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SYSTEM APPROACH TO PUPILS TRAINING OF CHEMISTRY

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System Approach to Pupils Training of Chemistry
Scientific-theoretical basics of application of system approach to an actual problem of system training of pupils of chemistry on the ecological and humanistic principles are covered. Theoretical research of approaches to definition of concept "system", consideration of its main signs and properties, selection criteria of its components allowed us to mark out the main system properties which gave the chance most substantially and precisely to describe training of pupils of chemistry as system, and also further will be the basis for its creation already as pedagogical system. For research of system of training of pupils of chemistry as the most expedient the following aspects of system approach were chosen us: system-component, system-structural, system-functional, system-communicative (system-information), system-integration (system-administrative), system-historical (system-genetic). The general innovative concept of system training of pupils of chemistry which professes not chemo-centric model of school chemical education which regards as of paramount importance "mold" of the chemical science adapted under age and temporary features of training of chemistry at school, and ecological and humanistic (human-bio-centric) model according to which the priority is given to the identity of the pupil, his formation ecologically and morally pure inner world is created. The specified concept includes five theoretical provisions combining all previous and predetermining the subsequent theoretical and methodological material of our research.

Key words: system approach, school chemical education, ecological and humanistic values.

Training of pupils of chemistry demands obligatory use of system approach as it is the key methodological direction of modern general scientific knowledge and consists in research of any object or the phenomenon as systems. The teacher of chemistry has to know theoretical bases of system approach that you will allow it to construct system of training of chemistry most effectively. Therefore tasks of our research are, first, to allocate those theoretical bases of system approach by means of which will become possible most substantially and precisely to describe training of

pupils of chemistry as system; secondly, on the basis of the received material and theoretical and methodological generalizations of an ecological and humanistic orientation to define the general innovative concept of system training of chemistry.

Performing the first task, we will note that the original general scientific concept which represents historically first developed version of the general theory of systems, was stated by the Russian doctor, the philosopher and the economist A. A. Bogdanov (a pseudonym; a real name – Malinovsky) in three-volume work "General organizational science (tektologiya)" (1911–1925). The main ideas of a tektologiya (from Greek – "the doctrine about construction") consist in recognition of need of approach to any phenomenon from the point of view of organization where organization is understood as property whole to be more than a sum of the parts, and also in identity of the organization of systems of different levels (from a microcosm – to biological and social systems), and each system needs to be studied as from the point of view of the relations of its parts, and its relations as whole with all external systems – environment [1].

With high degree of reliability it is possible to claim that the general theory of systems as the independent scientific direction started being formed in the late forties of the XX century from works of the Austrian biologist and philosopher L. von Bertalanfi. At the heart of the theory it used analogy, in particular isomorphism of processes which proceed in all systems. With its help not single properties of certain systems which are a subject of other concrete sciences, and, generally their general structural construction as strictly proved isomorphism for systems of the different nature gives the chance to build the generalized models of systems and to transfer system knowledge from one subject branch to another had to be studied [2]. The most important achievement of Bertalanfi – introduction of concept of open system which constantly exchanges substance, energy and information with environment, and also use by it for the characteristic and the description of systems of such formal system properties as integrity, the hierarchical organization and others is valuable to our research.

Further theoretical system concepts actually refused claims for generality for the purpose of achievement of high level of abstraction and, usually, rather accurately were guided by research of strictly certain classes of system objects (abstract and mathematical, biological, technical), using thus languages of the theory of sets (M. Mesarovich), algebras (O. Lange), logic (A. I. Uyomov), probability theory (M. Tod and E. H. Shuford), etc. The powerful contribution to development of system representations was also made by R. L. Akof, A. N. Aver'yanov, P. K. Anokhin, V. G. Afanasyev, I. V. Blauberg, K. Boulding, M. S. Kagan, E. Kveyd, V. P. Kuzmin, V. A. Lektorsky, S. L. Optner, F. I. Peregudov, L. A. Petrushenko, A. Rapoport, V. N. Sagatovsky, V. N. Sadovsky, M. I. Setrov, B. S. Fleyshman, Yu. I. Chernyak, G. P. Schedrovitsky, U. R. Eshbi, E. G. Yudin and others.

