

PEDAGOGY

TRANSDISCIPLINARY PARADIGM OF STEM-KNOWLEDGE MANAGEMENT IN THE CONTEXT OF ADAPTIVE APPROACH

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ABSTRACT

The authors suggest an analysis of the main innovative transformations in modern education, presenting an agreed construct: transdisciplinarity ↔ STEM ↔ adaptive management. Thus, the emergence of a completely new structure is revealed, which requires scientific awareness, confirmation, justification and development of new solutions to gain knowledge. In that sense, the emergence of such a "scientific anomaly" – a transdisciplinary paradigm that generates a new vision on knowledge management in the period of the formation of a STEM education – STEM management is evidenced. In addition, an adaptive approach will play a key role in the course of this process. Since any process in the educational space cannot be carried out without the impact of its system management, it makes sense to consider the phenomenon of STEM education in the vector of appropriate STEM knowledge management. It is also important that the emerging innovations in the context of the adaptive approach represent a definite vision of the paradigm – transdisciplinary, which has been gradually introduced into the existing education system for many years, having the basis of interdisciplinary, integration relationships and models. The article raises the problem of the need to develop new scientific concepts and theories that will provide a description of this paradigm in all its extraordinary outpouring and practical directions of scientific knowledge.

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Introduction. At the junction of global transformations of world space, a transformation of the existing scientific worldview takes place, namely the emergence of completely new trends, the so-called "scientific anomalies". It is the transition to the information society that leads a whole galaxy of innovations in all spheres of human activity: in science, education, culture, life, and the like. And it is very important that innovative changes have a significant impact on the conditions of human existence in

the professional environment, which is formed in the mode of constant changes – cultural, educational, spiritual, intellect, developmental, technical and technological, social and psychological, and so on.

Now the main aspect in the development of the personality of the post-industrial space is the paradigm of the knowledge economy – knowledge management not only in the context of their acquisition by people through the educational environment, but also their training in the methodology for finding necessary and useful knowledge in rapid information complexes. To assistance in implement this idea come such educational innovations as the introduction of a systemic methodology of transdisciplinary education (STEM-context), adaptive management technologies of social and pedagogical systems, relevant knowledge management information technologies, etc. Thus, there are many questions that modern science has the opportunity to find answers to:

- What historical events cause STEM-innovations, and what exactly is the scientific basis for the emergence of a transdisciplinary educational paradigm?
- Why does the need arise for an innovative transition to STEM education, taking into account the provisions of the transdisciplinarity approach?
- How can STEM knowledge be managed?
- How is the adaptive perception of underlined processes formed, as well as how to accept these changes and agree with the inevitability of innovations?

Analysis of publications and researches. The analysis of philosophical, informational, scientific and other sources showed that such representatives of science as G. Bergman, V. Goncharov, J. Eccles, A. Koppel, T. Kuhn, K. Popper, and others studied the paradigmatics of world reincarnations.

The issue of transdisciplinarity also attracted the attention of scientists standing on the frontiers of innovation science, such as, for example, Y. Danilov, M. Zhamborova, L. Kiyaschenko, A. Knigin, E. Knyazeva, V. Moiseev, V. Mokiy, M. Mokiy, P. Romanov, M. Simonov, A. Stryzhak, A. Shegai, M. De Mello, A. Judge.

The multitude of existing educational paradigms are justified by science. However, the transdisciplinary paradigm of modern education in the epoch of constructing the information society is in a sustainable development and has not yet been widely disclosed by scientists. In this context, to research in the field of implementation of the idea of STEM-education (the abbreviation was first proposed by the American scientist R. Colwell) expressed an interest S. Galata, H. Gonzalez, N. Goncharova, D. Cuenzi, A. Kuzmenko, A. Korshunova, D. Langdon, N. Morse, K. Nichols.

Certain advanced experience in introducing the provisions of the STEM approach of most countries, namely Australia, Kazakhstan, Canada, Malaysia, Russia, USA, Ukraine, Finland, and also European countries: Austria, Great Britain, Germany, Italy, France, etc. is used in scientific justification of the advanced development of modern educational systems. In addition, the future already indicates the need for specialists of the new generation, who already today should start acquiring STEM professions. However, the characteristic of a transdisciplinary approach in the aspect of STEM-knowledge management on adaptive principles is not fully presented by scientists.

At the same time, the structure of management science consists of various theories, such as: the general organization theory – A. Bogdanov's tectology [2; 3]; the general theory of systems by L. Bertalanffy [4]; W. Ross Ashby's cybernetics [1], in particular, the theory of adaptive control by G. Yelnikova [7] and others.

