O.V. Yezhova

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Simulation in professional education

O.V. Yezhova[1]

[1]Kirovohrad Volodymyr Vynnychenko State Pedagogical University, Kirovohrad, Ukraine

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Abstract

The article is devoted to the issues of simulation as means of research in professional education. A classification of pedagogical models is developed according to their most essential features: application area, form, structure, subject of research, development in time, level of reflection of system's core features, level of specification, problem broadness. A brief explication is provided for each class of models. Definitions of the terms "model of a specialist" and "model of specialist's training" are proposed..

Key words: professional education, simulation, classification, model of a specialist, model of specialist's training.

Problem identification

The terms "model", "simulation" are widely used in pedagogical literature, when speaking about educational and tutoring processes. Thus, in "Pedagogical Constitution of Europe" adopted in 2013 by the Association of Rectors of Pedagogical Universities in Europe, among the constituents of the pedagogical strategy as a philosophy of education the principles of "functioning and implementation of educational models and technologies" are underlined [1, p.6]. An article by V.S. Gryzlov is worth noticing [2]; it proposes a competence-modular unified model of engineering education. At the same time, one of the aspects of the educational aim is determined as "development of industry-specific functional models of professional activity". A topical issue is the determination of the application area and classification of models in professional education.

Analysis of relevant research and publications

The first example of scientifically grounded application of the simulation method is considered to be the work on researching hydrodynamic characteristics of water carriages in experimental tanks conducted in the latter half of the XIX century [3]. In the first half of the XX century, the term "model" referred not to the science, but to the industry, first of all, to metallurgy and architecture. In the 1940s-1950s, the disciplines of cybernetics, computational mathematics, and programming have rapidly developed. This has determined the need and opportunity for torrid growth of simulation as means for scientific cognition.

Theoretical background of this research is based on the works of V.M. Glushkov [4], V.A. Venikov [5], V.A. Shtoff [6] on the issues of simulation. This article uses the classical definition of the term "model" in the context of theory of knowledge: "Model is a contemplated or a materially realized system, which, while displaying and simulating the subject of research, is able to substitute it in such a way that studying it provides new information on the subject" [6, p.19]. A model is seen as an instrument or a form of cognition.

Author's previous publications propose a classification of models in pedagogical research [7].

This article complements and generalizes author's research on the problem of pedagogical simulation. Definitions of the terms "informational model", "model of a specialist", "model of specialist's training" are proposed in this study.

The aim of the article is to characterize the classification of models used in professional education.

Table 1 provides systematized results of the author's research on models' classification used in professional education, as well as the characteristics of the main model types. Classification is proposed as a result of scientific literature analysis on the problems of pedagogical simulation, cybernetics and systems research.

This research discloses the most valuable classification features of models used in professional education.

Besides the stated above features, each model of professional education can have stable, mastered and time proved, as well as variable elements related to the introduction of new materials, equipment and technologies in industry and education.

Conclusion

As a result of the conducted analysis of scientific publications on the issues of pedagogical simulation, cybernetics and systems research, a classification of models

Table 1. Classification of models in professional education

Class of models	Characteristics
Application area	
Educational models	Used for teaching: models of atomic and molecular structure, prototypes of machines and mechanisms, solution models for textual tasks, etc.
Scientific and research models	Used for conducting scientific research Reporting or conceptual models disclose the state of a system, give an opportunity to determine its components and study their interconnections. These models are suitable for understanding state-of-the-art of systems and set up of research objectives. Research models allow conducting real, as well as imaginary (virtual) experiments. Imitation models replicate the existing features of systems' behavior and allow researching the influence of external factors on systems' performance. They give answers to such types of questions, as 1) what will happen if ...?; 2) what was the cause ...?; 3) what should be done in order to ...?; 4) is the hypothesis ... correct?
Form	
Material models	A system materialized in tangible medium, which is compatible with the subject by its geometry, physical, structural or functional characteristics.
Informational models	A system expressed in the language of symbols, signs, images, words, which represents a subject of research and allows to reflect features of the subject essential for the research, as well as to receive new information on the subject.
Structure	
Hierarchical models	Objects are allocated on certain levels; at that, the objects of lower levels serve as components of the upper level ones. The hierarchical principle is used to create classifications and management schemes for educational institutions.

