

LATIP 2021
International Conference on Language and Technology in the Interdisciplinary Paradigm

**VISUAL PRESENTATION OF EDUCATIONAL MATERIAL AND
MODELLING IN TEACHING**

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Abstract

The article considers the possibility of using knowledge visualization and modeling in pedagogy, application of models being a modern educational technology for training competent specialists. The possibility of using modeling being one of the main methods of epistemology is analyzed. Modeling is always based on the model. The article describes the characteristics of the concept “model”. The conditions for creating models are discussed. Various ways of classifying the models and brief characteristics of various types of models are given. The types of models used in pedagogical modeling are highlighted. A diagram of a functional block model for the development of students’ professional competencies in independent work is presented as well. The article describes this model, which consists of invariable and variable parts. The conceptual basis of the functional-block model including methodological approaches is reflected. The leading principles of the development of students’ professional competencies are highlighted and the developmental components are proposed. The article also presents pedagogical conditions contributing to the development of professional competencies. The characteristics of logical-semantic modeling and logical-semantic model are given. The article describes new principles of instrumental didactics being the basis for logical-semantic modeling. The model of solar radial-circular shape in the disciplines “Hydraulics and oil and gas hydromechanics”, “Hydraulic resistance” is considered and described. The application of logical-semantic models in disciplines mastering is analyzed.

2357-1330 © 2021 Published by European Publisher.

Keywords: Functional-block model, logical-semantic modeling, model, solar radial-circular model



1. Introduction

The main task of modern higher technical education is to train highly qualified personnel who can freely navigate in new difficult circumstances and quickly respond to any changes in production conditions, as well as be able to professionally change the strategy of their actions (Fahrutdinova et al., 2016; Mukhtasarova & Safin, 2018). The use of various modern educational technologies contributes to the task solution (Shaidullina et al., 2017).

2. Problem Statement

The fundamental transformations that have taken place in the sphere of productive forces and information society formation also contribute to the search, development, application and dissemination of new forms of education, which are possible to implement through the use of information and educational resources, information and communication technologies, etc. (Ibatova et al., 2016; Mukhtasarova & Safin, 2020; Shangareev, 2018). The events that happened in 2020 and were associated with the outbreak of a pandemic and the introduction of general restrictions contributing to the urgent adoption of a distance form by all higher education in Russia had a huge impact on education in general and the search for new forms of education.

Effective knowledge transfer is a form of learning (Safin et al., 2020; Shangareev, 2019; Yusupov, 2018). It is believed that in the process of learning, human consciousness uses two mechanisms of thinking, which are associated with the activity of different hemispheres of the human brain (Jonassen, 1998). Logical thinking is associated with the left hemisphere, and figurative thinking is associated with the right hemisphere of the human brain. Studies have shown that the use of visual objects in learning has a positive effect on learning outcomes (CheiChang, 2008). The use of visualization in the transfer of information and knowledge is also facilitated by the avalanche-like growth of information since the graphical presentation of the material makes things that are too complex for perception and learning easier to understand (Gavrilova et al., 2011).

The universal adoption of a distance form in higher education at the beginning of 2020 and the subsequent provision of all educational materials in electronic form also contributed to the visualization of knowledge and the fact that knowledge was transmitted in graphical form and in the form of visual models.

3. Research Questions

Modeling is one of the main methods of the knowledge theory. The method is characterized by the fact that an object is studied through a model. The model displays the entire structure and relationships between the elements of the process under study. A model (from the Latin *modulus*, which means *measure* or *sample*) is any analogue, image of an object, phenomenon or process presented in the form of an image, diagram, description, drawing, etc. Modeling is widely used in educational research. A model is a system (imaginary or material) that reflects the properties and characteristics of the studied object.

These properties and characteristics are essential for modeling purposes. Therefore, the model can replace the object for the purposes of modeling (Steinberg, 2013).

To create a model, it is necessary to have an idea about the entire structure of the object under study or about the elements that make up this structure. The goals and objectives of the structure elements are concretized in a model. Their relationship and sequence are also displayed, and the means and methods of achieving the research goals are determined.

There are various ways to classify models. It is conventionally accepted to classify models into three types: physical, which have a nature similar to the original; real-mathematical with a possible mathematical description of the behavior of the original; logical-semiotic, constructed from special symbols, signs and structural schemes. The models used in pedagogy most often belong to the second and third groups. According to the areas of application, the models are used in chemistry, biology, pedagogy, psychology, etc. According to their purpose, the models are subdivided into research and didactic ones. According to the method of construction, material models imitating the structure or functions of an object and perceived by the senses, and mental models existing as a reflection of objects and at the same time not directly perceived by the senses are distinguished. Shtoff subdivides thought models into figurative (iconic), sign (symbolic) and mixed (figurative and sign).