During the construction of the world knowledge society, the problem of knowledge management is certainly being addressed as one of the important conceptual trends of educational innovations, which plays the significant role of a transformational redefinition of the nature of identifying, shaping and developing the intellectual and labor potential of the country as a whole and of each individual directly. The fundamental scientific works of such scientists as A. Weber, A. Gaponenko, V. Makarov, B. Milner, T. Orlova, V. Raskov, S. Rumyantseva, T. Davenport, P. Drucker, D. Leonard-Barton, J. Nonaka, L. Prusak, P. Romer, T. Stewart, and H. Takeuchi are devoted to the development of this idea. Unfortunately, scientists do not fully highlight the features of STEM-knowledge management in the context of an adaptive approach.

One of the main aim of education is the training of scientific and pedagogical personnel, who already have an appropriate level of professional competence, necessary for establishing adaptive interaction in the process of transdisciplinary training of STEM specialists.

It should be noted that the adaptive approach in education, namely the adaptive management of social and pedagogical systems, is revealed by V. Afanasyev, B. Gershunsky, T. Davydenko, G. Yelnikova, G. Zaitsev, N. Zaruba, N. Kapustin, N. Kovsh, E. Lunyachek, V. Milkop, P. Tretyakov, T. Shamova, I. Yakimanskaya, E. Yamburg, etc. Also representatives of the public organization

“School of Adaptive Management of Social and Pedagogical Systems” (chaired by G. Yelnikova) works in this context. It was Professor G. Yelnikova who was one of the first to raise the problem of the sustainable development of Ukrainian STEM education from the position of adaptive processes for its implementation [8].

It should be noted another important aspect in this sense. According to some domestic researchers (in particular V. Goncharov), the management of the organization of the development of a paradigm environment is also considered as an affirmation of the cultural basis for the training of a teacher (teacher).

Actually, in the opinion of V. Goncharov, this causes a thorough study of the methodological frameworks of the adaptability of the cultural environment, as well as, among other things, the general definition of this development idea - the national idea for Ukraine, etc. [6, p. 9–10].

Domestic researchers, analyzing modern European trends in the upgrading of teaching staff come to the conclusion that the effectiveness of the latter is a kind of a balance between personal characteristics and general qualifications, as well as pedagogical qualifications [6, p. 271].

To the priority aims of managing such an environment, incl. knowledge management, V. Goncharov classifies : solving the problems of internationalization and integration of world education; the organization of a new, intercultural pedagogical experience based on the effects of various forms of consciousness in collaboration with the emotional excitement of life; reduction by teachers of the susceptibility of pupils and students to the factors of external and internal determination, which became in the late XX–XXI centuries catastrophic; as well as the realization that an important manifestation of a teacher’s moral culture is his ability for spiritual creativity, the conditions and process of which have certain contradictions that need to be resolved in the course of adaptive influence, namely, between: the objective need for a teacher’s own spiritual level and the lack of socio-economic conditions of its provision; freedom of spiritual creativity of the teacher and its politicization; content of the spiritual values of the individual and the forms of their security declarative and guaranteed possibilities for the manifestation of the teacher’s spiritual creativity; the urgent needs of the development of the spiritual creativity of the teacher’s personality and the insufficient scientific and methodological provision of them [6, p. 273–277]. To our mind, this becomes possible due to the adaptive management of STEM-knowledge management on adaptive basis, because the teacher’s cultural environment is one of the important components of the transdisciplinary paradigms of STEM-knowledge management of subjects of education.

Thus, an analytical review of the source base of philosophical, informational, scientific and pedagogical achievements in the course of studying the topics outlined above leads us to thoughts about birth and the formation of transdisciplinary paradigms of the modern world perception of reality. Therefore, the aim of the article is to reveal the idea of balancing the process of STEM-knowledge management in the context of an adaptive approach to the implementation of STEM-education in the context of the formation of transdisciplinary paradigms of a unitary information space of the country.

The presentation of the basic material. It is obvious that the globalization of social communications, the transformation of the economy through the rapid transition to market relations, the need to form a knowledge economy put forward new requirements for training and education.

