TECHNOLOGY AND TEACHING METHODS OF TRAINING AND EDUCATION

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UDC 373.51

*ONTOLOGICAL APPROACH TO CREATIVITY DEVELOPMENT AS A BASIS OF COGNITIVE EDUCATIONAL TECHNOLOGY**

SUMMARY. The possibility of creating cognitive educational technology on the basis of ontological approach and the use of information computer technologies is theoretically proved. Ontology as a method of engineering knowledge shows the model of organization of the information resources necessary for creation of individual information and activity trajectory of training, and on its basis — the process of management of educational — and — cognitive activity of pupils is described. The features of cognitive educational technology as a method of development of mental and creative abilities through formation of cognitive (notional, conceptual) intelligence structures are revealed. The use of test cards for the entry assessment of knowledge and their opportunity in the formation of a pupil's individual informative trajectory are described as a new technology element. The author shows the option of partial replacement of a teacher's training role with a computer program as an intellectual system providing the management of a pupil's educational and informative activity with the use of information databases (electronic resources).

KEW WORDS. Creativity, cognitive educational technology, ontology, individual trajectory of training, conceptual structures.

The major educational result, the modern school must achieve, is the upbringing of a creative person. This is a natural requirement because creativity today is a highly

* The research was carried out with the assistance of the Ministry of education and science of Russian Federation within the State order for 2012-2013 (6.1048.2011).

demanded quality directly connected with the possibility of innovative development of the society, its economic and social fields.

It is common knowledge that "creativity is an ability developed and acquired in the educational processes" [1; 182], i.e. in the processes of education and training. Due to the specifics of creativity as a general ability to create something [2], its development in the educational process faces a number of difficulties. They are caused by the contradiction between a tendency to technologize the educational–cognitive process, to organize it according to the normative purposes, standards (competences, knowledge, skills ...), algorithms and technologies of their achievement, and criteria of the learner's creative activity organization, learner's activity and cognitive freedom, realization of one's own interests and needs, achievement of personally significant purposes of education.

The above mentioned contradiction is eliminated if an educational technology is interactive, if it responds to the learner's personal features, his\her academic achievements; if it is adaptive to his\her individual cognitive profile. Such technology has to be customized and adaptive. The requirement of individualization has been the main challenge in education organization. Due to the mass nature of education, a teacher is unable to trace individual changes in cognitive, personal fields of all the learners (the dynamics of mastering new material, the level of its understanding, the quality of remembering, etc.). In fact, the individual work is organized only with a small group of children who get in the spotlight (for example, participants of the Olympiads and conferences, or poor achievers).

To avoid such a situation, information computer technologies and electronic resources should be used. They make it possible to construct a cognitive educational technology (CET). The cognitive slant of educational technology allows to focus on the development of learners' creative abilities by forming cognitive structures of their intelligence (cognitive schemes according to M. E. Bershadsky [3], conceptual structures according to M. A. Holodnaya[4]).

Electronic resources (including the programs of managing learners' educational-cognitive activity) are meant not only to facilitate the educational process for learners or intensify it, but mainly to open up new cognitive opportunities, to make one's actions more informative and productive, to get one interested in the cognitive process [5; 33]. These purposes answer the main objective of modern education — the priority development of a learner's identity, realization of his creative potential, valuable focus and motivation [6; 9]. In order to make such technology interactive and to make it consider a learner's individual profile and academic achievements, it has to be constructed on the basis of the ontological model of learner's educational- cognitive activity management. Thereby, it should represent the intellectual system that models some aspects of a teacher's activity.

The concept of "ontology" is complicated and its understanding depends on the contents and purposes of its use. In philosophy this is the study of the nature of being, about how the world is arranged (from Greek: ontos — being, logos —word). In information-computer, linguistic sciences it stands for a method of knowledge

engineering, a method of content systematization and structuring, a form of representing knowledge about the real world. This is the knowledge formally presented via conceptualization (the specification of conceptualization [7]). There are two tendencies in the ontology construction: 1) the creation of ontological type information resources (various databases stored in computer memory) and control systems; 2) the development of hierarchical conceptual systems of the subject field — ontological engineering. It is a powerful cognitive tool, allowing visualizing the structure of the knowledge [8].

