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TRENDS IN THE DEVELOPMENT OF EDUCATIONAL MODELING: A CASE STUDY OF TECHNOLOGY TEACHERS' TRAINING

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Abstract

This article explores the essence of educational models. It also examines the theoretical foundations and functions of educational modeling, as well as the results of research on the development of educational models.

Keywords: modeling, educational models, functions of educational models, types of educational models, development of educational modeling.

The modeling method is quite multifunctional. However, it would be incorrect to view this multifunctionality (as it exists in modern research practice) as an original characteristic of modeling. Based on an analysis of the sources, we can conclude that the functional capabilities of the modeling method have undergone a complex evolution. During this evolution, models acquired the ability to perform new functions; at the same time, previous functions became more complex and profound, the mechanisms for their implementation were refined, and the effectiveness of modeling research results increased.

In our study, we did not aim to trace all the specific lines and stages of the evolution of the functions of educational models, but the purpose of this paper is to identify the characteristics of the main general trends in the development of the functions of educational models.

Based on a content analysis of the scientific literature on modeling, we identified two particularly important trends, which incorporated the essential characteristics of smaller definitions. These are the trend toward theoretical development and the trend toward practical development.

Let us first consider the trend toward the development of the theoretical foundations of educational models.

Research conducted in the training of Technology teachers, studying the theoretical foundations of the scientific modeling method and its practical application in educational systems, suggests that this process expresses the dialectical development of pedagogical theory – through a multitude of models (the first stage of searching for and analyzing analogs based

on similarity criteria) characterizing individual aspects of the educational process, to a synthetic theory that consistently reveals, in accordance with experiment (the second stage of creating and operationally studying the model), the essence of the process as a whole (the third stage of synthesizing and transferring knowledge). [1]

It is obvious that the imitative function of modeling is inextricably linked with the activity of cognition. When conditions for constructing a coherent theory are not yet ripe, a model of a phenomenon or system, incorporating obvious points of simplification, serves as the first point of cognition in a new sphere of pedagogical reality, marking the initial moment of scientific and pedagogical knowledge's penetration into this new realm.

This point will be expanded later in the modeling process, but this does not diminish the model's role as the first step in research. Expecting a complete, ready-made theory to emerge immediately is, in most cases, to condemn pedagogical knowledge to passivity and illusory nature. In scientific and pedagogical research using modeling, knowledge progresses from initial models that significantly simplify the picture of the process to models that are increasingly adequate to the process and, finally, to a coherent theory of this process.

In the course of our epistemological analysis of the functions of educational modeling, we identified a number of functions that are certainly not alternative but can coexist in educational models. At the same time, not all of these functions necessarily have to be inherent in each of the models under consideration. On the contrary, we believe that such functions are inherent not only to models but also to other cognitive forms. However, taken as a whole, all of these functions, in their dialectical unity, represent a generalized epistemological systematization of the role of the modeling method in scientific and pedagogical knowledge. Of course, as it turns out, this role cannot be overemphasized; it is revealed by considering the unity of the model method with other cognitive forms and methods. Moreover, a crucial consideration in analyzing the cognitive role of a model is its relationship with scientific and pedagogical theory. [2]

We believe that in the process of modeling educational systems, the existing, constructed model represents a kind of preliminary form of explanation, within which the "embryonic" of a new theory—the highest product of pedagogical knowledge—is concealed. This question can be posed when examining the cognitive forms of a model and their development trends. Of course, it is important to remember that a model is not an end in itself, but a means for the development of a new theory.

From this it becomes clear that the primary cognitive task is to construct a coherent theory proven by practice, and the model serves as a means for scientific theory to emerge as an end. A new pedagogical theory, once it emerges, does not discard existing models (educational systems), but rather subordinates them, imbuing them with new content. After constructing a new pedagogical theory, old dynamic models become a methodological tool for its clarification and assimilation, and logical inferences become the theory's criterial apparatus.

In training Technology teachers, we rely on this model. The educational process is based on the theory of knowledge, and in practice, the application of acquired knowledge.