For conscious use of system approach in training of chemistry it is necessary to consider, first of all, the available approaches to definition of the basic concepts of system research as we consider that formation of the specified values is system which has a certain structure. The theoretical analysis of a problem showed that despite of intuitive clearness and great importance of concept "system" for scientific investigations, doesn't exist hitherto its standard definition that is connected with development of this concept at the same time of ontological, gnoseological and methodological aspects [3]. The wide review of definitions (about 40) concepts "system" is presented in V. N. Sadovsky's robot of "The basis of the general theory of systems" [4, p. 92 – 102], and also in A. I. Uyomov's book "System approach and the general theory of systems" [5, p. 103 – 117]. Thus it is possible to allocate the following approaches in interpretation of system which developed throughout development of the theory of systems, of use of this concept in practice and are of interest in the context of our work:

1) consideration of system as complex of the interacting parts. For example, L. von Bertalanfi defined system as a complex of the interacting elements [2, p. 29], and "The big Soviet encyclopedia" – the direct translation from Greek "sýstēma" as whole, made of parts [6, p. 463];

2) inclusion in concept “system” of characteristics (requirements). So, I. V. Blauberg, V. N. Sadovsky and E. G. Yudin, proceeding from complete character of system, qualitatively define her concept through such signs: coherence of elements of system; the system forms special unity with Wednesday; any system is an element of system of the highest order; elements of any system, usually, act as system of the lowest order [7, p. 29];

3) creation of definition on the basic concepts: “a thing – property – the relation”. In particular, in such context V. S. Tyukhtin [8] and A. I. Uyomov [5, p. 79 – 89] consider system as a set of objects (components) which own beforehand set properties with the fixed relations between them;

4) definitions of system on the basis of one leading category – “integrity” (V. G. Afanasyev) [9, p. 24], “sets” (A. N. Aver’yanov) [10, p. 9], “organizations” (L. A. Petrushenko, A. D. Ursule) [11, p. 54] and others;

5) cybernetic and mathematical understanding of system (R. Akof, L. Arnof, U. R. Eshbi, M. Mesarovich, U. Cherchmen, etc.) [11, p. 54];

6) introduction to definition of system of concept “purpose” in the form of the end result, backbone criterion, function (P. K. Anokhin, V. I. Vernadsky, U. R. Gibson, M. G. Gaaze-Rapoport and others). In some definitions formation of the purpose conditions – environment, an interval of time within which there will be a system and its purposes as it is made, for example, in V. Sagatovsky's definition are specified: “The system is a final set of functional elements and relations between them allocated from the environment according to a definite purpose within a certain time interval” [12, p. 13 – 14];

7) inclusion in definition of system along with elements, communications, their properties and the purpose also “observer” (S. Optner, Yu. I. Chernyak, etc.). I pointed by the first to need to consider interactions between the researcher and the studied system кибернетик U. R. Eshbi, however the economist Yu. I. Chernyak accurately registered: “The system is reflection in consciousness of the subject (the researcher, the observer) properties of objects and their relations in the solution of research problems, knowledge” [13, p. 22].

The review of different interpretations of concept “system” testifies that it is possible to allocate such main related semantic aspects: the most widespread, but also at the same time narrower, the “engineering” understanding of system as the interconnected set of elements and ways of their combination which serve a definite purpose is; in “design” understanding the system moves as design and creation of a certain complex of methods and means which the researcher (developer) applies to achievement of a definite purpose, to performance of the task; in research treatment “system” appears as the general methodology of research of processes and the phenomena which belong to a certain area of human knowledge; in theoretical informative aspect “system” is considered as a way of thinking [14, p. 14].

Sufficient for our research we consider the definition of system given by T. A. Ilyina. “The system is the ordered set of the interconnected elements united by an overall objective of functioning and unity of the management entering interaction with Wednesday as complete unity allocated on the basis of certain signs” [15, p. 16]. Such basic definition of system will help us with the description of system of training of pupils of chemistry.

