (Gaussian curve)

Opinions and knowledge are classified by the need for substantiation. The basis of the first field consists of opinions and knowledge, which do not need to be substantiated. These opinions and knowledge were perceived without special speculations. They totally satisfy our perception of life and are beyond any doubt. The basis of the second field consists of opinions and knowledge, which require substantiation. Also, not just a fact of substantiation is important, but methods as well (Nikiforov, 2009). Details of the results of generalization of all possible knowledge by means of a model of context space (systems transdisciplinary model of spatial unit of order) allows clarification that knowledge, which does not need substantiation, plays the role of unconditional (absolute) type or as knowledge of intuitive type. Knowledge, which needs substantiation by means of logical and empirical proofs, developed by inductive or deductive methods, plays the role of knowledge of speculative type and knowledge of empirical type accordingly (see Figure 2).

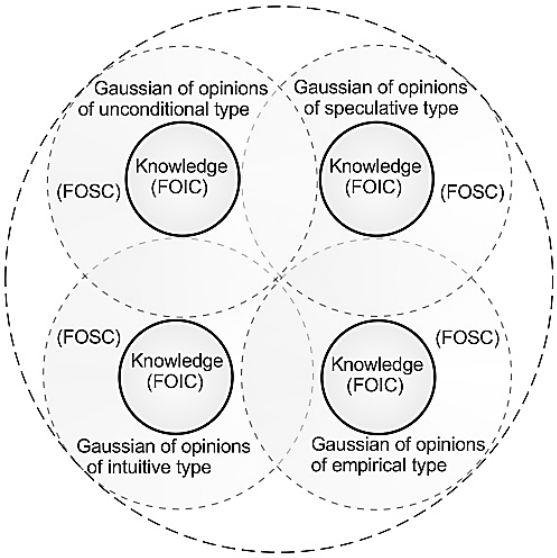

Figure 2. Model of context space of all possible opinions

It should be remembered that the age of science in its current form is not more than 300 years. The age of modern science is even less. For thousands of years, people have understood, explained, and perceived the world through the prism of religion, philosophy, and myth. Therefore, the mythical picture of the world as a single ocean of energy, the philosophical holistic picture of the world, the religious picture of the world as the highest true reality, and the quantum picture of the world as a single oscillating environment are similar in essence. Each picture exists due to the fact that some of the subjective opinions are separated into mythical, religious, philosophical, and scientific knowledge. Therefore, we cannot say that some type of knowledge is more valuable than another type. However, we can say that subjective opinions about these pictures of the world are developing and improving. This fact serves as a reason for integration and generalization of such opinions. Such integration and generalization, which can be performed by trained professionals, will ultimately develop each type of knowledge and will certainly serve the development of the human society.

Models of presentation and solution to the problems of cognition, interpretation and evaluation of the results, and admissible within a certain package of values, methods, approaches and skills existing in a certain type of rationality serve as a paradigm. There is a certain connection between knowledge and a paradigm. In a certain period of time, influence by a paradigm and all possible knowledge is separated from its original volume. Only those that correspond to achievement of current and cognized goals are used. Afterwards, influenced by accumulated mass of unclaimed knowledge, content of the paradigm itself goes under correction with meanings of current social and cognized goals accordingly.

One should suggest that all possible mythological, religious, and scientific opinions will also submit to the "law of normal distribution" of K. F. Gauss. Therefore, the results of distribution of the content of such opinions will be possible to show by their own Gaussian curve. In turn, generalization of four main types of opinions of each Gaussian curve is possible to be shown with a corresponding model of context space.

This circumstance allows making generalization of knowledge of myth, religion, philosophy, and science within a context space of opinions and knowledge of existing rationalities (see Figure 3).