In embarking on a theoretical study of a new area of pedagogical reality, for which a coherent theoretical concept cannot be immediately constructed due to a lack of data, pedagogical science begins to model this phenomenon piecemeal. At this point, the research faces a complex question: which of the disparate experimental data should form the basis of the emerging innovative model? This is the problem of selecting initial theoretical information, the problem of how the cell from which a new scientific theory will eventually grow is conceived. We believe that the methodological principles upon which researchers will rely can play a decisive role in this process. Pedagogical research proceeds from a certain initial methodological idea to an ontological hypothesis, embodied in a model that characterizes the essential aspects of the original object itself, directly related to the initial methodological idea. [2]

The history of pedagogy offers numerous remarkable examples confirming the validity of such conclusions. A well-defined, essential characteristic of the ideas of reformist pedagogy enabled the creation of a number of unique educational systems in Europe and America (the Labor Schools of Germany, the Summerhill Schools in England, the French Lyceums, the Just Communities and Kohlberg Laboratory Schools in America, etc.). [4]

From all of the above, a principle important for understanding the theoretical mechanism for constructing innovative educational models emerges: the essentiality of the initial conceptual feature of the phenomenon or system being modeled, which underlies the construction of a new model. This principle represents the epistemological condition of the theoretical foundations of educational system modeling, expressed in the general methodological requirement of concreteness, which must be sought based on the criterion of practice and taking into account the connection of models with all other forms of knowledge, and primarily with theory, the search for which underlies the entire act of modeling innovative educational systems. If the tendency towards theoreticism characterizes the functional evolution

of modeling, first of all, in terms of the emergence of new, more theoretical functions, that is, in terms of the macrostructure of this evolution, then the tendency towards heuristicism characterizes it, first of all, in terms of development within each function, that is, in terms of the microstructure of evolution.

Before analyzing the heuristic tendency in and the development of educational modeling, let us define this concept. All definitions of the term "heuristic" are associated with discovery, foresight, prediction, and guessing of the future. Generally, this connection is unmistakable. Indeed, the fundamental characteristic of any discovery is that it always relates to the future.

Through our experimental work, we were able to identify four heuristic characteristics of educational models:

- foresight based on the simple recurrence of pedagogical phenomena;
- foresight by analogy and model-based foresight;
- foresight based on the system's own conceptual law;
- foresight based on a newly created pedagogical theory. [4]

The identification of the simple recurrence of pedagogical phenomena in research practice can be called an empirical relationship or an empirical law. Clearly, an empirical law is a weak form of capturing the lawful relationships established in educational processes. Accordingly, predictions based on the simple repetition of pedagogical phenomena turn out to be very unreliable, since there are many secondary factors (environment, heredity, upbringing) that can have an unexpected reaction to the result at any moment.

But despite its unreliability and imperfection, predictions based on the simple repeatability of pedagogical phenomena are widespread in the practice of knowledge, and, above all, in the everyday consciousness of researchers.

In the initial stages of a model experiment, when the study and selection of educational systems is just beginning, when laws and regularities are unknown, and when there is as yet no corresponding theory, this form of heuristic search is certainly necessary. Therefore, a scientific approach to studying an educational object cannot be associated solely with the high level of knowledge development that occurs when a coherent, well-developed theory exists.

First, theory itself does not emerge immediately, and the establishment of empirical laws is often a necessary prerequisite. Second, one should not sharply contrast or separate science from everyday pedagogical consciousness, for they closely interact and are interconnected, at least from the standpoint of critical understanding of the experiment.

Prediction by analogy represents a higher level of development, a predictive ability for the general trend of educational modeling. However, despite this, it cannot be called a completely perfect and accurate form of foresight.

The fact is that the attributes of phenomena, the identification of which in this case forms the basis of foresight, may, as further stages of exploring the model's capabilities progress, prove to be insignificant and accidental. In such situations, the pedagogical "discovery" turns out to be false.

As systemic educational modeling develops, prediction by analogy is constantly being refined, increasing its accuracy.

When constructing an educational model, we examine an object whose laws are more or less well-understood. In other words, the model (or its component) destined to perform the predictive function is an object whose behavior can be predicted based on knowledge of its own laws. A characteristic feature of model-based prediction is that it is based not on the law of the predicted object, but on the law of another similar object.

Prediction based on its own law of development is characterized by the specific characteristics of this law.

One such characteristic is the degree of generality. The greater the degree of generality of the law used as the basis for prediction, the greater the degree of generality of the resulting forecast; that is, this forecast is as specific and detailed as the scientific law is. This heuristic characteristic of modeling functions is transitional in nature compared to theory-based prediction. Translating the above propositions into the language of a modeling experiment, we see that this level of heuristic modeling tendencies is quite high and emerges as early as the third stage of the modeling process, when the innovative model begins to synthesize and transfer theoretical knowledge to both individual elements of the original and its analogs, as well as to form a new theoretical pattern. However, this aspect has certain specifics.

