PEDAGOGY

Psychological principles of fundamentalization of professional training of future IT specialists to productive activities

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Abstract. The article is devoted to solving the problem of training of future IT specialists for productive activity through the fundamentalization of education. Based on research on the theory of personality, theory of creativity and psychological models of knowledge representation, the psychological foundations of the development of a system for teaching computer disciplines of future IT specialists are substantiated. The ways of organization for productive educational and cognitive activity on the basis of natural-mathematical fundamentalization of computer disciplines are described.

Keywords: *fundamentalization, professional training, IT specialist, computer disciplines, representation of knowledge, productive activity.*

Introduction. The main purpose of fundamentalization of professional training of future specialists in the field of information technologies (IT specialists) is their preparation for productive professional activity, namely: designing and creating new samples of computer hardware or software.

We determined that to achieve this goal, it is necessary to carry out a continuous and systematic fundamentalization of the content of all the cycles of the future IT professionals' training. The development of a fundamentalized system of teaching computer disciplines requires the definition of the psychological principles of continuous and systematic fundamentalization of the professional training of future IT professionals.

Brief review of publications on the topic. The problem of fundamentalization of professional training of specialists of different specialties is reflected in the researches: I. Levchenko, S. Semerikov, V. Kohut, M. Shishkina (informatics education), S. Balayeva, V. Kondratiev, E. Luzik, N. Reznik, A. Subetto (technical and technological education), S. Goncharenko, M. Kovtonyuk, O. Sergeev, V. Sergienko (pedagogical education), G. Dutka (economic education). The given works cover theoretical and methodical principles of study of fundamental disciplines and integrated courses. However, the methodology of the fundamentalization of academic disciplines, which would contribute to the systematic and continuous fundamentalisation of students' professional training for productive activities, remains to be elaborated.

The basis for our research is the works devoted to the theory of personality, the theory of creativity, and the psychological models of knowledge representation (J. Anderson, L. Vygotsky, J. Ditric, F. Clix, M. Lazarev, O. Matiushkin, V. Molyako, A. Payivio, Ya. Ponomarev, S. Rubinstein, R. Solso and others.

Purpose. The purpose of the article is to determine the psychological principles for the development of a fundamentalized system of training computer disciplines of future IT professionals.

Materials and methods. The methodological and theoretical basis of the research is the scientific works on psychological theories of the person, the theory of creativity, models of representation of knowledge, on the problems of training of future IT specialists at universities. The validity of the obtained results is confirmed using various generally accepted and specific methods: theoretical generalization, abstraction, dialectical analysis, comparison and systematization, system approach.

Results and their discussion. The system of fundamental teaching of computer disciplines of future IT specialists at the university should be constructed in such a way as to ensure the effective formation of their professional competencies to perform productive activities. To do this, all components of the system of teaching computer disciplines should provide continuous systemic fundamentalisation.

In this aspect, it is important to define a system of training objectives for future IT professionals to carry out productive activities for the improvement or development of computer software and hardware.

The content of the training of future IT professionals can be presented as a representation of the professional knowledge and skills necessary for performing productive professional activities [2].

Productive educational-cognitive activity is a motivated, purposeful learning by students the content of education, in which the individual educational products created by them become a means of their further development [9].

Products of students' productive educational and cognitive activity should be new knowledge in the form of a forecast of a possible object state in specific conditions on the basis of knowledge of objective reasons, fundamental laws, conditions, assumptions, formed professional qualities of the individual, in particular, logical and critical thinking, etc. (internal products) and directly received new IT objects (external products).

To determine the conditions for the organization of productive educational and cognitive activity of students, it is necessary to consider such mental operations as analysis and synthesis. These categories are fundamental to developing the psychological foundations of content, methods and teaching methods for future IT professionals, since they reflect the mechanism of analytical and synthetic mental activity, which results in a person gaining knowledge about different objects.

On the basis of a mental operation, "analysis", indicating the decomposition of a complex object or phenomenon on its components, simpler elementary parts and the allocation of individual aspects, properties, relationships, can organize reproductive learning activities. This educational and cognitive activity of students should be aimed at identifying internal trends and opportunities for the development of the IT object, through the combination, reproduction of the links of individual elements, sides, components of a complex phenomenon, and thus in comprehending the whole in the unity of its components.

Productive learning activities must be built on the basis of a synthetic acceptance of thinking, which denotes the connection of components of a complex phenomenon, since the result of the synthesis of old knowledge is absolutely new knowledge.

However, "analysis" and "syntheses" are dialectical thinking, since without the preliminary analysis of a complex IT object (decomposition of its parts) it is impossible to synthesize a new IT object. Therefore, productive educational activity of students, aimed at obtaining a productive concept in computer discipline, will provide for the phased implementation of the first reproductive activity, and then – productive.