The solution of the main task of the modern education system is determined by the trajectory of innovations, which are aimed at training of a new generation of people who have certain abilities for self-improvement, self-development, self-education and finally for self-realization in the profession. That is, to our mind, the educational system should contribute to the creation of appropriate conditions for the formation and development of the country's human capital (scientific, intellectual, labor potential of the country) as an important component of the knowledge economy. At the same time, the legitimate transience of the emergence of information resources - technical means, production technologies and management affects the development of innovative educational systems of developed countries. This suggests that the leading factor in the innovatization of education in the most countries is the STEM component. For example, the national program for the training of STEM educators is already functioning in the USA (100,000 are planned over a period of 6 years) [10].

P. Sitnikov made a n interesting statement considering that in modern conditions in the process of school education the concept of polytechnism, which only teachers who have received additional vocational training and who are ready to work in an integrated system of educational disciplines and technologies can realize -it should be taken into account [11].

Indeed, in considering the problem of the national education system, it stands out that pedagogical training is conducted according to clearly limited specialization (technology, biology, mathematics, etc.). This situation leads to the idea that students receive a fragmentary level of

knowledge. Therefore, based on the retrospective experience of teaching subjects, it is necessary to note the fact that the poly-specialization of pedagogues (tutors, teachers), in particular, informatics, who are a priori trained for the interdisciplinary discipline, allows to integrate unique technical, technical and technological, special, etc. aspects of knowledge acquisition, and therefore intensify the process of managing students' knowledge. It is the innovatively oriented consciousness of specialized subject teachers in the nowadays situation of introducing STEM educational technologies that focuses on real solutions to many issues in this vector of education of the younger generation.

In fact, not much is needed: it is necessary to organize appropriate scientific and methodological support for the training of teaching staff, that is, both in the implementation of the STEM educational process in higher education institutions and in the educational process of that educational institution (school, out-of-school, vocational, etc.) where the implementation of the pedagogical competence of tutors, teachers, methodologists, etc. This is where effective management of the environment for obtaining complex, interdisciplinary knowledge based on the principle of scientific character in STEM-knowledge management of both teachers and their students will be needed. Thus, the advanced professional development of the intellectual and labor opportunities of educational personnel is intended to ensure the deepening of scientific content in the area of research pedagogical competence; contributes to the level of formation of its components - STEM-literacy and the ability to STEM-knowledge management, both in their own and among students. In turn, effective STEM-knowledge management becomes possible in the context of an adaptive approach to education and high-quality scientific support of this process.

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Thus, N. Zaruba characterizes the adaptive approach as an interdisciplinary scientific approach, which has been developed and applied in many scopes and areas of society: sociology, management, cybernetics, biology, pedagogy, etc. She considers that the development of an adaptive approach in pedagogical science and its active application in practice results from permanently certain changes in the life of society, and, above all, the innovative nature of modern education [9]. The scientist draws attention to the fact that in accordance with the evolutionary-cybernetic approach to modeling the adaptive behavior of the system, from the point of view of M. Burtsev, unlike other scientific approaches, "with the adaptive approach, current information is actively used to fill in the missing a priori information. That is, "an adaptive approach can also be applied in cases where the application of the traditional approach, although possible, is associated with a lot of work on the preliminary determination of distribution functions". The researcher says, "if it is not clear in advance which process we are dealing with deterministic or random, and their characteristics are even more unknown, then the only sensible solution is related to training and adaptation in the process of experimentation, that is, using an adaptive approach" [5; 9].

In this regard, the Ukrainian scientist G. Yelnikova notes that STEM-education and the essence of adaptive management are very similar in purpose and specific tasks. She claims that adaptation accompanies STEM-education to the core, because adaptive management always occurs arbitrarily in the process of change, coordinating the multi-directional effects on the subject of activity [8].

In our opinion, STEM-knowledge management is the adaptive management of transdisciplinary interrelations in the process of studying the interdisciplinary term space by the subjects of the STEM environment, as well as their training in the methodology of finding the necessary practical STEM-oriented knowledge (S -Science- knowledge based on scientific knowledge of the world; T -Technology- technical and technological knowledge; E -Engineering-knowledge of engineering; M -Mathematics - analytical and mathematical knowledge; MK - Management Knowledge - knowledge of management processes and their psychological and organizational impact (Fig. 1).