The creation of the educational-cognitive activity management model, aimed at the development of learners' creativity and formation of his\her creative potential, requires the ontological approach due to:

1) operating and managing a big amount of various information of the declarative and procedural character, collected in databases (electronic resources), necessary to adjust the educational-cognitive process to a learner's individual cognitive profile, his\her relevant and perspective academic achievements;

2) organizing interaction between a user and electronic resources of the program (databases) and forming on this basis the structure of a learner's individual information and activity base.

The offered CET option is interactive and adaptive. It is constructed on the basis of the information computer technologies (ICT) using such assets of the program (information resources), as:

1) declarative knowledge:
— descriptive texts with online links;
— drawings, schemes, pictures, graphs;
2) procedural knowledge:
— a number of task management methods;
— test cards;
— tasks;
— exercises (creation of conceptual schemes, clusters);
3) learners' personal files:
— academic progress;
— intelligence and creativity indexes;
— subject interests;
— update information about the results of fulfilling tasks and exercises;
4) navigator of the program:
— a number of the questions operating the navigation of the program;
— guides;
— a virtual assistant giving references.

Interactivity and adaptability of the CET on the basis of ICT allow the teacher to use this technology where individualization is least of all possible: practical application, activization of knowledge, control and correction of knowledge and the ways of educational-cognitive activity, assessment of learners' achievements, levels of their actual and future progress. Teaching with the use of intellectual systems to control

learners' activity is more effective from the point of view of individual development.

The education (development) control of the learners is carried out with the help of the program module of ontological type. It forms the *individual information -activity trajectory* (**IIAT**) from the databases according to a number of criteria that reflect the level of learners' actual development and their perspectives for intellectual and cognitive growth.

The criteria for IIAT creation might include:

1) learner's cognitive profile:

— academic progress on a subject;

— the level of psychometric intelligence;

— the level of the general creativity;

— focus of learner's subject interests;

2) update information about the quality of mastering of the material:

— assessment of actual mistakes;

— the structure of learners' knowledge (connections, logical mistakes).

The structure of the ontological model of learner's educational-cognitive activity management (in the individual work mode) is presented in picture 1.

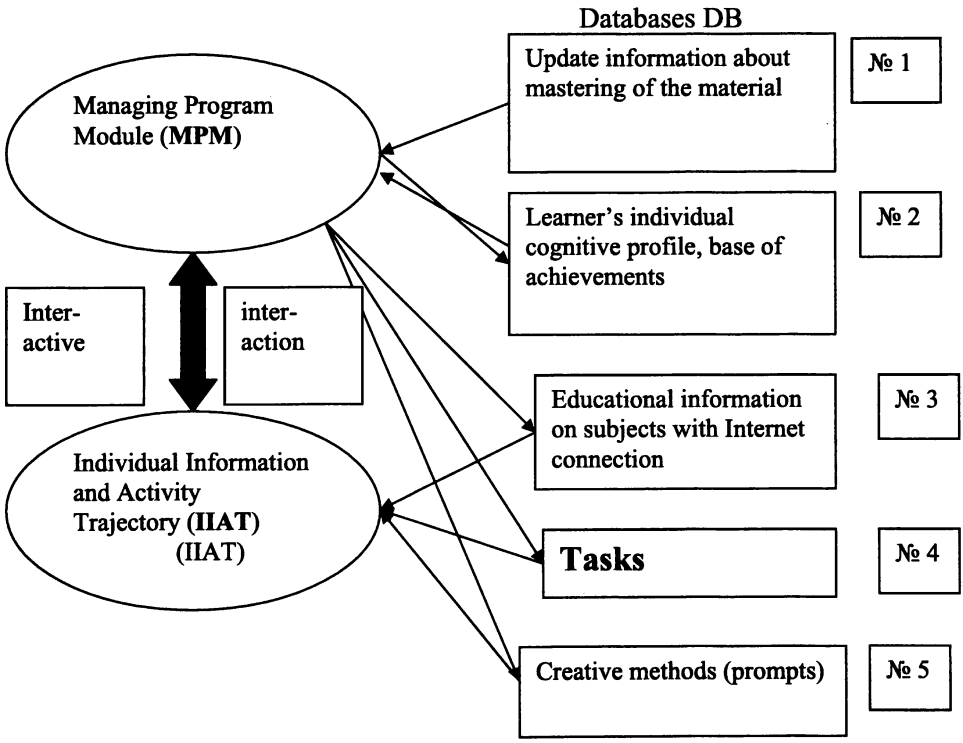

Fig. 1. "Ontological Model of Management"