The new pedagogical theory obtained as a result of the model experiment is not simply a sum or a collection of laws, but a specifically organized, logically coherent system of scientific and pedagogical laws. As the study revealed, the laws in the innovative system are interconnected into a single complex, a kind of organic whole. Therefore, the new pedagogical theory is broader than any individual scientific law, richer in content. This theory is not limited to reproducing the knowledge expressed in a scientific law, but rather provides an explanation for the objective, essential relationships reflected in the law of pedagogical science, while simultaneously interpreting all other facts and processes interacting with these relationships. It

is precisely because of this that the theory is capable of creating a basis for predictions that are more precise and comprehensive than those based on individual laws of pedagogical science. One of the essential features of the scientific modeling method for educational systems is that the multi-stage modeling process itself is composed of a set of laws, which by the third stage of research are condensed into a specific theory that provides direction for further research and leads to the prediction and discovery of new laws and facts. This is one of the key characteristics of the theory obtained through modeling.

One of the most important questions that can be addressed through such analysis of educational systems is the completeness of this theory. This requires a thorough study of its structure and the addition of missing links. Such additions and clarifications are essentially predictions.

Of course, this isn't the only method of theory-based foresight. However, it is extremely important, as it enriches the theory itself. The fact is that theoretical foresight is often implemented that adds virtually nothing to existing theory. For example, various modified systemic developmental learning approaches have undoubtedly enriched pedagogical practice, but they haven't changed or added anything to the fundamental tenets of V.V. Davydov's theory of developmental learning; they merely clarified, added, and fragmentarily verified certain elements. [5]

To more precisely define these two types of foresight, we will use the terms "analytical prediction" and "synthetic prediction." Analytical predictions, however, do not expand the underlying theory.

Thus, analytical foresight in educational modeling is simply the application of an existing theory to a particular case. This is pilot work, for example, on the implementation of various educational technologies in the teaching and learning process, while synthetic work, on the contrary, builds upon an as-yet-incomplete theory, supplementing it with missing links. An example here is the direct process of modeling, as a result of which pedagogical theory is significantly enriched, and simultaneously, all the structural components of its subsystem are imbued with new methodological ideas.

Strictly speaking, analytical foresight is nothing more than applied foresight, realized through the use of theory in practical or cognitive activities. It is the transfer of the original model to another environment for the purpose of its applied use, namely, the construction of its analogue for a more in-depth study of its explanatory theory, with the goal of finding a new theory for an innovative breakthrough in educational technologies.

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The analysis conducted is important for characterizing the development of pedagogical theory in general and its predictive role. Scientific pedagogical theory tends to evolve into an increasingly complete and refined (relatively closed) system of laws. Therefore, the more developed and complete a theory is, the lesser the role of synthetic predictions in the predictions made on its basis, and, conversely, the greater the role of analytical predictions.

In philosophical science, in particular, K. Popper calls analytical predictions technological, instrumental, and applied, based on an existing theory. Developing this idea further in his book, K. Popper identifies three main functions of science: verification of laws, prediction, and explanation. If we project this position onto the modeling process and group and integrate all the functional characteristics of this method, it turns out that all types and forms of educational models fulfill these three main functions at each individual stage.

The function of verifying laws is a model as a form of initial knowledge about an object; a model as a diagnosis; Retrospective model.

The foresight function is a forecasting model; an interpretation model; a project model; a criterion model.

The explanation function is a research model; an idealization model; an adaptation model; a different reality model; a new form of knowledge model.

One of the main objectives of such structuring of model forms, in our opinion, is to limit the diversity in cognitive educational systems. The analog model, without violating the objective diversity inherent in the original system, identifies its most relevant aspects, requiring reflection at a specific moment in the experimental work. It is well known that as the information capacity of a model increases, its heuristic effectiveness grows not in direct proportion to the amount of information taken into account, but according to an extremal law, that is, up to a certain limit, after which the effectiveness of a given model declines and it is necessary to move on to another. The conducted research allows us to note the sharply increasing importance of the heuristic role of educational models, which is associated both with the growth of their theoretical significance and with the transition to the operational level of their technological support.

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