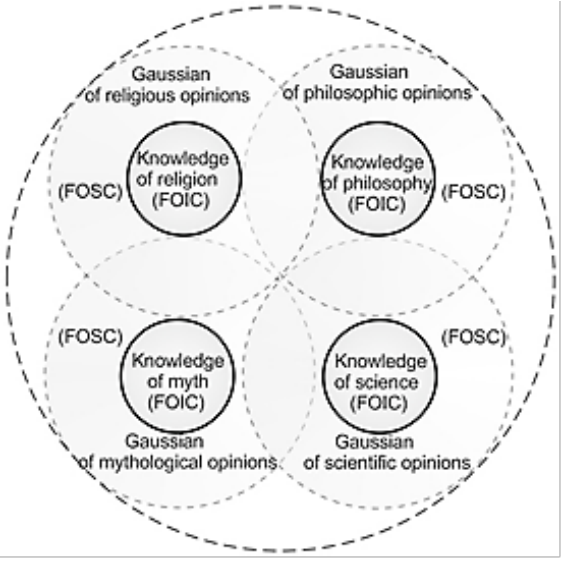

Figure 3. Model of context space of opinions and knowledge of existing rationalities

According to this model, all possible opinions and knowledge of myth, religion, philosophy, and science will be classified by needs of their substantiation. Opinions and knowledge of religion and myth do not need substantiation. Opinions and knowledge of philosophy and science require logical and empirical substantiation, developed by means of inductive or deductive methods.

So far the paper has examined the first of the three classifications for the systems approach which is based on opinions and knowledge. The paper now turns its attention to the second approach, based on the holistic generalist.

IDENTIFICATION ATTRIBUTES OF HOLIST GENERALISTS

The term "generalist" may be associated with such terms, as erudite, universalist, and specialist of a broad spectrum. However, a specialist, who is known for professional usage of one universal approach, admissible to all combinations of possible opinions and knowledge about object, does not belong to any of these terms. In this case, the term "generalist" is derived from an English noun 'generalization' (Generalization, 2019). Consequently, generalist is a specialist who is able to generalize all possible opinions and knowledge about object by means of system approaches and methods. Psychology describes generalization as a certain cognitive process. During this process, man initially discovers and fixes existing inner connections, which determine objects as a whole system. Later, man coordinates individual parts and attributes of object into an undividable whole operating with theoretical domains and corresponding models. As a result, knowledge about the object becomes more specific, more detailed, and complete (Meshcheryakov & Zinchenko, 2008).

All possible data about all the elements of the world is being formed by humans by means of initially natural psychic perception through spatial illustrative form (image) or gestalt (see Figure 4).

Figure 4. The most common example of a gestalt (image of a vase, formed by two profiles of human faces)

Psychologists explain the building of a psychic image as a feature of individual cognition. It represents a special act of comprehension and momentous catching of relations in the perceiving field (Petrovskiy & Yaroshevskiy, 1990). It is known that the role of the perceiving field in systemic approach can be played by a combination of those elements (parts), combination of their interaction, and combination of interaction of object as a system with the environment. Within each direction of system approach, specialists form a number of subjective opinions, which refer to the image of the whole object and laws. This form and supports its wholeness. Such opinions are spread by content into models of context spaces of all possible opinions. Consequently, a model of context space of all possible space can be played by a gestalt of a generalist of the whole (holist generalist). Such image of object presents opinions and knowledge as parts of the whole. However, knowledge of four types cannot interact with each other and influence each other directly. Still, they can have a direct impact on paradigms that limit the knowledge.

This interaction and influence may be caused by opinions, known as apologists and adapters. Knowledge of a specific type, simplified, and that which is explained by its own apologists and adapters can be perceived and interpreted by apologists and adapters of knowledge of the neighbor field (see Figure 2 and 3). Later, these interpreted opinions can have an impact on knowledge and correct paradigms.

Figure 5 shows a model of interaction of knowledge, served as apologists and adapters. At each stage, there might be a correction of opinion, knowledge and, consequently, a paradigm of a Gaussian curve of unconditional, intuitive, empirical, and speculative types. However, only opinions of two neighbor Gaussian curves can be used for each specific type of knowledge. Therefore, the process of generalization of knowledge by a holist generalist may include four independent stages (a, b, c, d).

Also, a holist generalist must be aware that opinions, which determine and control normative parameters of interactions, belong to Gaussians of unconditional and intuitive types. According to Plato, these opinions have a direct relationship to underlying basics of human psychics known as anamnesis (derived from Greek language, recall) and, therefore, do not need substantiation. Opinions, which support and develop normative parameters in such interaction, belong to Gaussians of empirical and speculative types and differ because of high clarity, productivity, and general acceptability (see Table 1).