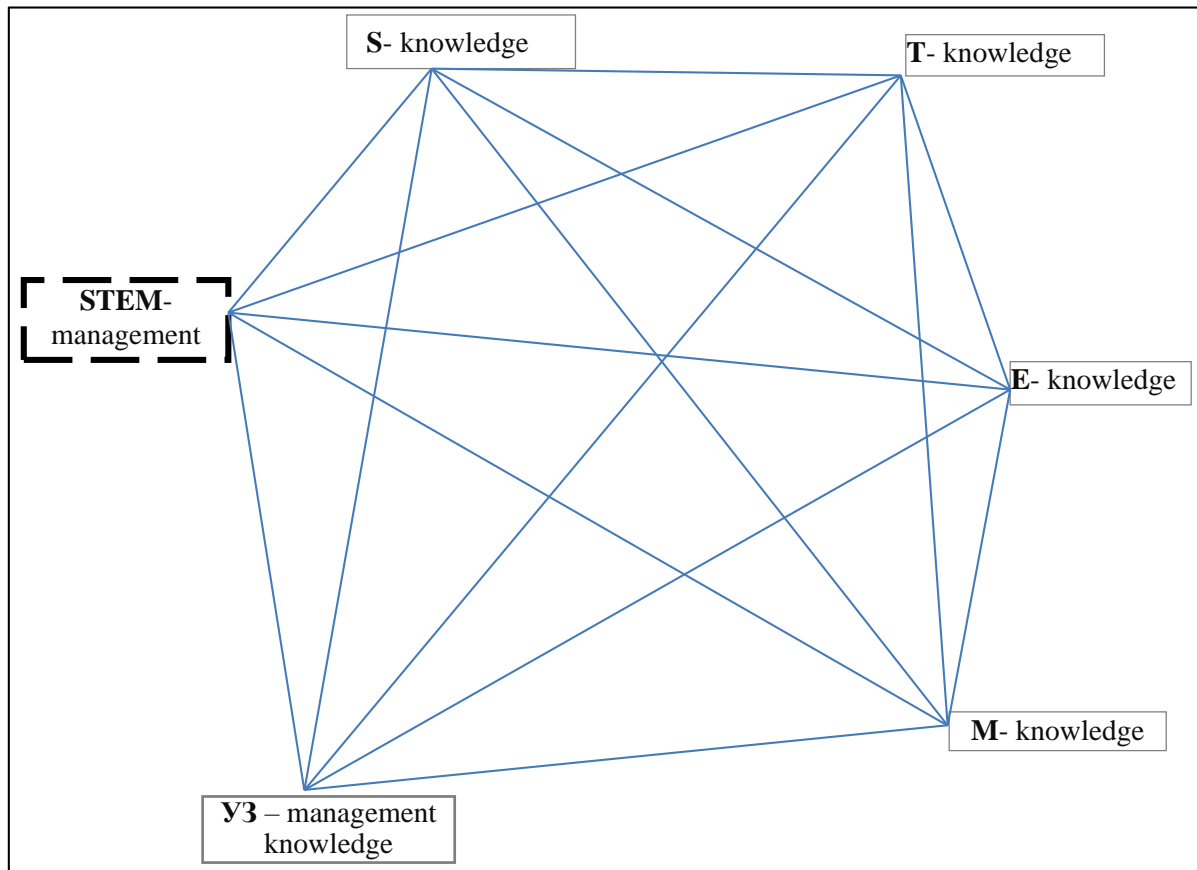


Fig. 1. The adaptive construct of transdisciplinary relationships of the STEM-knowledge management process

Thus, the construct shown in the figure indicates the adaptive cross sections of the thermal field – S, T, E, M and MK, which indicates the presence of a transdisciplinary environment, that is, the spread of the scientific worldview on the development of the emergence of a new scientific anomaly – the STEM-knowledge management transdisciplinary paradigm".

To our mind, this is a way to expand the scientific worldview, which allows us to consider a particular phenomenon outside of any scientific discipline. We agree with A. Lebed, who asserts that "it is necessary that every scientific discipline, which is a part of a transdisciplinary complex, to be both an open and a closed system. It has to be open to new cognitive schemes imported from related scientific disciplines with a highlighted heuristic significance and ready to cooperate to implement joint research projects. It should be closed insofar as it must preserve its specific subject and aspect of research, develop research methods and strategies" [12].

Conclusions. So, in the context of studying the source base of the scientific heritage of classical scientists and modern scientists, based on the retrospective and taking into account the practice orientation of generations, innovations outlined by a certain vector of knowledge management process are presented using complete new approaches, new technologies and methodologies that are progressing in this direction. We believe that it is the transdisciplinary paradigm of STEM-knowledge management in the context of an adaptive approach that combines the existing paradigms of education into a single information and educational world space, creates an adaptive social-pedagogical system, provided awareness by mankind of the processes of formation of the so-called information society, which led to the emergence of a new generation of man. This is the future of each country in particular, and the world as a whole!

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