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ILLUMINATION OF SYNERGETIC CONCEPTS IN NATURAL FUNDAMENTAL EDUCATION

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Abstract

The article discusses the analysis of self-organization phenomena occurring in open systems far from equilibrium using synergistic concepts and categories and the issues of illuminating these processes in natural fundamental education.

Synergetic concepts and categories are briefly described, and it is shown that it is possible to increase the effectiveness of education by using a synergetic and integrative approach and a systematic analysis method in modern natural fundamental education.

Keywords: open system, systematic approach, non-equilibrium state, dissipative system, dissipative structure, synergetics, self-organization, nonlinearity, bifurcation, attractor.

INTRODUCTION

It is known that physics, chemistry, biology, and other natural sciences are taught in higher education institutions. In the process of teaching these subjects, the use of methods based on scientific ideas is one of the main features of modern pedagogy, and it is of great importance in the process of learning and acquiring scientific knowledge. Also, it is observed that thanks to the use of interactive, integrative methods of teaching, a synergistic approach to education, and methods of systematic analysis, it is possible to achieve great results in learning.

The rapid increase of scientific information that must be acquired at the current stage of educational development, and the growth of students' thinking abilities require the rational use of new pedagogical theories. In this situation, the need to improve didactic principles, use methods such as creating controversial and interactive situations in the course of the lesson, and teach students independent education began to emerge. In other words, not only classical theories but also new methodological theories began to be reflected in pedagogical sciences.

In addition, as a result of the development of natural sciences, the emergence of new sciences in their related fields causes a sharp increase in the amount of scientific information to be acquired. In such conditions, there is a need to apply the methods of integrative, systematic analysis, and synergistic approach to education. For this purpose, providing students with knowledge about synergistic concepts and categories and introducing synergistic principles into education will have a great effect. Thus, a comprehensive analysis of modern educational problems shows that the application of the theory of synergetics to the field of pedagogy is the need of the hour. Below, the issue of synergetic concepts and categories in natural fundamental sciences is explained.

MAIN PART

At the current stage of the development of society, the role of science has risen to a very high level. The whole life of society changes in terms of content based on scientific knowledge. Science and technology are closer than ever. And science becomes the productive force of society. The success of new information technology and computing tools, genetic engineering, and biotechnologies indicates that a radical change will occur in the development of society.

At the same time, the system of scientific knowledge itself is radically changing. The clear line between practice and cognitive activity is disappearing. In the system of scientific knowledge, there is a rapid transition from a differential form of knowledge to an integrative form, and complex and interdisciplinary research is developing. New ways of knowing, methodological instructions, and new elements of the worldview are emerging.

At the beginning of the 21st century, a new historical period of natural science development began. This period is characterized by the priority of complex research carried out by integrative sciences.

Research objects of modern integrative sciences include unique systems characterized by openness and development. Among such unique systems, natural complexes (ecological objects, methodological-biological objects, biotechnological objects, human, machine systems, etc.) that include humans have a special place. Information about closed linear and open nonlinear systems, their development, and evolution is important in the description of synergetic concepts in natural fundamental education.

Most of the real systems have an open and complex structure. This means that they exchange energy, matter, and information with the external environment. Among the complex systems, the systems in which the phenomenon of self-organization takes place stand out. Such complex open self-organizing systems include physical, chemical, biological, social, and other systems, all of which are important for human life and activity.

In the second half of the last century, the theory of complex self-organizing systems began to develop rapidly. Research conducted in the field of mathematical modeling led to the emergence of synergetics, a new scientific direction in modern natural science, which is considered the theory of self-organization. Synergetics, like cybernetics, requires an interdisciplinary approach. Synergetics is focused on researching the principles of self-organization, development, and self-complexity. The world of self-organizing systems is more complex than the world of closed linear systems, and their modeling is a difficult problem.

Synergetic methods can be used to model many complex processes in self-organizing systems, such as morphogenesis in biology, some aspects of brain function, the flutter of an airplane wing, self-oscillations in molecular physics and chemistry, the evolution of stars, processes in electronic devices, and even the formation of public opinion and demographic processes. it was possible.