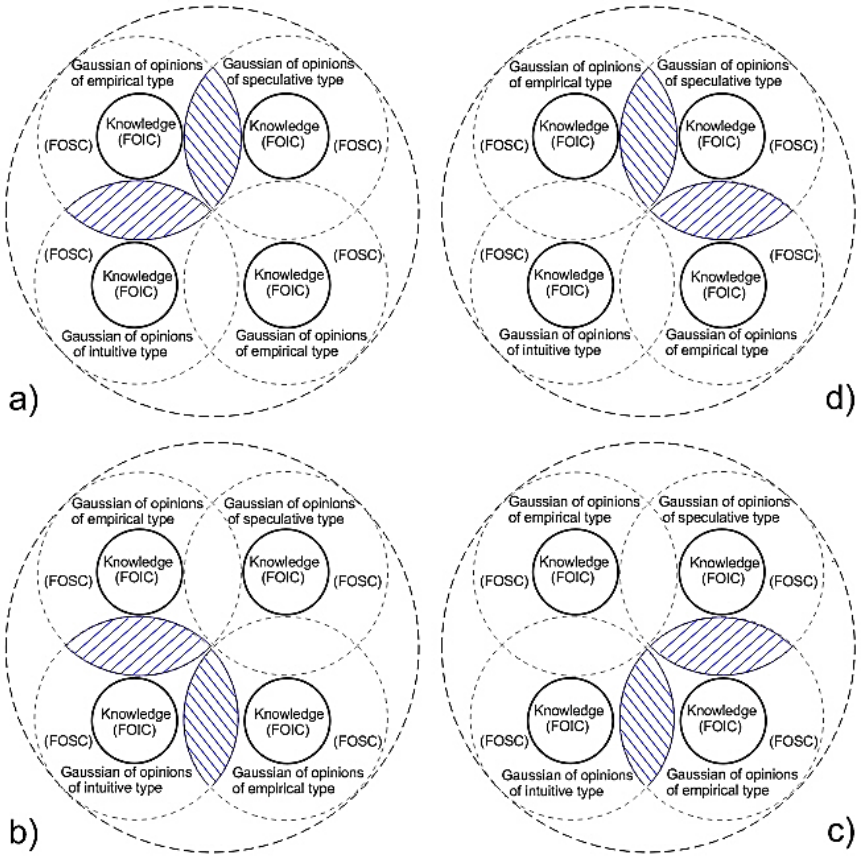

Figure 5. Model of interaction of opinions of apologists and adapters

Table 1. Relations of opinions of Gaussians in interaction

OPINIONS, WHICH **DETERMINE** AND **CONTROL** NORMATIVE PARAMETERS OF INTERACTION	OPINIONS AND KNOWLEDGE, WHICH **ARE CONTROLLED** IN INTERACTION	OPINIONS, WHICH **SUPPORT** AND **DEVELOP** NORMATIVE PARAMETERS OF INTERACTION
Opinions of Gaussian of intuitive type	a) Opinions and knowledge of Gaussian of unconditional type	Opinions of Gaussian of speculative type
Opinions of Gaussian of unconditional type	b) Opinions and knowledge of Gaussian of intuitive type	Opinions of Gaussian empirical type
Opinions of Gaussian of intuitive type	c)Opinions and knowledge of Gaussian of empirical type	Opinions of Gaussian of speculative type
Opinions of Gaussian of unconditional type	d) Opinions and knowledge of Gaussians of speculative type	Opinions of Gaussian of empirical type

Depending on a set goal and level of substantiation of its solution, holist generalist will have to act in two directions. First, he will purposely determine and implement one of the four possible stages of generalization of opinions (a, b, c, d). Second, in the pursuit of generalization of opinions in order to make a correction into knowledge of all types, a holist generalist will have to consequently repeat each of the four independent stages of generalization (a, b, c, d). During "untwisting" of this "spiral of generalization", there will be a consequent increase in the volume of knowledge and correctness

of knowledge of different types. This will provide evolutional development of cognizing of the world and coordinate all possible opinions and actions in the achievement of social cognized goals of society. An order, which conditions wholeness of object, allows the projection and substantiating of opinions and knowledge about it as they exist in reality.