The program includes the following operational stages:

The 1st stage (interactive):

The initial control of learners' knowledge on the topic is carried out with the help of a test-card. The use of the test card at this stage informs about the factual mistakes (mistakes in formulas, inaccuracies of formulations and definition of the concepts), as well as about logical (structural) mistakes that indicate incorrect cause and effect relation, invalid semantic links.

The 2nd stage (internal work of the program):

It includes the formation of a learner's individual information-activity base using the information resources of the program. The learner's individual cognitive profile is taken into consideration (DB 2). Considering the learner's mistakes (DB 1), the **MPM** selects the educational information (DB 3), necessary to correct the learner's knowledge, and selects the tasks (standard, adaptive, correcting, creative, DB 4) and necessary creative methods to deal with the creative tasks (DB 5). Thus, the integrated resource which combines the information elements (content units) in the integral individual structure (ontology) is being formed.

The 3rd stage (interactive):

Within the learner's individual base, the individual information-activity trajectory of educational-cognitive activity is implemented. The learner defines this trajectory him\herself due to the areas offered by the **MPM** (revision of theoretical material, doing tasks of various types, work with creative methods, choosing different topics for tests, learning new material while working with the additional online information resources).

The technology (the program) replacing some functions of the teacher at the certain stages of a lesson can be referred to the main peculiarities of the program, which allow to define this technology as cognitive and aimed at the development of creative thinking and creativity. It models the teacher's intellectual activities on organizing learners' individual work. Moreover, it analyzes learners' mistakes, selects the tasks according to the learner's individual features (his cognitive profile), selects necessary educational information, gives recommendations and prompts for doing creative tasks; thereby, it enhances the learner's ability to cope with difficult tasks, that is a sign of the artificial intelligence model implementation [1; 377]. The program "studies" the learner in the process of his\her activity (processes and stores information on the results of the learners' work, gives directions for further actions, sends information to the teacher to analyze and design further work with the learner, with the class). In other words, it fulfils cognitive and managing functions.

Using test-cards at the stage of initial knowledge control encourages involuntary formation of the knowledge structure; and therefore, of the various cognitive schemes. It is an immediate objective of the cognitive educational technology that is emphasized by E.M. Bershadsky: "Education should be considered as the process of cognitive schemes formation, relevant to those types of information which is necessary to learn and process in order to meet the requirements of the society"[3; 20].

The creative methods offered by the program for the solution of creative tasks are selected for learners according to the level of their actual development (academic progress), their intelligence (IQ), creativity (CQ) and subject interest. It allows to focus the work on the nearest future development (L.S. Vygotsky). Offered creative tasks (i.e. tasks with unknown algorithm of solution) are the tasks "for future growth". The learner will cope with them if he\she receives the necessary help: the recommendations about application of creative methods and heuristic techniques encouraging creative thinking (for example, making a conceptual-sign cluster, using methods of reduction, or the intermediate purposes method [9; 74]), in the form of indirect and direct prompts, helping to do the task, to define the algorithm to achieve the purpose.

While training practical skills of task management, a learner can choose any trajectory, for example, a bottom up path, and successively deal with the tasks of all levels:

— typical tasks are necessary to consolidate standard, reproductive actions on the theory application;

— adaptive tasks are selected after the learners have already mastered some theoretical material (and don't make any mistakes). Adaptive tasks define the degree of comprehension and efficiency of the mastered information;

— corrective tasks include the elements of the theoretical material which a learner has not yet mastered. Such tasks might be fulfilled if the learner's knowledge is corrected;

— creative tasks are challenging for a learner. The learner can deal with them, if being assisted.