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Class of models	Characteristics
Table-form models	Main subjects and their features are presented in side tables in a listed form. Their qualitative and quantitative characteristics are presented in corresponding table cells. The table form is used to create curriculum models, comparison models, etc.
Network models	Describe systems with a complex structure of elements interaction.
Subject of research	
Model of a specialist	A system that reflects both the input parameters, which have the biggest influence on a specialist (innovation development foresight and others), and the output parameters, i.e. professional and other qualities of a specialist (knowledge, skills, competences).
Model of specialist's training	A system, which reflects a system of future industry-specific specialists' professional training and is capable of replacing it in such a way that studying it provides new information on its interconnected structural elements tentatively joined into blocks: factorial, target-oriented, theoretical and methodological, contextual and technological, result-oriented.
Model of educational means	Models of curricular, programs, guidebooks, visual aids, technical teaching means, laboratory equipment, etc.
Development in time	
Static models	Reflect the state of a system in a particular fixed moment of time Historical models reflect the state of a system in the past. Actual models simulate the current state of a system.
Dynamic models	These models simulate development of systems in a researched period of time. They can be discrete or indiscrete. Discrete ones reflect the state of systems within a number of fixed periods or moments of time. Indiscrete models indicate continuous changes of system's state depending on time. Historically comparative models allow comparing system's state in a certain period of time in the past to its current state. Foresight models reflect state of a system in the future after a certain period of time, taking into account events and processes that have already happened and will affect the system in the future (for instance, modernization of educational equipment requires changes in study programs, books and guidance materials). Prognostic models are created based on research of trends in changing the contents and organization of work, social interaction of future specialists, equipment, materials and technologies they use, as well as trends of societal development (for instance, based on the prognosis described in [8]).

Class of models	Characteristics
Level of reflection of system's core features	
Principle-based models	Reflect the most essential connections and features of a system [9]
Structural models	Provide a general understanding of the form, location and number of the most essential components, as well as their interconnections
Functional models	Reflect specifics of system's functioning according to its intended purpose. They can be presented in graphic forms, such as block-chains that indicate a set of actions aimed at achieving the result [10, p.79]. These models are widely used for description of complex technological processes.
Parametric models	Mathematical models that allow determining quantitative interactions between systems' parameters.
Level of specification	
Enlarged models	Provide information on most valuable elements of a system and their interconnections. Allow investigating pedagogical systems at large, take strategical decisions on routes and prospects of educational system's development.
Explicit models	Provide thorough information on selected sub-systems
Detailed models	Provide the most detailed information on selected sub-systems and their components
Problem broadness	
International models	Provide information relevant for education as a particular sphere of action.
National models	Provide information relevant for an educational system of a certain country.
Regional models	Provide information relevant for an educational system of a particular region.
Unique models	Provide information relevant for a particular educational institution or structural division.

applied in professional education has been developed. The research discloses the most valuable classification features: application area, form, structure, subject of research, development in time, level of reflection of system's core features, level of specification, problem broadness. The main distinction of the proposed classification from the similar developments lies at the root of the choice of the classification features and the fact that determination of models' classes takes into account the specifics of professional education. Particularly, definitions of the terms "informational model", "model of a specialist", "model of specialist's training" have been developed. The proposed classification of the models applied in professional education serves for the purpose of development of simulation as means of scientific pedagogical research.

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Project-Based Learning and Research at University

S.S. Kugaevsky[1]

[1]Ural Federal University, Ekaterinburg, Russia

S.S. Kugaevsky

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Abstract

The article analyzes the changes in practice-oriented training of stu-dents. It describes the example of making arrangements for enhancing stu-dents' motivation to conduct research and development activities while im-plementing the project within the framework of the Resolution No. 218 of the Government of the Russian Federation.

Key words: higher education, practice-oriented training, cutting tool, 3-D modeling.

The issues related to education modernization have received increasing attention in recent years. Particularly, it concerns training of engineering students, namely, specialists in machine-building industry. It is obvious that the level of knowledge of future engineers, designers, technicians, operators directly affects the future of the country, its economic potential, and independence in the field of up-to-date technologies. The basic problems faced by a modern university are as follows: methodological and technical support of the training process, faculty staff, motivation of students for effective material acquisition.

Lack of students' practical skills gives rise to the intensive criticism both in Russia and abroad [1].

In Soviet times, practical skills were basically developed during summer internships by gaining hands-on experience (fig.1). Education quality at a real workplace is secured by supervisors' interest in new employees, attraction of specialists-tutors from qualified staff of the enterprise and opportunity for students to operate equipment, machinery or motor vehicles. The memories of most experienced specialists about the first working day, the first mistakes and help of elder employees are still alive.

Since 1995 the situation has changed dramatically (fig.2).

Enterprises stop financing student internships, while qualified employees have come to consider interns as their future competitors. Needless to say, that the entire internship was reduced to the formal process: safety induction, excursion, familiarization with documents and goodbye! The interest of supervisors in interns is maintained at the stage of pre-diploma internship placement when the enterprise is striving to get at least some specialists for the opening positions. It is obvious that in this case time has already elapsed as the training process has already finished.

The obvious question arises: what to do? The situation could have been saved by conclusion of a trilateral agreement between university, student, and employer. Such agreement serves as a good motivation for all actors. However, an enterprise should have surplus funds, but it is still insufficient.

One of the powerful tools of a State to enhance the education quality is a State subside in the form of Resolution No. 218 of the Government of the Russian Federation [2]. According to this Resolution, the State should return the funds as a subside spent by the enterprise on research, development, and technological work. The main