Systems multidisciplinary approach is an approach which might be a methodological instrument for holist generalists' activities. According to its definition, one may see that that this approach is a way of correct selection and modeling of a complex object or a complex multifactor problem as a whole multidisciplinary system. This allows selection of a corresponding complex of system methodologies for researching complex objects and problem-solving. At present, due to shortage of specifically trained specialists, holist generalists, attempts of generalization of opinions and knowledge of different types are carried out within temporal creative collectives of specialists – carriers of different type of knowledge. Still, there is no certainty that all the specialists interpret gestalt problems in the same way seeing either image of a vase of profiles of two faces (see Figure 4).

So far, the paper has examined the first two of the three classifications for the systems approach. The first is based on opinions and knowledge, the second on the holistic generalist. The paper now explores the third and final approach, the unicentrist generalist.

IDENTIFICATION ATTRIBUTES OF UNICENTRIST GENERALISTS

Presence of complex multifactor problems, which accompany development of modern society, and the presence of crises in ecological, economic, and social spheres shows that there is a need for the usage of additional new technologies, such as a principle or a mechanism of generalization of opinions and knowledge and, also, specialists who can implement this generalization (Bokova, 2012). Unicentrism is one of such principle. Transdisciplinary Gaussian (gestalt-of-the-one) is such a mechanism. And general-of-the-one or unicentrist generalist is such a specialist.

In XX century, principles of unicentrism transformed the image of system from "multiplicity of oneness" into "oneness of multiplicity", i.e., into one order. Therefore, the concept of unicentrism suggests that multiplicity of allegedly possible ordered mediums, objects, and their interaction, which are being studied by different directions of myth, religion, philosophy, and science, will be considered as a combination of natural elements – fragments of the One Ordered Medium. Simply put, such media, objects, and their interactions are not just put into One Ordered Medium, they are the One Ordered Medium itself. This allows the presentation of all possible opinions and knowledge with a model of transdisciplinary Gaussian (see Figure 6).

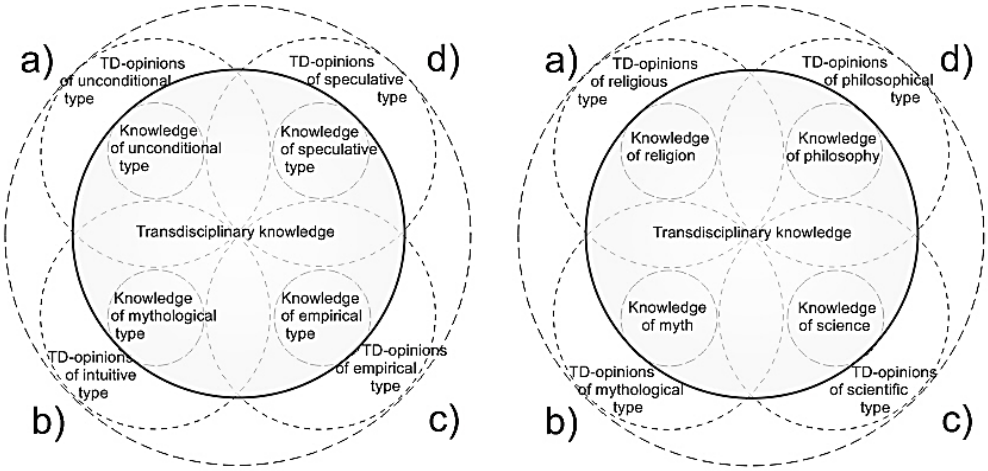

Figure 6. Model of context space of transdisciplinary opinions (transdisciplinary Gaussian)

This model may serve as a spatial illustrative form gestalt-of-the-one, momentously catching all possible relations in perceiving field of all possible opinions and knowledge of different type. Gestalt-of-the-one is different from gestalt-of-the-whole (see Figures 2 and 3). It allows the transformation of opinions and knowledge of four types as parts of the whole into a new level of natural fragments of one transdisciplinary knowledge. Transformation of four types of knowledge into one transdisciplinary knowledge is implemented by means of their systematization into isomorphic (similar in forms and features of structure) systems transdisciplinary models of spatial, informational, and temporal unit of order (Mokiy, 2019b). A review of this systematization can be found in the systems transdisciplinary research (Mokiy, 2015; Mokiy & Lukiyanova, 2017b).

