CHAPTER 2
INNOVATIONS IN THE MANAGEMENT OF EDUCATIONAL INSTITUTIONS

COGNITIVE MODELING IN THE MANAGEMENT OF EDUCATIONAL INSTITUTIONS

Oleksandr Balanutsa[1]

[1]*Ph.D. (Economics), Ambassador Extraordinary and Plenipotentiary of Ukraine to the State of Kuwait, e-mail: balanutsa.alex@gmail.com, ORCID: https://orcid.org/0000-0002-3470-9486*

Abstract*. The article substantiates the possibility of using cognitive analysis for strategic management of educational institutions. The aim of article is to study of the problem of choosing the factors influencing the quality of education. Accounting for the assumption that complex and poorly structured management decision-making tasks can be formalized by constructing cognitive maps that allow them to model changes in results. The main method used in article is semantic analysis of the main to understand the subject area. The main features of cognitive modeling are considered. The main definitions are introduced. The cognitive system is seen as a decision support system. The cognitive map is considered as the basic cognitive model.*

Keywords: *cognitive model, educational institutions, cognitive map, management, decision making, modeling, university.*

JEL Classification: JEL I0; I20

Formulas: 1; fig.: 0; tabl.: 0; bibl.: 14

Introduction. The difficult living conditions of the 3rd millennium "will largely be related to the knowledge that allows us to survive in extreme conditions" taking into account socio-cultural specifics and identifying "system-forming factors that determine our own educational practice, the same that can allow man with our type of sociality to live in moderation, in harmony with himself and the world of nature "[5].

Modern development of society requires a new system of education - innovative learning, which would form in students the ability to strategically determine the future, responsibility for it, self-belief and their professional abilities to influence this future.

Universities play an important role in the development of the economy, the state, civil society, providing the knowledge, skills, ideas and basic research needed by any country to ensure economic, social, political development and growth. Almost all universities see their mission and role in being centers of education, science and culture.

The processes of modernization that take place in the higher education system require scientific understanding, systematic research and long-term modeling of the educational process in higher education institutions.

The essence of university models is not in the denial of any of the functions of the university, but in the predominant development of one of the activities that becomes the basis for this university.

The organization of effective management and optimization of the educational process are the most important tasks facing the administration of different levels of higher education institutions.

Direct experiments on such a real system are possible in practice, but undesirable. For socio-economic, political and other complex systems, a "natural" experiment on a "living" system is costly, impossible or unacceptable (dangerous). An experiment on the system model is required.

Literature Review. The method of modeling is the subject of wide use in modern scientific and pedagogical research (V. Grinyova. O. Dubasenyuk, N. Nychkalo, S. Sysoeva, V. Chernilevsky, etc.), in particular modeling of the professional profile of the future teacher (V. Bespalko, N. Kuzmina , A. Markova, V. Slastyonin), training of future teachers (O. Budnyk, N. Gluzman, O. Savchenko, L. Khomych, etc.) as a method of cognition, which aims to reflect the holistic process of professional training of future professionals and its design (O. Yaroshynska, L. Vygotsky, J. Gibson, V. Yasvin, V. Manuilov, V. Rubtsiv, etc.). Modeling (Englishmodelling, simulation, German modellieren, modellierung, simulation) is a method of studying phenomena and processes based on changing a specific object of research (original) to another similar to it (model). Modeling in a broad sense is a special cognitive process, a method of theoretical practical indirect cognition, when the subject instead of the direct object of cognition chooses or creates a similar auxiliary object - a substitute (model), explores it, and transfers the information to real subject of study [14, p. 17].

Aims. The aim of article is to study of the problem of choosing the factors influencing the quality of education. Accounting for the assumption that complex and poorly structured management decision-making tasks can be formalized by constructing cognitive maps that allow them to model changes in results.

Methods. The main method used in article is semantic analysis of the main to understand the subject area.