Comprehensive investigation of any system includes establishment of structure of components, structure and functions as systems in general, and its components, factors which provide integrity and relative independence of system, and also history of its emergence, formation and development. In this regard creation of system of training of pupils of chemistry provides obligatory application of the following main aspects of system approach:

– the system-component – consists in research of component structure of system;

– the system-structural – allows to gain an impression about the internal organization of system (interaction of components, their subordination and communications);

– the system-functional – is caused by definition of the all-system purpose, local goals (is more whole than components of system which are realized by performance of specific functions of components), a set of means (resources)

necessary for achievement of this purpose and functioning of system in general as integration result of functioning of its components;

– the system-communicative (system-information) – determines need of identification of communications of components of system among themselves, each of components with system in general, and systems in general with systems of the environment and not system educations;

– the system-integration (system-administrative) – considers factors (internal and external) system integrity, that is mechanisms which provide preservation of qualitative specifics of system;

– the system-historical (system-genetic) – provides research of stages and temporary conditions of development of system, since its emergence, formation, further functioning, and also possible tendencies of development [16, p. 69 – 71].

Application of the specified aspects of system approach, and also the system principles (the principles of integrity, degree of structure, an ultimate goal, functionality, autonomy and communication of components, development, interdependence of system and environment, hierarchy, plurality of the description of system, etc.) gives the grounds to recognize training of chemistry by system as in it there are following signs of system: compound components, structure, focus, integration qualities, functional characteristics of system in general and its separate components, communicative properties, historicity (continuity) and management are provided. We will understand only those its structural parts which are in continuous interaction with other structural units within this complete system and which interaction causes identification inherent whole qualitative features as components of system. For implementation of this requirement at creation of innovative pedagogical system of training of pupils of chemistry it will be necessary to prove that the allocated components are components of this system, but not incidentally assorted and untied structural parts.

Investigating numerous classifications of systems by different signs (N. T. Abramova, A. N. Averyanov, R. Akof and F. Emery, S. I. Arkhangelsky, V. G. Afanasyev, St. Bir, A. A. Bogdanov, B. A. Gladkikh, V. V. Druzhinin and

D. S. Kontorov, M. A. Slemnyov, S. P. Nikanorov, L. A. Petrushenko, M. I. Setrov, Yu. I. Chernyak, etc.), we came to conclusions that the system of training of chemistry is difficult (organic), live (social), open, dynamic, artificial (organizational and technical), conceptual (abstract, descriptive, logical), hierarchical, active (purposeful), determined, developing, regulated (with the combined management).

At the same time the system of training of chemistry is a kind of pedagogical system as has all signs inherent in such system: forms the basis of theoretical judgment and creation of pedagogical activity; includes a certain set of the interconnected means, methods and processes necessary for creation of organized, purposeful pedagogical influence on formation of the personality with the set qualities; provides performance of valuable and semantic, standard, technological and procedural and productive functions of pedagogical activity; achievement of goals of development of the person is promoted [17, p. 79].

On the basis of stated above we will mark out the main properties of system of training of pupils of chemistry which at the same time is criteria of viability of this system and will be the basis for its creation already as pedagogical system:

– integrity and divisibility – system of training of pupils of chemistry (further – the studied system) is, first of all, complete set of components, that is, on the one hand, this complete education, and with another – in its structure complete objects (components) are accurately allocated, and this system behaves as a single whole if changes of one of components cause changes of other components. But not components form whole (system), and on the contrary, at division whole components of the studied system are found;

– non-additive of system (emergent – suddenly to arise, appear) – cumulative functioning of the interconnected components of system generates emergence of qualitatively new functional properties of system, therefore, functioning of the studied system can't be reduced to functioning of its separate components;

– focus – the studied system aims and the actual behavior of system goes and is under the influence of anticipation of the purpose;

– degree of structure – in the studied system is available set of internal continuous and essential communications between components that defines the main properties of this system. Decomposition of the studied system allows to allocate in it the components available to the analysis, and their elements which according to tasks of research aren't divided into components;

– hierarchy – in the studied system is available level subordination of components (the order is defined from higher to lower);