In our opinion, the main condition for the fundamentalization of the content of IT disciplines is the structuring of educational material based on the allocation of logical structure, systematization and streamlining of knowledge, definition of fundamental concepts and relationships between them. This reflects the static characteristic of knowledge [5]. The dynamic property of knowledge [5] is related to the need to determine their sequence, deepening and updating, establishing and obtaining new knowledge in the process of training.

The fundamentalization of the training of future IT professionals for productive activities should be based on both static and dynamic knowledge characteristics as a content system. This is explained by the fact that in order to ensure the continuity and systematization of fundamentalization, it is necessary to teach students to use the acquired basic general scientific and general-sector knowledge about IT objects for obtaining new ones that are established in the process of development and improvement of existing objects.

In psychology, processes of structuring, systematization and presentation of knowledge are called representation [2–5]. Psychologists have developed many semantic and plural models that explain the mechanism of representation of knowledge [5].

In our opinion, to effectively train future IT specialists for productive professional activities, it is necessary to develop a unified system approach to presenting the teaching material of various computer disciplines, which will allow students to develop the fundamental methodological knowledge and skills for creating new computer software or hardware technologies.

In our view, it is advisable to apply the universal hierarchical model of the technical object of M. Lazarev [4], which was created on the basis of the multiple representation model using the features of F. Clix [5] and J. Dietrich [4], for the systematic description of the concepts of computer discipline. According to this model, each concept of a technical object (P) can be characterized by a system of features that are related to each other by relationships.

A generalized representation of the concepts of the technical branch on the basis of semantic features [4] has the form: P = {R, S, D, H}, where P is a word, a phrase, which means the name of the concept; R is the set of hierarchical features that represent the purpose and use of an object (destination attributes); S is the set of hierarchical features that represent the structure, composition, structure, or structure of the object (features of the composition); D – a set of hierarchical features that represent the principles and mechanisms of action and function of the object (features of the operating principle); H is the set of hierarchical features that represent the parameters, characteristics and properties of the object (parameter features).

The use of a universal hierarchical model for describing an IT object on an example of databases is given in Table 1.

In our opinion, to ensure the effectiveness of the training of future IT professionals for productive activities, students need to be trained not so much knowledge about IT objects, but methods of obtaining new knowledge about them based on fundamental laws and concepts. Therefore, educational and cognitive activity of students should simulate the process of creating a new or improved existing computer hardware and software and have a productive character.

In our opinion, to determine the psychological fundamentals of continuing fundamentalization of content and the appropriate methods of teaching future IT professionals, we need to consider the J. Anderson's semantic model of knowledge representation (ACT theory*) [3]. The ACT* theory describes the process of acquiring, transforming and applying knowledge. According to J. Anderson, knowledge is divided into declarative ("propositions" – statements, judgments about the surrounding world) and procedural ("knowledge-operations" with the conditions and addresses of their application).

Table 1. Examples of reflections of the knowledge representation model based on the features in the content of the discipline "Databases"

Object	Destination features	Structure features	Operating principle features	Characteristic features
Database	- presentation of a set of logically related data and their description; - control over the data redundancy; - ensuring the data consistency; - data integrity support.	- conceptual (infological) level; - logical (datological) level; - physical level.	- hierarchical data model; - network data model; - relational data model; - object-oriented data model; - "Entity-Relationship" data model.	- data structuring; - data integrity; - structural data independence; - data integrity.

We will draw analogies between the process of fundamentalization of IT professional training and the process of gaining new knowledge by J. Anderson. At the first stage of fundamentalization, declarative knowledge (fundamental physical, mathematical, and philosophical laws and concepts studied earlier) become procedural during compilation, processing and composition of knowledge in obtaining the reproductive technical notion of computer

discipline. At the second stage of fundamentalization, universal procedural knowledge becomes specialized, thus forming an industry foundation.

Thus, the J. Anderson's model of ACT* defines the mechanism of transformation of fundamental laws and concepts from physics, mathematics and philosophy (declarative knowledge) into procedural (branch fundamental laws and concepts). This model can be used to develop training methods to improve basic or create new IT objects based on fundamental philosophical, mathematical and natural laws and categories.

In this approach, the concept of computer discipline is expedient to deduce based on fundamental natural-mathematical and philosophical laws and concepts.

In this regard, the model of the IT object P = {R, S, D, H} can be represented as: P = {R(F, N, M), S(F, N, M), D(F, N, M), H(F, N, M)}, where F is philosophical laws and categories, N are natural laws of the phenomenon, M are mathematical laws and concepts. To obtain a new notion of computer discipline it is enough to determine the relationship between fundamental laws and concepts and semantic features of an IT object.