Results. Creating models of pedagogical processes and phenomena on a scientific basis is the subject of such a direction of pedagogical knowledge as "Pedagogical design", defining the general principles of pedagogical design, namely: a) the principle of sequence of transitions from theoretical to normative model, and from the latter to specific activity programs; b) the principle of conformity of the means offered at each stage of designing, to the pedagogical purposes and conditions of realization of process which is investigated [6]. The main requirement for the model is its "adequacy, that is compliance with reality, the essential properties of the object" [4]. The defining principle of modeling is to preserve the structural and functional correspondence between the model and the modeled object. To the basic methodological principles of pedagogical modeling scientists [9] include the following: the principle of purposefulness and subordination to the goal; hierarchical interdependence and coherence; the reality of performance; specificity; predictability; feedback on the status of the achieved result; functional and logical structuring of the system; contradictions (unity of intuitive-semantic and formal methods of studying

the object); clarity; certainty; objectivity; conceptual unity of axiomatic and semantic-existential aspects; information sufficiency.

This problem is solved by simulation methods.

Cognitive analysis is one of the most powerful tools for the study of poorly structured environments, helping to understand existing problems, identify contradictions and qualitative analysis of the processes occurring in these environments. The essence of cognitive modeling as an element of cognitive analysis is to simplify the reflection of the most complex problems and trends in the system, the study of possible scenarios of crisis situations and ways and conditions to overcome them.

The methodology of cognitive modeling, designed to analyze and make decisions in poorly defined situations, was proposed by Axelrod [3]. It is based on modeling the subjective perceptions of experts about the situation and includes: methodology for structuring the situation; model of representation of knowledge of the expert, in the form of a sign digraph (F, W), where F - a set of factors of a situation, W - a set of causal relations between factors of a situation; methods of situation analysis.

Currently, the methodology of cognitive modeling is developing in the direction of improving the apparatus of analysis and modeling of the situation. Here are proposed models for forecasting the situation [3; 10; 12]; methods for solving inverse problems [10]. However, the existing methodology of structuring the situation and the model of presentation of expert knowledge does not allow to analyze complex situations. Creating large models involving dozens or hundreds of factors requires the development of another model to represent knowledge of the situation, a methodology for structuring poorly defined complex situations, methods for explaining and interpreting modeling results, and supporting decision generation.

The purpose of cognitive modeling is to form and refine the hypothesis of the functioning of the object under study, which is considered as a complex system consisting of individual elements and subsystems interconnected.

Stages of cognitive modeling:

- identification of factors that characterize the situation, system, environment.

For example, the essence of the problem "Training" can be formulated in factors "Educational service", "Non-payment of educational services", "Revenues of higher education", "Demographic status", "Number of students", "Costs for the organization of the educational process" and others. ;

- Identifying the links between the factors. Determining the direction of influences and interactions between factors, for example, "Number of applicants" affects the "Income of higher education";

- determining the nature of the impact (positive, negative). For example, increasing (decreasing) the factor "Number of students" increases (decreases) "Costs for the organization of the educational process" - a positive impact; and increasing (decreasing) the factor "Non-payment of educational services" reduces (increases) "Revenues of higher education" - a negative impact. At this stage, a cognitive map is built in the form of an oriented graph;

- determining the level of influence of factors on each other (weak, strong). At this stage, the cognitive model in the form of a functional graph is finally built [13].

Discussion. The educational process can be considered as one of the ways to manage the cognitive activity of students, which has a specially organized structure. Therefore, modeling issues for the learning process are important in creating new teaching methods: "In the study of the learning process modeling allows you to analyze the learning process in parts, elements; reveal the inner essence and conditionality of facts and phenomena of learning; apply schematization and generalization; suggest ways to search and verification of research indicators; select, summarize and evaluate the data of experience and experiment; check the criteria of objectivity of evaluation; specify methods, forms and techniques of educational work and experiment; test and refine hypotheses and adjust data on the subject of research"[1, p. 93].

To build a model it is necessary to: identify significant factors that may affect the results of solving the problem; select those that can be described quantitatively; combine factors on common grounds; establish quantitative and qualitative relationships between the elements of the educational process.

The factors that determine the course of the educational process in a given model, we include the following: problem formulation; determination of strategy and tactics of organization of educational process, reflecting the concept of procedural-cognitive approach; study of students' cognitive abilities in order to develop individual educational strategies; defining the goals of cognitive learning; identification of the basic principles underlying cognitive learning with its activity nature.

Conclusions. The cognitive model we develop is a model that implies the processing of information into semantic components of professional consciousness, the transformation of knowledge into ways of action. From the point of view of the development of cognition is associated with changes in the nature of thinking that occur in an orderly manner.