– an integrationist – division of the studied system into components, research of each of them separately it is impossible to learn all properties of system in general;

– equi-potentiality – the studied system can be considered as a subsystem of system of the highest level and vice versa – the subsystem can be considered as system with the structure of components and communications between them;

– functionality – the studied system has certain, inherent only to it internal and external functions, an optimum combination of these functions;

– the synergism – efficiency of compatible functioning of components of the studied system is higher, than total efficiency of the isolated functioning of the same components;

– an information's – the studied system has information exchange between components for realization of the functional properties, i.e. are available not only communication channels, but also material fullness their signals;

– interdependence between system and environment, openness – the studied system forms and shows the properties at interaction with environment which does it open. It develops under the influence of environment, but thus tries to keep qualitative definiteness and properties which provide high resistance, independence and adaptability of its functioning;

– balance – the studied system is capable to store the state as it is possible more long (both at absence, and in the presence of active external influences);

– firmness – the studied system can keep parameters in the set limits and come back to an equilibrium state after its removal from this state action of external influences;

– reliability – the studied system is capable to function smoothly at failure of one of components;

– dynamism – the studied system has the dynamic nature, that is it processes of emergence, formation, development, change and the termination of existence [14, p. 21 – 23; 18, p. 52 – 66; 19, p. 63 – 65; 20, p. 86 – 87].

This last system property defines realization of the second task of our research – justification of the general innovative concept of system training of pupils of chemistry without which formation, further development and improvement of the studied system is impossible. The specified concept professes not chemo-centric model of school chemical education which regards as of paramount importance "mold" of the chemical science adapted under age and temporary features of training of chemistry at school, and eco-humanistic (human-bio-centric) model according to which the priority is given to the identity of the pupil, his formation ecologically and morally pure inner world. Such innovative conceptual provisions which combine all previous will be its basis and predetermine the subsequent theoretical and methodological material of our research.

1. Quality school chemical education has to be based on an ecological and humanistic paradigm and modern social and philosophical scientific views, and form knowledge not as set of the acquired information, and as a component of the general culture of the identity of the pupil, a basis of his key competence, including chemical and ecological.

2. Relevance and need of the system organization of training of pupils of chemistry for general education educational institutions of Ukraine have to proceed from need of overcoming of three main contradictions between:

– the social order of society for formation of ecologically humane identity of the graduate of school and the imperfect maintenance of school education which doesn't provide the high level of formation of ecological and humanistic values of the young man;

– need of the solution of a task on formation of ecological and humanistic values in the course of school chemical education at the theoretical level taking into

account modern ecological and humane representations and the settled scientific views on valuable world outlook components of the content of chemical education;

– the potential opportunities of chemistry as development tools of the valuable sphere of the personality and the valuable attitude towards chemical knowledge which isn't created at school students.

3. Training of pupils of chemistry has to be constructed as pedagogical system, where:

– the purpose is directed on realization of ecological and humanistic potential of chemistry for formation of the chemical and axiological consciousness of pupils which is based on system axiological perception of chemical knowledge;

– the contents is focused on an axiological of school chemical education, its common cultural orientation, acquisition by pupils of key competence (in particular chemical and ecological) and provides design of an individual educational route of their ascension to understanding of own position in the course of creatively active and the valuable focused mastering chemical and ecological knowledge, abilities and the relations;

– the pedagogical technologies rely on integration axiological and system approaches, consider values, ideals, belief of pupils with emphasis on creatively active, personally painted acquisition of knowledge, skills by them;

– the pupils as actively acting subjects of pedagogical interaction aim own activity and an active position in its achievement, make use of own experience in educational process, coordinating it with the public; recognize values of the general experience, interaction value in educational process, social and environment; carry out reflexive introspection for the purpose of spiritual moral development and self-development;

– the teachers of chemistry are the leading subjects of teaching and educational process on condition of their professional (scientific theoretical, practical, psycho-physiological and psychological) readiness for formation humane, what chemically competent, competent, intellectually and creatively developed identity of the pupil;

– the social and environment is the pedagogical system which is directly localized in structure that allows pupils to consider any chemical and environmental problem in the wide social range taking into account priorities of the general human humanistic beginnings, to analyze interaction of society and the nature in global and regional scales, to expect the closest and remote consequences of influence of the person on environment.