If a learner passes the initial control test (the test card), he\she can immediately move on to the adaptive and creative tasks.

On the whole, **IIAT** will be defined by the cognitive needs of a learner. Having passed the initial control test (the test card), he\she can begin working with the educational information (revision of the material, refinement of the certain theoretical data, facts, laws, studying additional information by means of educational online resources, through the links given by the MPM). After that, the learner can go back to get re-tested or to pass over to tasks. The learner can start working with a new topic included into the subject directory of the program, or to perfect his skills while fulfilling advanced tasks, using creative methods as "helpers".

The results of the learner's work (mastered topics, correctly solved tasks and the tasks where the learner failed, made mistakes, the frequency of using prompts, the preferable level of the solved tasks, etc.) are stored in the memory of the program (in the base of the learners' achievements) and are used later to manage the revision of the material. This information can be used by the teacher to assess educational-cognitive achievements of the learner and to organize creative work, to revise the material and to assess the knowledge.

The described technology is partially implemented today in a computer version, and partially in a "manual control" mode. In the computer version the initial control is carried out by means of the program "The Test- card. Version 1.0" (the certificate

of the computer program state registration No.2012614046, May 3, 2012, the authors: R.M. Ganopolsky, S.N. Degtyaryov). The teacher presents the creative methods of the advanced tasks solution and select tasks and exercises for the learners according to the developed teaching materials, for example "Creative methods and heuristic means of the solution of advanced tasks", a user's guide for learners and teachers (Tyumen, TRSIDRE, 2011, S. N. Degtyaryov).

The similar technologies are also implemented in the system of higher education, but with a higher degree of the computerization of educational-cognitive activity management and with a bigger range of information resources. For example, the technology of vocational training on the basis of system methodology of design activity and creative (projective) pedagogy [10; 200] (developed by the Corporation "University Knowledge Networks" and Scientific Research Institute of innovations and conceptual design of RSU of oil and gas n.a. I.M. Gubkin). This technology, meant to develop engineering creativity, helps learners to overcome numerous psychological barriers, using the various bases of branch reproductive and intersectoral productive knowledge, and also the bases of the intersectoral heuristic techniques promoting the search for new ideas, original solutions [10; 203].

Our approach is original due to the fact that at the stage of the initial knowledge control, the divergent card tests (test- cards), not usual knowledge tests (the list of control questions and tasks), are used [11; 59]. This allows to estimate not only the level of the actual knowledge, but also the structure of knowledge and to form this structure involuntarily (implicit training), which is directly connected with the formation of creative abilities. According to M.A. Holodnaya, the conceptual structures, being the carrier of mental properties of intelligence (the so-called intelligence-forming factor), have a positive correlated link to creativity (verbal and nonverbal). M.A. Holodnaya concludes that: "the higher the conceptual structures formation level is, the better the indicators of verbal and nonverbal creativity are" [4, page 178].

It was empirically proved during the preparation of the senior students for various subject Olympiads. The formation of the structured knowledge filled with systematized logical connections and associations (not only cognitive, but also personal (emotional, motivational)) was the key element of learners' training.

The reference schemes of the teaching material and the divergent cards graphically presenting conceptual schemes of the key concepts (for example, in physics: energy, physical laws, physical processes and phenomena) were used as the didactic materials. Work with the cards and teaching learners how to use creative methods during the reformative experiment in the Tyumen state university gymnasia brought significant positive results in the development of the learners' creative thinking. The results of the regional Olympiads (all the prizes in physics were won by the senior students of the gymnasia, as well as the 1st prize at All-Russian conference "Step to the Future") proved the theory.

It gives grounds to consider the pedagogical technologies providing the formation of the learners' knowledge structure (by explicit and implicit means [2; 243]), to be creatively focused cognitive technologies.

The development of the customized system of the learners' educational activity control is the most challenging task in the process of the creation of computerized versions of such technologies. This task is solved by the development of the operating module program and the use of ontological approach in organization of information resources and creation of didactic materials. It allowed to stimulate the solution of different pedagogical issues: individualization of training, development of information competence, formation of the basis of learners' creative thinking.

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