



# The principles of constructing a methodical system for teaching computer science in general educational school

## Los principios de la construcción de un sistema metódico para la enseñanza de la informática en la escuela general de educación

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#### ABSTRACT:

The article considers the concept of constructing a methodical system for teaching computer science as an educational subject. This concept is expressed in the nature, structure of the system and in the set of methodological principles applicable to this training. The authors suggest the principles of construction of the system for teaching, basing upon the student-centered approach for education. Personal development of a student is envisioned as a cornerstone for the system, while the teaching methods are supported by the universal system model, or logic complete model (as authors suggest) implementing a systematic approach to social-information environment in the educational sphere.

**Keywords.** System, methodology, principle, model, informatics, informatization, training.

#### RESUMEN:

El artículo considera el concepto de construir un sistema metódico para la enseñanza de la informática como asignatura educativa. Este concepto se expresa en la naturaleza, estructura del sistema y en el conjunto de principios metodológicos aplicables a esta formación. Los autores sugieren los principios de la construcción del sistema para la enseñanza, basándose en el enfoque centrado en el estudiante para la educación. El desarrollo personal de un estudiante está previsto como una piedra angular para el sistema, mientras que los métodos de enseñanza son apoyados por el modelo universal del sistema, o el modelo completo de la lógica (como los autores sugieren) la aplicación de un acercamiento sistemático al ambiente de la social-información en el ámbito educativo.

**Palabras clave.** Sistema, metodología, principio, modelo, informática, informatización, formación.

# 1. Introduction

The concept of methodological system of teaching subject introduced by the Russian researcher A. M. Pishkalo, includes objectives, content, methods, means and forms of the study (as basic components) (Pishkalo 1975). Considering the problems of methods of subject teaching in the social context of education development in Russia in the late 20th century, he concludes that the development of means of Informatization requires radical rethinking of the aims, content, forms and methods of teaching of any academic discipline at the new modern level, including the system level. These ideas receive further evolution and rethinking through the development of global Informatization, social and informational aspects in the scientific-educational sphere (Abdurazakov 2015; Abdurazakov 2016; Abdurazakov, Zenkina and Shafranova 2016; Kuznetsov, Monakhov and Abdurazakov 2016).

In modern education the personality of the student as an independent subject of cognitive activity, the development (self-development) of this person comes to the foreground that defines the task of identifying patterns of his development. Therefore the addition of methodical system of training the subject with the following components is proposed: "the learning outcomes" and "the student's personality", (Sarantsev n. d.). In the modern sense the component of the "the student's personality" is seen as a result of the development of the personality of education subject based on his/her individual qualities. That is, this component of the methodical system of subject teaching should be understood as "*Personal development*".

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## 2. Methodology of research

Here we suggest main principles for the construction of the system for teaching of Informatics, which we consider to be determinative for the modern socio-cultural conditions. To have the independent components "The learning outcomes" and "Personal development" is particularly important and fundamental for modern developing methodical system of teaching science:

- The learning outcomes are in self-expression with elements of other components and together with them they express system relations. The learning outcome is not only information competence of the subject, but also the informational subculture in its various manifestations.
- Personal development is multifaceted – intelligent, spiritual (socio-cultural) and acquires its expression in the informational subculture.

Therefore, the introduction of these additional components in the methodological system of Informatics teaching is imposed as a *principle* of construction of the system:

### **Introduction of additional components – "The learning outcomes" and "Personal development" - into classical composition of methodical system components of Informatics teaching.**

Personal development of a pupil, considered here as the active subject of education and a competent subject of socio-information environment, transits into another plane and acquires a new quality. Consequently, the teaching of Informatics is developing: it aims at the formation of versatile developed and creative personality, capable of adapting to changing environmental conditions, of the developing of a personal information environment in accordance with his/her needs and important social issues.

A developing personality of the subject of computer science teaching requires:

- information competence, intellectual capacity of adaptation in the information environment, in the sphere of Informatization;
- information subculture that defines the stable (invariant) ability of the subject to adaptation in social and information environment, development and self-development, learning and self-education.