4. Axiological of school chemical education in general education educational institutions through integration of axiological and system approaches – a new, innovative way to formation of ecological and humanistic values in the course of which personal values and moral reference points in use of chemical knowledge, an image of communication of the chemical phenomena with the phenomena of world around, ability to distinguish scientific knowledge in daily ecologically safe use of chemistry, social activity at improvement of knowledge in the field of chemistry develop. We consider this process as a necessary condition for socialization of the personality, recognition of moral standards in relation to achievements of chemistry, diversification of future activity with use of chemical education without harm for the natural and social environment.

The developed conceptual provisions are a basis for further justification and creation of the declared innovative pedagogical system of training of pupils of chemistry that answers further tasks of our research. Performance of this task will also be carried out on the basis of the analysis of pedagogical methodology of system approach and already existing models of pedagogical systems.

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Роман С. В.

Системний підхід до навчання учнів хімії

Розглянуто науково-теоретичні засади застосування системного підходу до актуальної проблеми системного навчання учнів хімії на еколого-гуманістичних принципах. Теоретичне дослідження підходів до визначення поняття «система», розгляду її основних ознак і властивостей, критеріїв виділення її компонентів дозволило нам виокремити основні системні властивості, які дали можливість найбільш змістовно й точно описати навчання учнів хімії як систему, а також у подальшому будуть покладені в основу її створення вже в якості педагогічної системи. Для дослідження системи навчання учнів хімії в якості найбільш доцільних нами було обрано такі аспекти системного підходу: системно-компонентний, системно-структурний, системно-функціональний, системно-комунікативний (системно-інформаційний), системно-інтеграційний (системно-управлінський), системно-історичний (системно-генетичний). Створена загальна інноваційна концепція системного навчання учнів хімії, що сповідує не хеміоцентричну модель шкільної хімічної освіти, яка ставить в основу «зліпок» хімічної науки, адаптованої під вікові та часові особливості навчання хімії в школі, а еколого-гуманістичну (людинобіоцентричну) модель, згідно якої при навчанні хімії

пріоритет надається особистості учня, формуванню його екологічно й морально чистого внутрішнього світу. Зазначена концепція складається з п’яти теоретичних положень, що поєднують увесь попередній та визначатимуть подальший теоретико-методологічний матеріал нашого дослідження.

Ключові слова: системний підхід, шкільна хімічна освіта, еколого-гуманістичні цінності.

Роман С. В.

Системный подход к обучению учащихся химии

Рассмотрены научно-теоретические основы применения системного подхода к актуальной проблеме системного обучения учащихся химии на эколого-гуманистических принципах. Теоретическое исследование подходов к определению понятия «система», рассмотрение ее основных признаков и свойств, критериев отбора ее компонентов позволило нам выделить основные системные свойства, которые дали возможность наиболее содержательно и точно описать обучение учащихся химии как систему, а также в дальнейшем будут положены в основу ее создания уже в качестве педагогической системы. Для исследования системы обучения учащихся химии в качестве наиболее целесообразных нами были избраны следующие аспекты системного подхода: системно-компонентный, системно-структурный, системно-функциональный, системно-коммуникативный (системно-информационный), системно-интеграционный (системно-управленческий), системно-исторический (системно-генетический). Создана общая инновационная концепция системного обучения учащихся химии, которая исповедует не хемиоцентрическую модель школьного химического образования, которая ставит во главу угла «слепок» химической науки, адаптированной под возрастные и временные особенности обучения химии в школе, а эколого-гуманистическую (человекобиоцентрическую) модель, согласно которой приоритет отдается личности ученика, формированию его экологически и морально чистого внутреннего мира. Указанная концепция включает пять теоретических положений, сочетающих весь предыдущий и предопределяющих последующий теоретико-методологический материал нашего исследования.

Ключевые слова: системный подход, школьное химическое образование, эколого-гуманистические ценности.

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