Important for the fundamentalization of the professional training of future IT professionals for productive professional activities is that knowledge of reproductive and productive IT objects should be mastered in the process of productive educational and cognitive work on solving problem problems [6].

In studies devoted to the laws of the development of technical systems [1; 5] states that it is enough to change the structure or principle of the latter for obtaining new technical objects (P') with improved characteristics (H') on the basis of existing objects (P): P' = {R', S', D', H'}. In this aspect, the model of representation of knowledge about a technical object based on its multiple attributes during fundamentalization the content of IT disciplines can be used to describe both reproductive and productive knowledge.

Thus, the notion of a discipline about basic IT objects should be described in chronological order of their appearance. With this approach, each of the following concepts about IT objects will be defined as an improved version of the previously studied basic IT object.

For the organization of productive educational and cognitive activity of students for obtaining new IT objects, appropriate methods and didactic means should be applied.

Any method is a system of conscious sequences of human actions that contribute to the achievement of a result that corresponds to a certain goal [9]. Realizing his purpose, a person carries out activities, that is, a system of actions, due to the means at its disposal.

Since the purpose of educational and cognitive activity of students, provided the fundamentalization of education is the acquisition of knowledge and skills for the creation or development of new or existing models of computer software and hardware, the method of training should reflect the algorithm of actions for obtaining or improving IT objects.

In our opinion, important for the development of methods for the fundamental training of future IT specialists, is the study of O. Matiushkin [6], which determined the psychological patterns and mechanisms of productive activity in the process of solving problems. The process of solving the problem in his opinion consists of the following steps:

- The emergence of a problem situation and the search for means of analysis of the problem conditions. At this stage there is a correlation of conditions with the requirements of the problem, the known with the unknown;
- Use of known methods for solving the problem;
- Expanding the search for possible solutions to the problem, achieving the goal, the origin of the hypothesis;
- Realization of the found new principle of solving the problem;
- Check the correctness of the decision.

Therefore, when developing methods and didactic means of productive learning to create new IT objects or to improve basic ones, it is necessary to consider the described stages of solving problem problems.

The next step is to define the psychological principles of developing the teaching methods for future IT professionals to carry out productive professional activities.

Under the means of learning we understand those material and materialized subjects that the teacher places in between himself and student [7, p. 261]. Means of education serve as means of management and information support of cognitive activity of students [7, p. 417]. In the process of performing cognitive tasks in the minds of students there are traces of activity – knowledge, skills, habit patterns, beliefs. The acquired knowledge (learning products) is used further to solve more complex tasks, that is, they begin to perform a new function of their learning tools [7, p. 271].

Given the fundamentalization of education, in order for the training tools to be able to produce a productive professional activity of an IT specialist, they need to be knowledgeable about how to apply fundamental laws and phenomena to obtain new IT objects.

Adhering to the provision that the process of assimilating educational information is realized through the process of the subjects carrying out the study of certain actions and solving tasks by means of the targeted bases of action [5], the means of training should reflect the content of the training, to conform to the method.

It is important to use hints for the successful resolution of creative tasks [8]. The hint should be given only at a time when the subsequent solution of the task becomes impossible because of overcoming all methods. The content and volume of the hint are also significant.

Conclusions. Consequently, from the above, we can draw the following conclusions. To organize the qualitative training of future IT specialists for productive activities, it is necessary that all components of the system of teaching computer disciplines provide continuous systemic fundamentalization. Teaching and learning activities of students should simulate the process of creating a new or improved existing computer technologies and have a productive character. The concept of computer discipline should be deduced based on fundamental natural-mathematical and philosophical laws and concepts. For a systematic description of the concepts of computer discipline, it is advisable to apply a universal hierarchical model of the IT object. Learning methods should reflect the algorithm for obtaining or refining IT objects. Learning tools should simulate productive professional activities of an IT specialist and provide information tips.

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Психологические основы фундаментализации профессиональной подготовки будущих ИТ-специалистов к продуктивной деятельности

И. А. Бардус

Аннотация. Статья посвящена решению проблемы подготовки будущих ИТ-специалистов к продуктивной деятельности путем фундаментализации образования. На основе исследований по теории личности, теории творчества, психологическим моделям репрезентации знаний обоснованы психологические основы разработки системы обучения компьютерным дисциплинам будущих ИТ-специалистов. Описаны способы организации продуктивной учебно-познавательной деятельности на основе естественно-математической фундаментализации компьютерных дисциплин.

Ключевые слова: *фундаментализация, профессиональная подготовка, ИТ-специалист, компьютерные дисциплины, репрезентация знаний, продуктивная деятельность.*