The construction of methodical system of Informatics teaching in general education is a critical step in this training that determines the whole further educational and cognitive activity and

appropriate educational interaction. In modern education, methodical system of computer science teaching has to be quite invariant, as it should be, in any information, scientific and educational system. However, it must be constantly developing conceptually, meaningfully, methodologically and also structurally. Therefore, a necessary set of fundamental principles of construction and formation of methodical system of Informatics training, defining the concept of this construction and its development as an open scientific information systems is needed.

The principles of methodical system of Informatics training are defined, in their turn, by:

- the requirements of the society, modern society, Informatization to modern education, information education;
- trends of development of society, education, information environment, its contents, resources, infrastructure;
- purposes of education, information learning, the intended results of this training, relevant to its purposes.

In this case, the "determination" means a logical following from requirements, trends, and goals mentioned above. The identification of principles, the formation of their complex is the task of the majority methodical system of teaching computer science itself as a differentiated scientific-methodical system. Herewith, the logical following from the requirements, trends, goals, relying on them as an intellectual foundation should be considered as one of the fundamental principles of construction and development of methodical system of Informatics training.

The construction, formation and development of Informatics training is due to the expectations of modern society, the requirements of social development, security, social culture, specified in the document "Strategy of information society development in Russia", "Information security doctrine of the Russian Federation", the requirements of modernization of the country, its socio-economic sphere. These requirements, aims of development and modernization contribute to the evolution of information culture of all subjects of education (pupils, students, teachers, professors), the culture of their information and educational interaction, the development of their information and legal competence, personal information environment.

It is obvious that the inclusion of the components "The learning outcomes" and "Personal development" in the structure of methodical system of teaching science, proposed here as the principle of its construction, is due to the above mentioned demands of society and trends of development of society, education, social and information environment, that is determined by the principle of its construction and development.

Conceptual and methodological direction of Informatics training to the formation, development and improvement of information competence and personal information culture of education subjects logically follows from the general *objectives of education*, information education, the nature of modern information and educational communication, levels and state of information society culture (Kuznetsov, Monakhov and Abdurazakov 2016).

The determining principle of methodical system of Informatics training construction, like any other methodical system of subject training is its scientific character. Therefore, it sets up a scientific-methodical system. It means that it as an independent, differentiated research system should have its own methodology of setting its aims and the specificity of expressing this methodology, methodological approaches and principles, and their methodical implementation.

As the crucial property of the object of cognition is systematicity, and the main objective of the research is to identify the system of connection, characteristics of intersystem interaction, so the following *principle of systematicity* should be put as the main principle of construction of methodical system of Informatics training:

**The implementation of the system-information approach to the construction of methodical system of Informatics training through the definition of system relationships, system patterns, systematization , support for the universal theory of systems - systemology.**

Thus, the Informatics teaching has the following character:

The Informatics teaching is competence-based, aimed at the development of all components (cognitive, motivational, and organizational) of the subject of study competence.

The Informatics teaching has a strong *socio-cultural and ideological orientation* that aims at the formation of the invariant properties of a social personality, filled with intellectual and spiritual content.

*Information competence* is the level of knowledge of the subject about the information sphere, information, information processes and Informatization processes, information communication, and social information relationships, principles and the character of their implementation, realization; applicability of the knowledge, expressed in complexes of skills and abilities. As a result of training there is the implementation of a system of competencies defined by Informatics learning objectives as a standard set by the State Educational Standard and curriculum subject.

While the crucial property of the object of cognition is systemic nature, and the main objective of the research is to identify the system communication characteristics of intersystem interaction, therefore, the main principle of construction of methodical system of training to Informatics is the following: the implementation of the system-information approach to the construction of methodical system of training in Informatics through the definition of system relationships, patterns, systems, filing, support for a universal theory of systems systemology.

*Personal information culture* is a culture of the interaction in social and informational, educational environment in the aspect of mutual respect of the subjects of the interaction, compliance of social and legal rules, information security (security of information, environment and the subject itself). In a broad sense, personal information culture is the level of overall development (personal development) of the subject, including the level of knowledge, culture of knowledge and cognition. That is, personal information culture is also the level of information competence of the subject, while the information competence of the subject directly contributes to the development of its information culture.