When there is any need in showing the results of transdisciplinary research of complex objects and solution of complex multifactor problems by image or language of one of four types of knowledge, a need of their obvious argumentation may also arise. In this case, unicentrist generalist uses argumentation of opinions and knowledge of all the types, which are be found in logical relations (see Table 2).

Table 2. Relations of knowledge of myth, religion, philosophy, and science during formation of transdisciplinary knowledge

KNOWLEDGE, WHICH **DETERMINE AND CONTROL** PARAMETERS OF FORMATION OF TD-KNOWLEDGE	KNOWLEDGE, WHICH **SERVE AS BASIS** FOR FORMATION OF TD-KNOWLEDGE	KNOWLEDGE, WHICH **SUPPORT AND DEVELOP** PARAMETERS OF TD-KNOWLEDGE
Systemized knowledge of myth	Systemized knowledge of religion	Systemized knowledge of philosophy
Systemized knowledge of religion	Systemized knowledge of myth	Systemized knowledge of science
Systemized knowledge of myth	Systemized knowledge of science	Systemized knowledge of philosophy
Systemized knowledge of religion	Systemized knowledge of philosophy	Systemized knowledge of science

In turn, subjective opinions of four types are formed into corresponding transdisciplinary opinions. Transdisciplinary opinions within the transdisciplinary Gaussian do not interact with each other. They play the role of apologists and adapters of transdisciplinary knowledge when interacting with the results of generalization of opinions and knowledge by holist generalists. For example, the order, which conditions the unity of object of research, gives an attribute of objectivity to all possible opinions and knowledge about it. This allows the presentation of object, opinions, and knowledge of different types in the way they must be in true reality. That is why, on the contemporary level of development of knowledge of all four types of a gestalt-of-the-one, the opinions and knowledge are not divided by a need of substantiation. They should simply go through systematization in systemic transdisciplinary models of spatial, temporal, and informational unit of order to be considered. Thus, they prove their logical match with opinions and knowledge of different types, and the fact of undergoing this systematization can be considered as substantiation.

With these approaches in mind, the paper now considers what it means to be trained as a generalist.

FORMS OF TRAINING OF GENERALISTS

It becomes much more common now to hear some individuals or memorandums of international organizations appealing to find ways to the solution of complex multifactor problems of modern society. Along with appeals in scientific society, there is also an active search of approaches, ways, and methods that can be used for solution of these problems However, the most crucial questions are still left without answers. Which specialists of fields are able to provide solutions to these problems, including temporal creative collectives of various fields? What should the process of education of such unique specialists involve? How different should their education be from traditional forms of education of specialists in higher education?

The role of such unique specialists should be played by holist generalists and unicentrist generalists. The fundamental difference between the generalists should be clarified. A holist generalist is an integrative specialist. This person's task is to collect opinions and knowledge that will form the object as a system. A unicentrist generalists is a unifying specialist. This generalist's task is to generalize opinions and knowledge within the boundaries of the universal image of the transdisciplinary system and to also present the object as an element of a certain functional ensemble of objects.

According to peculiarities of their identification attributes, one should mention two levels of the specialists. The first level is a level of generalists who solve problems in the field of specific knowledge (see Figure 2). For example, generalists of science should be divided into holist generalists and unicentrist generalists.

Scientific holist generalists should generalize opinions and correct knowledge of specific types within one scientific direction. Trained unicentrist generalists should generalize opinions and correct knowledge of four types of this scientific direction or knowledge of all direction of science. The second level should include generalists, who are challenged to solve complex multifactor problems, including knowledge of different disciplines, direction, and prepared carriers of knowledge of myth, religions, philosophy, and science.

