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New approaches to learning knowledge-intensive activities

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***Abstract* – The article aims at investigating the managing activities in the context of management learning and its fundamental constituencies: formalization of information, transition to the language of another activity or another language of the same activity (for example, transition from the language of drawings to the technical description language), etc. The author's algebraic approach for creating a model is considered as the basis for the knowledge-intensive activities in the information environment. We identify the algebraic approach for designing such models as the system of three components: 1) systems of basic models; 2) systems of typical transformation and typical combination models; 3) an approximation mechanism dealt with submission of the required model as the result of applying standard transformations and typical combinations of basic models. The strategy concept definition, interpreted as a mechanism for creating reference models of activity, is viewed as the basis of an activity management system. The most significant type of such models is an activity plan. We recognized that the knowledge-based activity implementation requires specific types of managers with administrative-and-research competencies in the research management sphere alongside with the sphere of activity coordination in the framework of complex multidimensional researches. The knowledge-based activity particularities in the modern information environment are also highlighted.**

Keywords – modeling theory, information environment, knowledge-intensive activities, strategy, activity plan, algebraic approach to modeling.

I. INTRODUCTION

Implementation learning of modern managerial technologies and knowledge-intensive activities contradicts the traditional "knowledgeable" or "knowledge-oriented" training, which de facto dominates in Russia in school and higher education systems in terms of teaching mathematics to future engineers and economists. Nowadays the content knowledge is growing so fast that a specialist is unable to track the emerging results and trends even in his restricted professional activities. Therefore, activity and competency-based approaches alongside with the other ones are widely accepted in the learning practice.

A significant result of the information technologies development is manifested in diverse database availability; to great extent, the issue of acquiring necessary information is focused on filtering and evaluating a huge amount of available information as well as its reliability and content checking. Consequently, a modern computer science is focused on the transition from database to knowledge database, which enables to acquire information not embedded initially into the corresponding database.

Taking into consideration the above mentioned factors, we suggest that both activity management and management learning are widely spread in such significant activity areas as information formalization, knowledge acquiring, etc. Nowadays, this problem can be solved with a help of psychology, theory and practice of personnel management, implementation of the most successful management practices, etc. Thus, knowledge-intensive activities in the information environment require definite tools for connecting heterogeneous models and designing complex multidimensional models as well. We propose the author's interpretation of an algebraic approach as tools' basis for carrying out a model presented below.

II. MATERIALS AND METHODS

The research is determined by its pure theoretical subject matter. Its methodological basis involves the theory of activity (S.L. Rubinstein, P.Ya. Halperin, L.S. Vygotsky, etc.) and the system analysis (A. A. Bogdanov). The results of pedagogical researches, the Yu.B. Melnikov's theory of modeling, based on the formal-constructive interpretation of the model, in particular, the theory of adequacy, the strategy theory, etc. are considered as theoretical basis of the research.

III. Results of theoretical research

In recent years, there has been an increasing role of knowledge in economics and management [1, 2]. The companies with the highest intellectual property rate in terms of patent rights are more top requested in comparison with those companies with considerable production capacity; on the other hand, it is not worth underestimating the role of the "traditional" industry in the market environment conditions [3]. In this regard, the role of knowledge-intensive types of activity is increasing constantly, and the management of such activity in many cases differs intrinsically from the forms and methods typical for the industrial structure. Actually, this type of activity often has a creative character, coinciding with the activities of scientists, inventors, writers, musicians, but not with the activities of most engineers, economists, technologists, etc. Management issues are defined as key areas for management experts in terms of their professional activity. Undoubtedly, psychology, sociology, management theory methods contribute a lot to solving the problems relevant to a creative activity.

A. Plan and strategy as management tools of activity

One of the most popular types of activity models is a plan [4, 5]. Each item of the plan can be perceived either as a reference to a widely accepted activity algorithm or as a reference to a local, secondary activity goal. A plan item perception may be different and subjective depending on its maker or performer. The plan itself and its constituents can be designed as a reference to a well-known algorithm; in this case, the performer is not required to work out any plan independently. He should simply carry out a sequence of actions effectively. Secondly, the performer is not responsible for carrying out the plan results. This is the developer's area of responsibility. Thirdly, the plan's maker can be sure that in case of a conscientious execution of the plan, he will get exactly the result he expected. On the other hand, a plan with local goal perception is usually more compact, and secondly, can be easier adapted to changing situations. But under these circumstances the performer should be able to plan his activity independently; moreover he should be good at taking responsibility and analyzing the current situation; he should also be involved in the process of coordinating his activities with the other ones.