- In pedagogical modeling, structural and functional models are mostly in demand. An object in these models is considered as an integral system including its constituent parts, components, elements, subsystems. In this case, parts of the system are connected by structural relationships that describe subordination, logical and temporal sequence of solving individual problems.
- The method of logical-semantic modeling is also highlighted. It implies allocation of semantic meaningful elements of information presented in the form of words and the relationships identified between them.

According to Steinberg (2013), logical-semantic modeling is binary (two-component) modeling of knowledge. It is based on the identification of nodal key elements of the content being the first component, and the identification of links between them being the second one. Herewith, taking into account the visualization requirements, the designations of the first and second components are collapsed. The logical-semantic model is presented in the form of a figurative-conceptual model and is made in a solar radial-circular coordinate-matrix form and is based on the principles of the cognitive knowledge representation. In logical-semantic models, the knowledge is structured, the key points of the content are highlighted, and connections between them are revealed.

Some studies have shown that solar structures, which have a broad sociocultural genesis, are similar to the artificial organizations developed in the theory of artificial intelligence.

4. Purpose of the Study

The study aims to build a functional block model for the development of professional competencies in the independent work of students of technical universities.

The model is called functional because it simulates the way the original behaves (functions). At the same time, it consists of a number of blocks: a problem-setting block, a conceptual block, a procedural block, a block of pedagogical conditions, a control and evaluation block and a resulting block.

The model serves as a reference point for the development of professional competencies in the independent work of students. It represents a system that consists of interrelated elements: goals, objectives, principles of implementation, pedagogical conditions.

As well, a model of the solar radial-circular form “Hydraulic resistance” has been developed. It visualizes knowledge by a graphical form that is more convenient for understanding and operating, which contributes to a more successful process of mastering the topic. The schematization of the image, which allows mentally excluding certain properties and qualities of the object and at the same time highlighting the main key points, also contributes to a better understanding and assimilation of the topic proposed for study (Budd, 2004; Guseinova, 2020; Kinchin et al., 2000).

5. Research Methods

Model contains invariable and variable parts. Invariable part includes problem-setting and conceptual blocks, which reflect the theoretical and methodological foundations for the development of professional competencies during the independent work of students. The procedural block and the block for the development of professional competencies and pedagogical conditions constitute the variable part of the model. The procedural block reflects the structure of the independent work organization.

6. Findings

The conceptual basis of the functional model is the following methodological approaches: competence-based, systemic, personality-oriented, activity-based and implementation principles.

The following principles are proposed as the leading ones: creation of conditions for acquiring the experience of independent problem solving, individual orientation of education, dialogism, ensuring students' motivation.

The following components of the professional competencies development are proposed:

- to specify professional competencies since the understanding of competencies embedded in modern educational standards is not adapted and the proposed extremely generalized formulations of competencies provide significant freedom for higher educational institutions in planning, organizing and measuring learning outcomes;
- to consider the specifics of professional activities;
- to consider the peculiarities of the educational process of a technical university.

The development of professional competencies in independent work is possible with the implementation of the following pedagogical conditions (Guseinova, 2018):

- creation of subject-subject relationship between teacher and students;
- building up prolonged differentiated tasks and their gradual complication in the process of studying academic disciplines from adaptive to developing and creative;
- monitoring the educational process.

The model presents the control and evaluation and resulting blocks containing criteria and indicators of the professional competencies development. There is a logical relationship between the blocks, each of which has a certain semantic load.

7. Conclusion

The result of the implementation of the functional-block model of the students' professional competencies development in independent work is the qualitative training students in institutions of higher professional education.

Logical-semantic modeling is carried out on the basis of new principles of instrumental didactics, which being associated with general pedagogical principles complement them. The principle of invariance of the educational system elements enables to increase the degree of the educational process integrity due to adopting actions with educational and developmental effects. The principle of humanization of education can be supplemented by the principle of instrumental nature of educational activities. Conscious attitude to learning and active participation in the educational process of students increases the principle of the didactic tools conformity.

In general, the use of logical-semantic modeling in the educational process of a higher educational institution contributes to its improvement and enrichment since it enables to effectively integrate the content of the educational material. The information provided for study in a logically convenient, folded form contributes to a better stimulation of the mechanisms of memory and memorization, and also improves the control of the acquired knowledge. The selection of logical-semantic connections in models leads to a deeper perception and understanding of the relationship between individual topics of the disciplines being read, which also contributes to a better absorption of educational material and the formation of a competent specialist.

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