The undergraduate form of higher education (bachelor's degree) provides students with simple basics of scientific world view. Therefore, students who have completed their graduate studies and have complete and formed scientific worldview should be qualified to become generalists. Also, such graduating students are able to use the basics of knowledge of the system approach for evaluation of non-standard situations in nature and society. They are ready to have understandable responsibility for organizing and managing decisions taken. Also, they have skills of independent studies in scientific research and activities.

It is reasonable to create a special form of training of high qualified specialists to become generalists, such as a post-graduate course. At the beginning level of education, studying materials should be based on detailed case study and ways of qualification of knowledge of four types, which is systemized within their organized carriers (myth, religion, philosophy, and science). Such studies should cover existing pictures of the world, approaches, and methods used for the research of the object.

At later stage of education, training of generalists should be independent. Training of holist generalists in methodology of systems multidisciplinary approach, which has a close connection with methodologies of other systems approaches (systems disciplinary, systems interdisciplinary and systems multidisciplinary approaches), should be carried out under the aegis of a concept of holism. A need in education of holist generalists will inevitably trigger development of theory of General systems, which presents a combination of different systems methods.

Training of unicentrist generalists in methodology of systems transdisciplinary approach must be carried out under the aegis of concept of unicentrism and within the framework of transdisciplinary science. Also, development of plans of education of unicentrist generalists will inevitably trigger further development of the concept of General System Theory, as an independent study. The founders

of general system movement, such as L. Bertalanffy, K. Boulding, A. Rappoport, and R. Gerard asserted that this is likely to happen in the future.

Distinct differences of generalists, which should be acquired during education, should be the highest level of tolerance to specialists-carriers of four types of opinions and knowledge; focus on unambiguous solution of complex multifactor problems; ability to correctly select methods and technologies, which allow to absolutely solve the problems; ability to organize effective activity of specialists-carriers of different types of knowledge within temporal creative collectives.

CONCLUSIONS

The task of higher education for actualization of the recommendations of the "World Declaration on Higher Education for the Twenty-first Century: Vision and Action" is the instilling (formation) of special (transdisciplinary) worldview position in students (World Declaration, 1998). Also, it includes learning skills of treating disciplinary knowledge through a prism of universal (transdisciplinary) regularities and models of reality, and acquisition of experience of usage of transdisciplinary approach in solution of complex multifactorial problems of nature and society. The experience of higher education justifies the possible effectiveness in solution of these tasks on condition of establishment of a special scientific direction for transdisciplinarity (American Academy of Arts and Sciences, 2013). Although transdisciplinarity has not yet received a single and commonly accepted meaning, it can be presented in the system of higher education and be used in scientific studies or solution of complex multifactorial problems of nature and society. Today, there are a number of conferences, seminars, established academies, and institutes of transdisciplinary education and transdisciplinary researching which successfully function and use transdisciplinary approach. Moreover, this approach is a part of the requirement for assigning a graduation work (thesis) or dissertation. Drastic changes are required in order to satisfy the growing need of the society in specialists that are able to actively use the transdisciplinary approach and systems transdisciplinary approach for solution of complex multifactor problems of nature and society. This is accomplished by creation of special departments in major universities. Therefore, the purposes of these departments and their staff (centers and laboratories) are:

- Analysis and grouping of concepts and methodologies, which exist in science, types and form of transdisciplinarity.
- Formation of scientific methodological base for the education of the transdisciplinary methodology in the universities, and development and systematization of expertise of insertion of transdisciplinarity into the higher education system.
- Development of educational programs, preparation of the appropriate educational and methodological literature, and organization and support of the preparation of instructors on the discipline "Transdisciplinarity and systems transdisciplinary methodology" and its disciplinary sections.
- Organization of programs of transdisciplinary re-preparation and increase in the qualification of specialists.
- Organizing of seminars and scientific-practical conferences for exchange of expertise in the utilization of transdisciplinary methodology in solution of complex multilateral multidisciplinary and disciplinary problems and also for the topics that stimulate the interest towards transdisciplinarity and transdisciplinary methodology.
- Assistance to the universities that entails educating the students and specialists in methodologies of transdisciplinarity.