The components of information culture are *the computer culture*, specific to human interaction with information and computer field, and *the computer ethics* developed by the American scientific school, (Johnson 1995; Moor 1995). Its value for computer science teaching means not only what the appropriate ethical rules propose, but in fact, it implies the rethinking of the nature of computer technology and our values, that is, it carries out the socialization of computer sphere.

Educational interaction with the expanding (physically and logically) cyberspace requires the following:

- the development of new forms of information culture – media culture, culture relations with cyberspace and in cyberspace;
- the formation of media competence of the subjects of education, competence of the subjects of SMART-education, developing their personal potential and creating new opportunities to enhance subject teaching, (Abdurazakov, Korotenzov and Mukhidinov 2016; Im and Lee 2013; Jeong, Kim and Yoo 2013; Korotenzov 2014);
- students' perception of the logic of interactions and interrelations in cyberspace, including the inherent to it modal logic having lexically expressed logical meanings with certain "modal" sense (Abdurazakov, Korotenzov and Mukhidinov 2016; Gang 2007; Smith 2017)

It is also fundamental for the construction and formation of methodical system of Informatics training in the aspect of growing importance of cyberspace to modern society (Abdurazakov, Korotenzov and Mukhidinov 2016; DuFour, DuFour, Eaker, Many 2010; Korotenzov 2015).

Thus, the balanced accordance to the information competence of the subject and its information culture, intellectual and spiritual levels of development of the subjects of computer science teaching, between their formation and evolution in this training with a corresponding reflection of it in its content and forms is fundamental.

The internal and external factors, the internal components as well as the components of the external environment play the vital role in the Informatics teaching. These factors and components by themselves are word-building, structural.

The information resources of the environment, the knowledge about the society and person, the structure of his/her thinking, psychology, culture, ethics, morality, law are also important for learning social and legal Informatics.

Hence, the general socio-information environment significantly affects the methodological system of computer science teaching, making its first (highest) level. On the one hand, the influence of general environment on the methodical system of computer science teaching is indirect (via education, pedagogy), however, it is projected directly at it, urging to expand and develop.

The second level of the external environment is a scientific-methodical system of education, its goals, principles, requirements, development trends and other defining factors. In particular, one of the determining factors of this environment is the informatization of education and its scientific and methodological system, having the significant effect on learning computer science, methodical system of training to it in the most direct way.

Another component of the external environment for the methodical system of computer science teaching is the scientific system of "*Informatics*" itself as "*the subject of a special scientific field*". The theory and the subject of Informatics get an idea in activity-cognitive form in the content of learning object. Knowledge and the subject of computer science cognition are extensive. That is why they get differentiated reflection in the content in accordance with the objectives, needs and priorities of the information education, current state standards of computer science learning, other requirements (factors of influence) of the external environment for the methodical system of computer science teaching.

*Informatics* as an object of scientific knowledge significantly affects all the basic components of methodical system of training: objectives, content, methods, forms and means of teaching. However, the expression of this influence is realized through the prism of the influence of other environmental factors and constructive interaction with it. Its impact is great on additional components of the methodological system of "the learning outcomes" and "student personality" that are not quantitatively and structurally different but are qualitatively others.

As the relationship of internal and external factors of the methodical system of computer science teaching is fundamental, we take it as one of the main *principles* of its construction:

**Definition and implementation of system interrelation of external and internal factors, the communication of the system components with its external environment.**

Computer science teaching, like every other educational subject consists of theoretical and practical parts, of the study by the subjects of education the theory of Informatics as fundamental science and the study by them the applied branch of computer science that constitutes the object of its study. Practice of computer science teaching includes:

- direct immersion of subjects in the information sphere and the interaction with the objects of this environment, information systems, resources, technologies;
  - study of the theory of information interaction with information systems, resources, technologies, their content, appropriate methods, algorithms and their computer representations.
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### 3. Results

All this information and cognitive activity and a theory belong to the applied computer science adjacent to the computer science and making its scientific and practical part. The applied computer science is a system integrating of the information activities elements of various themes and its technological support (Korotenko 2016; Korotenko 2015). It corresponds to some extent to the notion of cognitive computer science being developed in the USA and in

other countries and studying the sphere of interaction of natural human intelligence and artificial intelligence of computer systems (Taylor and Raskin 2014).