The matter is that learning activities in terms of carrying out plans are determined by the existence of verified tools. Theoretical analysis and our accumulated experience led to the formation of strategy concept as a perspective tool for knowledge-intensive activity management [6, 7]. It is worth mentioning that we consider a strategy as a mechanism for elaborating activity plans [8], see Fig. 1.

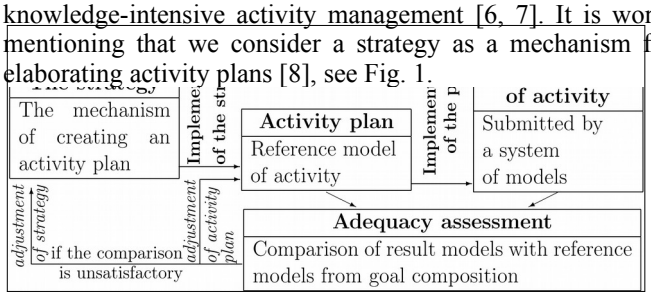

Fig. 1. Strategy and activity plan.

Unfortunately, the Russian education system pays precise attention to studying different academic disciplines rather than management. In fact this assumption refers primarily to the natural science and medicine. Such conclusion is determined by the education quality assessment [9]. It makes total sense, since it is easier to control the level of mastering knowledge than the managerial qualities formation. In our opinion, it was one of the reasons for emerging such concept as competence.

B. Algebraic approach to knowledge-intensive activities

At the moment the competence-based approach to training is adopted officially in the Russian education system. In practice, it does not always comply with the activity approach to learning since it is easier to present the available results. Under these circumstances, the students concentrate on memorizing certain information as means of knowledge acquisition. In the era of rapid knowledge deterioration, priority is determined by the formation of a subjective information processing infrastructure including such terms as perception, transformation, evaluation of its adequacy, adaptation to various conditions of its implementation, etc. This implies the development of complex multidimensional object models whereas an algebraic approach is viewed as a modeling tool embracing three components: 1) system of basic models; 2) systems of typical transformations and typical combinations of models; 3) an approximation mechanism dealt with submission of required model as the result of applying standard transformations and typical combinations of basic models.

In our opinion, the competence approach is not universal. On the one hand, in recent years much attention has been paid to the role of universities, taking into account not only their educational function [10, 11]. On the other hand, the role and functions of education are changing constantly, since in the era of rapid information deterioration, the most important function of education is the formation of appropriate cognitive structures providing perception and information processing.

For example, for students who do not plan to implement mathematics in their professional careers, the study of mathematical analysis enables them to form cognitive structures for perceiving ideas and constructions related to continuity, limited values, speed concept and rate of changes in various quantities, etc. Therefore, subjects' studying is focused on the cognitive structure formation; consequently such approach contributes to enhancing students' abilities in processing or information perception relevant to different subject areas. Obviously it is of crucial significance for development, evaluation and implementation of knowledge-based technologies. Thus, within the framework of an algebraic approach to learning, cognitive structures can be considered as an approximation mechanism for knowledge-intensive activities.

Evidently, it is worth investigating the process of algebraic approach implementation to knowledge-intensive activities in terms of indicators' system formation for commercial structures. The basic elements in this case include such widely accepted indicators of the company's operation as production volumes, financial turnover, market share, performance indicators (comparative assessment of labor productivity, resource intensiveness, etc.), number and composition of employees, etc. If managers, consultants and

other management experts possess intelligent cognitive structures relating to complex, multifaceted, multidimensional perception of phenomena, then it contributes to including not only direct estimation of commercial performance, but also evaluations of the social role, impact on culture, traditions, etc. Another block of indicators may be associated with the level of innovation activity alongside with the dynamics of indicator changes, etc. Specialists are aware of **typical converting and combining** methods of these indicators and different ways of measuring them. The approximation mechanism in this environment encompasses the system of management decision-making, specific peculiarities of the commercial structure management (for example, the ability to perceive new ideas, a reasonable choice of the most perspective projects, the willingness to carry out the necessary transformations, the experience of performing certain activities).

C. Administrative and research competencies

"Administrative and research competences" play a significant role in the management of knowledge-intensive activities. Firstly, they reflect the ability to identify various aspects of activity (technological, financial, personnel, ergonomic, social, etc.), carried out by definite groups of specialists; secondly, these competences aim at managing and coordinating activities fulfilled by specialists with different ways of thinking, traditions, heterogeneous conceptual framework in various activity areas; thirdly, the inclusion of partial constituents into the aggregate results requires specific competencies provision and the ability to identify unique features of a definite activity area.