Thus, today there is every reason to organize the training of generalists in the structure of higher education. Development of unique specialists-generalists and their participation in mutual work of specialists-carriers of different types of knowledge will make it possible to successfully solve com-

plex multifactor problems of the modern society. In addition, this would serve as a basis for transformation of understanding of the world to a whole new level.

REFERENCES

American Academy of Arts and Sciences. (2013). *ARISE II: Unleashing America's research & innovation enterprise*. Retrieved from https://www.amacad.org/multimedia/pdfs/publications/researchpapersmonographs/arise2.pdf

Bertalanffy, L. (1969). *General system theory: Foundations, development*. New York, NY: George Braziller Inc.

Bode, H., Mosteller, F., Tukey, F., & Winsor, C. (1949). The education of a scientific generalist. *Science*, 109, 553-558. https://doi.org/10.1126/science.109.2840.553

Bokova, I. G. (2012). *Preliminary proposals by the Director-General concerning the draft medium term strategy (37 C/4) and draft programme and budget (37 C/5)*. (2013). UNESCO, Doc. 190 EX/19. Retrieved from http://unesdoc.unesco.org/images/0021/002175/217551e.pdf

Brenner, J. (2014). Transdisciplinarities today. In B. Nicolescu & A. Ertas (Eds), *Transdisciplinary education, philosophy, & applications* (pp. 1-3). Lubbock, TX: TheATLAS,. Retrieved from http://www.theatlas.org/index.php/about-atlas-3/honoring-dr-john-warfield-4?download=5:transdisciplinary-education-philosophy-applications

Examples of attributes. (2018). *The yours dictionary*. Retrieved from https://examples.yourdictionary.com/examples-of-attributes.html

Gauss, C. F. (2008). *The Columbia encyclopedia* (6th ed.). Retrieved from https://www.encyclopedia.com/reference/encyclopedias-almanacs-transcripts-and-maps/gauss-carl-friedrich

Generalization. (2019). *The Cambridge dictionary*. Retrieved from https://dictionary.cambridge.org/ru/словарь/английский/generalization

Hall, M. L. W. (1995). Merging the world views of systems science and human values. In K. Ellis, A. Gregory, B. R. Mears-Young, & G. (Eds.), *Critical issues in systems theory and practice* (pp. 131-135). Boston: Springer. https://doi.org/10.1007/978-1-4757-9883-8_17

Kastenhofer, K., Steininger, K., Omann, I. & Stagl, S. (2015). Science policy for transdisciplinary research. *The Encyclopedia of life support systems (EOLSS)* Retrieved from https://www.eolss.net/Eolss_Publications_Catalogue.pdf

Kim, Y. (1998). *Transdisciplinarity. Stimulating synergies, integrating knowledge*. UNESCO, Division of Philosophy and Ethics. Retrieved from http://unesdoc.unesco.org/images/0011/001146/114694eo.pdf

Knyazeva, E. (2011). Transdisciplinary research strategies. *Vestnik TGPU, 10*(112), 193-201.

Lane, J. E. (2013). Higher education system 3.0: Adding value to states and institutions. In J. E. Lane & D. B. Johnstone (Eds.), *Higher education system 3.0: Harnessing Systemness, Delivering Performance* (pp. 3-26). Albany, NY: SUNY Press.

Max-Neef, M. A. (2005). Foundations of transdisciplinarity. *Ecological Economics, 53*, 5-16. https://doi.org/10.1016/j.ecolecon.2005.01.014

Mather, K. (1951). Objectives and nature of integrative studies. *Main Currents in Modern Thought, 8,* 11.

Meshcheryakov, B. G., & Zinchenko, V. P. (2008). Generalization. *The great psychological dictionary*. Moscow, Praym-Evroznak Publ.

Mokiy, V. S. (2009). *Foundations of transdisciplinarity*. Nalchik, EL-FA Publ., 47-48.

Mokiy, V. S. (2015). Systematization and integration of disciplinary knowledge in a transdisciplinary study. *Universum: Social Science, 6*(16). Retrieved from http://7universum.com/ru/social/archive/item/2275.