Fundamental for building a scientific-methodical system of the computer science training is:

**A balanced combination of the content of the computer science teaching theory and practice, subjects of theoretical and applied computer science, constituting a single system of scientific knowledge.**

The computer science is a meta-subject science having many interdisciplinary connections with many sciences and scientific-applied systems. Therefore, the subject of computer science forms many interdisciplinary connections with other systems of study like natural Sciences, and the Humanities, (Allen and Seaman 2013; Rogers, et al. 2012). The interdisciplinary connections with the subject of mathematics with which it in accordance with Federal state educational standard forms a single educational area at present are of particular importance to it.

Therefore, the following is essential:

**Methodical system of computer science teaching should be focused on the definition and the implementation of interdisciplinary connections with the teaching of mathematics and other educational subjects.**

The study and formation of methodical system of computer science teaching should be comprehensive in structure and systematic in content. Therefore, it should be carried out for all perspective areas of its development, in their combination and complementarity:

**Review of individual and integrated interinfluence of the methodical system of computer science teaching with the social-informative environment, and the Informatization of education.**

It is necessary to express the influence and its results on the formation of methodical system of computer science teaching and the contents of its teaching, the focus on the construction of methodical system, aimed at studying the fundamental trends in the frame of computer science.

The influence of Informatization of education on training and methodological system of computer science teaching, the content, forms, tools (resources, technologies) of learning is considered in a paradigm of the following intersystem relations:

**Education - Informatization of education - computer science - computer science teaching**

This should also be considered a principle of constructing the methodical system of computer science training.

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## **4. Discussion**

*Thus*, we suppose the following principles as the basis for development of methodical system of computer science teaching, its methodological design and formation:

1. *The principle of consistency*. The implementation of the systematic-information approach while constructing of methodical system of computer science training through the definition of system relationships, regularity systems, systematization, support for a universal theory of systems - systemology.

2. *The principle of scientific nature of computer science training*. The focus on the formation of the developing scientific-methodical system of computer science training.

3. *The principle of interrelation*. The definition and implementation of system interrelation of external and internal factors, the communication of the system components with its external environment.

4. *The principle of the universality of the study*. The review of individual and integrated interaction of the methodical system of computer science teaching with the social information

environment and the Informatization of society.

5. *The principle of structural completeness.* The introduction to classical composition of components of methodical system of computer science training of the additional components - "The results of learning" and "Personal development". The focus on personal development of the subject of learning as a creative personality, capable of adapting to changing environments, to self-development and self-improvement.

6. Balanced compliance of the information competence of the subject and its information culture, intellectual and spiritual levels of the evolution of subjects of computer science teaching, between their formation and development in this training with the corresponding reflection of it in its content and forms.

7. The balanced combination of the content of computer science teaching theory and practice, subjects of theoretical and applied computer science, constituting a single system of scientific knowledge.

8. The focus on the definition and the implementation of interdisciplinary connections with the teaching of mathematics and other educational subjects.

9. The consideration of the influence of Informatization of education on training and methodological system of computer science teaching, on the content, forms, means (resources) of study within the paradigm of intersystem relations **"education - Informatization of education - computer science - learning computer science."**

These principles are added by us with the following one:

10. *The principle of the universality* of methodical system of training:

- The construction of methodical system of teaching science as a result of systematization of its components, the component "the results of learning" in the form of the system model, the conceptual signs of which express the relations of other components.
  - The identifying patterns of methodological system based on the implementation of the interrelation of the elements of its components.
  - The identifying of private and specific methodical systems (for different forms of training) as specific implementations of the universal system. They are images of universal scientific and methodical system, whereas it acts itself as a universal system *model*.
  - The determination of the natural connections of methodical system with other scientific-methodical systems of education.
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## 5. Conclusion

Modeling in the methodological system of computer science teaching is considered as a *methodological principle of information cognition*, specifically expressing the general scientific principle of systematization and implementing a systematic approach to social-information environment in the educational sphere.

Simulation in the training and methodological system of computer science teaching is a system modeling, model is a system information tool knowledge.

Thus, in the framework of the educational-methodological description of the content of computer science training, it is advisable to talk about *logical complete model*, adequately reflecting the real prototype on the basis of which we can construct any specific model of learning based on actual conditions and requirements.

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