D. Mathematics as a tool and subject for forming competences in knowledge-intensive activity areas

At the moment, learning process in terms of knowledge-intensive activities requires a large amount of content knowledge. Mathematics provides considerable opportunities for such training. Firstly, mathematical phenomena are extremely abstract, leading to constant information formalization and its transformation from one type to another one with clearly defined rules, etc. Secondly, mathematical activity is strictly regulated, expecting to conform fully to its rules in conditions of severe restrictions. Thirdly, mathematics stipulates transition from a database to a knowledge base explicitly, resulting in mathematical assignment of some calculi: differential, integral, variational, and others.

Mathematics as a science benefits from its advantages: firstly, it enables to justify specific features of various activity aspects within its framework implying several subject sections; secondly, it contributes to combining abstract objects at different levels; thirdly, abstraction formalization for mathematics is of primary importance due to its abstract phenomena under consideration.

E. Knowledge-intensive activities and modeling in the information environment

The information environment deals primarily with models. To great extend, subject matter of knowledge-intensive activities is focused on dealing with models and is concerned about their creation, analysis, and change. Consequently, modeling is an essential component for operating in the information environment and knowledge-intensive activities.

In this context, knowledge can be viewed as a system of models (including activity models). The process of knowledge in many cases is limited to new models investigation and the establishment of links between models (an interface for the information exchange alongside with the inclusion of one model into another as an element or component, etc.). The more diverse these connections are, the better subject knowledge is organized and the more effective tools are implemented; all these suppositions lead to enriching association system [12]. In fact, these model connections contribute to applying more effective and diverse tools. For example, the purpose of "reducing production costs" can be solved successfully with a help of not only financial, logistic and technological models (for example, by means of evolutionary or revolutionary improvement of technology). Actually, this problem can be also solved by changing the working models and staff motivation, etc. Therefore, in training process (in case of advanced training or personnel retraining), it is worth paying precise attention to forming the whole perception of the information for designing and justifying a system of diverse connections and interfaces [13].

Today, in most cases, computation should be attributed to interface between definite activity blocks, since computation procedures in conditions of information environment usually require few resources from the performer. From this point of view, it is important in the training process to focus on learning and implementing interfaces. Obviously, mathematical phenomena, reported in terms of polyad-models, play a significant role in studying mathematics. A polyad-model is viewed as a system of models presenting the same aspect of prototype, whereas two conditions should be fulfilled. Firstly, the images are interconnected by an interface that enables to transfer information directly from the theory language of the first image to the theory language of the second image.

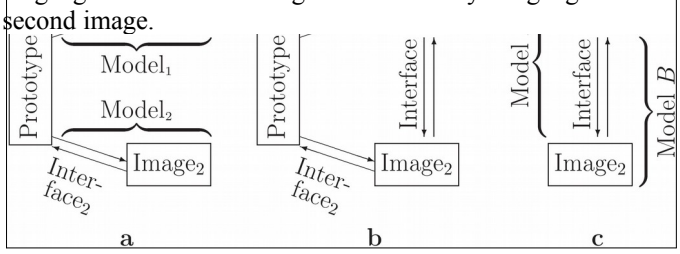

Fig. 2. Illustration to the "dyad-model" concept

IV. Conclusions and Discussion.

We have coped with considering an algebraic approach to knowledge-intensive activities aimed at dividing the formalization activity process into stages with clearly defined goals for identifying and formalizing: firstly, basic models; secondly, typical transformations and typical combinations of heterogeneous models; thirdly, the approximation mechanism, i.e. a model in accordance with specified requirements resulted in implementing standard transformations and typical combinations of basic models. According to the experience, the last objective is the most challenging one.

We have revealed that implementation of knowledge-based activities requires managers with administrative and

research competencies in order to organize the work of professionals operating in various fields of activity, i.e. to provide specialists involved in specific areas of activity (engineering, medicine, sociology, etc.) with subgoals within the framework of the initial complex goal; to coordinate specialists' activities according to their results; to present the obtained results in a compact and convenient format in terms of their perception and processing.

Taking into account conducted theoretical analysis and our teaching activity practice, we confirm that it is worth considering mathematics as a tool and subject for competence forming in knowledge-intensive activity areas.

Evidently, it is reasonable to consider knowledge-based activities in the information environment in terms of modeling context approach. In our opinion, the Yu.B. Melnikov's modeling theory, based on the formal-constructive model definition, is worth implementing widely.

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