Mokiy, V. S. (2019a). Systems transdisciplinary approach in the general classification of scientific approaches. *European Scientific Journal, 15*(19), 247-258. ESJ July Edition. https://doi.org/10.19044/esj.2019.v15n19p247

Mokiy, V. S. (2019b). Using the systemic-transdisciplinary approach to enhance the operational reliability and maintenance programming of complex technical objects. *Transdisciplinary Journal of Engineering & Science*, *10*, 133-145. https://doi.org/10.22545/2019/0124

Mokiy, V. S., & Lukyanova, T. A. (2017a). *Methodology of scientific research. Transdisciplinary approaches and methods.* Moscow, Yurayt Publ.

Mokiy, V. S., & Lukyanova, T. A. (2017b). Interdisciplinary collaboration in contemporary science: Approaches and perspectives. *Economics of Contemporary Russia*, *3*(78), 7-21. Retrieved from https://cyberleninka.ru/article/v/mezhdistsiplinarnye-vzaimodeystviya-v-sovremennoy-nauke-podhody-i-perspektivy

Nicolescu, B. (1994). Preamble. *1st World congress of transdisciplinarity*. Convento da Arrábida, Portugal, November 2-6, 1994. Retrieved from https://www.cocratos.nl/wp-content/uploads/2016/02/Charter-of-Transdisciplinarity.pdf

Nikiforov, A. L. (2009). Analysis of the concept of knowledge: Approaches and problems. *Epistemology and Philosophy of Science*. T. XXI. 3, 61-73.

Nikiforov, A. L. (2015). Language and worldview. *Epistemology and Philosophy of Science*. T. XLVI. 4. 9-28.

Petrovskiy, A. V., & Yaroshevskiy, M. G. (1990). Gestalt. *The psychological dictionary.* Moscow, Politizdat Publ.

Petts, J., Owens, S., & Bulkeley, H. (2008). Crossing boundaries: Interdisciplinarity in the context of urban environments. *Geoforum*, *39*(2), 593-601. https://doi.org/10.1016/j.geoforum.2006.02.008

Rimondi, G., & Veronese, M. (2018). Defining the dialogue between sciences: A view on transdisciplinary perspective in the human sciences. *Informing Science: the International Journal of an Emerging Transdiscipline, 21,* 255-268. https://doi.org/10.28945/4115

Rousseau, D., Billingham, J., Wilby, J., & Blachfellner, S. (2016). In search of general systems theory. *Systema. Special Issue – General Systems Transdisciplinarity*, *4*(1), 76-99. https://doi.org/10.1007/978-981-10-0892-4

Sadovcky, V. (1974). *Bases of the general theory of systems*. Moscow, Nauka Publ, 238.

Scholz, R. W., & Steiner, G. (2015). The real type and ideal type of transdisciplinary processes: Part II – What constraints and obstacles do we meet in practice? *Sustainability Science*, *10*, 653-671. https://doi.org/10.1007/s11625-015-0327-3

Transforming our world: The 2030 agenda for sustainable development. (2015). United Nations. Retrieved from https://sustainabledevelopment.un.org/index.php?menu=2361

World declaration on higher education for the twenty-first century: Vision and action. (1998). UNESCO, *World Conference on Higher Education.* Paris, 5–9 October 1998. Retrieved from http://www.unesco.org/education/educprog/wche/principal/declar.html

BIOGRAPHY

Dr. Vladimir Mokiy is Head of the Russian School of Transdisciplinarity (http://td-science.ru); Head of the Scientific Research Laboratory of Transdisciplinary Planning and Forecasting in Kabardino-Balkarsky State University, Russia (from 1996 to 2003); Director of Institute of Transdisciplinary Technologies, Russia (from 2007 to present); Member of the Russian Philosophical Society (from 2015 to present); Member of the Society of Architects of Russia (from 2013 to present); Member of the International Academy of Organizational Sciences, Russia (from 2016 to present); and Member of the Research Group Systems Science and Philosophy of the Bertalanffy Center for the Study of Systems Science (BCSSS), Austria (from 2017 to present). A complete bibliography of Dr. Vladimir Mokiy can be found by following this link: http://td-science.ru/index.php/kabinet-direktora/26-eng/473-curriculum-vitae