The theory of non-equilibrium situations was formed in three directions. One of them is the kinetics of acute disequilibrium processes based on statistical physics, the second is the non-equilibrium thermodynamics of open systems, and the third is the mathematical theory of decomposition and bifurcation. Non-equilibrium thermodynamics of open systems is the second branch of non-equilibrium analysis. This trend is related to the study of the properties of open systems by generalizing the concepts of classical phenomenological thermodynamics to strong non-equilibrium processes. To keep open systems in a certain state, matter, energy, and information must come to them. For example, to maintain the activity of the organism, all its parts exchange substances with the external environment. A constant exchange of matter, energy, or information is a necessary condition for the existence of unbalanced and unstable states. Closed systems, according to the second law of thermodynamics, always strive for a homogeneous equilibrium state.

As a result of the coordinated interaction of small systems that are part of large systems, processes such as ordering, and the formation of precise structures from chaos, their change and complexity occur. The greater the degree of disequilibrium, the greater the extent of correlation and correlation. Processes occurring in out-of-equilibrium systems are characterized by non-linearity, the ability to control the system using external influences, and the presence of feedback. In open dissipative systems, entropy decreases and self-ordered dissipative structures emerge from chaotic states.

Since the formation process of dissipative structures is similar to phase transitions in balanced systems (appearance of conductivity, magnetoelectric, ferromagnetic, and other properties), these processes are also called non-equilibrium or kinetic phase transitions. For kinetic phase transitions to occur and the resulting structures to remain stable, negative entropy flows from the outside are required.

According to the nature of the arrangement, these structures can be divided into spatial, spatiotemporal and temporal structures. Examples of phase structures include turbulence in fluids, convective Benar cells, lattices of vacancies in materials, etc. Examples of space-time structures include laser radiation, and time structures include vibration and wave processes in nonlinear systems.

In systems where dissipative structures can be formed, the second law of thermodynamics is not violated. This law is manifested in a more general way, defining the conditions of self-organization in systems. If dissipative structures from small open systems within larger closed systems is taken into account, the total entropy increases, and the second law of thermodynamics is not violated. The coordination of the second law of thermodynamics with the theory of self-organization is one of the great achievements of modern thermodynamics.

Self-organizing systems are usually very complex systems characterized by a large number of degrees of freedom. But not all degrees of freedom of the system will be equally important for its evolution. Over time, the system may have fewer fundamental degrees of freedom. Such basic degrees of freedom of the system are called attractors. Attractors characterize the directions of the evolution of an open, nonlinear system. In other words, the processes of transition of the system from one state to another lead to the formation of structures called attractors. If the system is in a state near a certain attractor, its evolution takes place towards this attractor, albeit in different ways. An attractor is a geometric structure that characterizes the behavior of an object over time in a multidimensional space. Self-organization of the system is not a smooth process. This process experiences sharp turning points called bifurcation points. Near bifurcation points, the role of large fluctuations and random factors in systems increases dramatically. How self-organization develops after the turning point is completely uncertain, and the system is in a position to choose one or another path of development. In this case, a small fluctuation serves as an impetus for the evolution of the system to take place in a certain direction. The state of the system can remain chaotic or move to a new state of order and organization. The formation of several phase transitions, dissipative structures, plasma instabilities, flutter, chemical vibrational reactions, structures in liquid, etc. can be proof of the above-mentioned points.

Synergetics has demonstrated that processes such as bifurcation, self-organization, and evolution of systems are not only related to physical phenomena but also to inorganic nature. A synergistic approach to issues in social spheres helps to predict the development of society. There is no doubt that the history of the development of nature is a history of the formation of more complex nonlinear systems.

CONCLUSION

Thus, modern natural sciences study ways to theoretically model the most complex systems capable of self-organization and self-development inherent in nature. The main characteristics of self-organizing systems are openness, nonlinearity, and dissipativeness. Such properties can be observed in nonlinear systems far from equilibrium. Illumination of knowledge about synergistic concepts and categories described above in basic natural education increases students' interest in acquiring this knowledge.

According to modern ideas, the educational system consisting of higher education institutions, students, teachers, educational process, the content of science programs, etc. can be considered a synergetic object. Students have the opportunity to get knowledge and scientific information not only from lectures and practical sessions but also from electronic textbooks, Internet systems, and scientific and popular periodical literature. One of the main tasks of the educational process is to systematize the knowledge acquired by future specialists and to develop ways of their effective application in public economic facilities.

It would be appropriate to use synergistic views regarding the current education system as an open, non-linear system. A synergetic approach to education requires giving students systematic knowledge and teaching them to think systematically, that is, to perceive events and phenomena in their interrelationship, as a whole, as a whole.

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