One of the common tools of cognitive modeling is the cognitive map. Cognitive map is a graphical representation of causal relationships between concepts, factors, indicators, parameters that interact with systems and their blocks [2]. Cognitive map allows you to give a comprehensive assessment of the situation, to determine the causal links between the parameters of the system, as well as the impact of parameters on the situation as a whole.

The classical cognitive map is a sign-oriented graph:

$$G=<V, E>, \quad (1)$$

Where $V = \{v_i \epsilon V, i = 1,2,3 .., k\}$ are the vertices of the cognitive map, presented in the form of many factors, goals or events; $E = \{e_i \epsilon E, i = 1,2,3 .., k\}$ - arcs of the cognitive map, many relationships that show the influence of factors, goals or events on each other [7].

Cognitive maps are most often considered to model cognitive (cognitive) processes associated with the acquisition, representation and processing of

information about the environment, during which the subject is not a passive observer, but actively interacts with the environment.

References

1. Arhangelsiy, S.I. (1980), Uchebnyy protsess v vysshey shkole. ego zakonomernyye osnovy i metody [Educational process at higher school, his appropriate bases and methods], M.; Vysshaya shkola 368 s. [in Russian]
2. Avdeeva, Z. K. (2007), Kognitivnyj podkhod v upravlenii [Cognitive approach to management], Problemy upravleniya. № 3, S. 2–8 [in Russian]
3. Axelrod, R. (1976). The Structure of Decision: Cognitive Maps of Political Elites. Princeton. University Press.
4. Bruhanova, N. O., Koroliova, N. V. (2015), Osoblyvosti modeliuvannia profesiinoi pidhotovky fakhivtsiv [Features of design of professional preparation of specialists], Profesiina osvita: metodolohiia, teoriia ta tekhnolohii. № 2. S. 21–34 [in Ukranian]
5. Dolzhenko, O. (2000), Sociocultural pre-conditions of becoming of new paradigm of higher education [Sociokul'turnye predposylki stanovleniya novoj paradigmy vysshego obrazovaniya], Alma Mater. № 10. M. S. 24-25. [in Russian]
6. Dutkevich, T. V. (2003). Psykholohichni osnovy vykorystannia interaktyvnykh metodiv navchannia u protsesi pidhotovky spetsialistiv z vyshchoiu osvitoiu [Psychological bases of the use of interactive methods of studies are in the process of preparation of specialists with higher education]. Vykorystannia interaktyvnykh metodiv ta multymediinykh zasobiv u pidhotovtsi pedahoha: zbirnyk. naukovykh prats. – Kamianets-Podilskyi: Abetka-Nova, 2003. – S. 26–33.[in Ukranian]
7. Filonenko, E. M., Fomin, A. A., Pavlenko, V. D. (2017). Ispol'zovanie kognitivnykh kart dlya vydeleniya faktorov uspevaimosti studentov distancionnoj formy obucheniya [Using cognitive maps to highlight the factors of academic performance of distance learning students]. Suchasni informatsiini tekhnolohii. Odesa. P.150-151.[in Ukranian]
8. Kosko, B. (1986), Fuzzy cognitive maps. Int. Journal man-machine Studies, №24: P. 65-75.
9. Lodatko, E. O. (2010). Modeliuvannia v pedahohitsi: tochky vidliku [Design in pedagogics: points of counting out.]. Pedahohichna nauka: istoriia, teoriia, praktyka, tendentsii rozvytku. № 1. URL: http://intellect-invest.org.ua/pedagog_editions_e-magazine_pedagogical_science_ vypuski_n1_2010_st_2/[in Ukranian]
10. Pappis, C.P., Sugeno, M. (1985), Fuzzy relational equations and the inverse problem. Fuzzy sets and Systems. №15, P. 79-90
11. Pedrycz, W. (1987), Fuzzy models and relational equations. Math. Modeling. №9. P. 427-434.
12. Roberts, F. S. (1986), Discrete mathematical models with appendixes to the social, biological and ecological tasks. Moscow. 496 p.
13. Tkachenko, O. (2019), Kohnityvne modeliuvannia skladnykh system [Cognitive modeling of composite systems]. It-tekhnolohii v osviti, mystetstvi ta kulturi. №1. P. 11-18.[in Ukranian]
14. Vitvitska, S.S. (2019), Modeliuvannia profesiinoi pidhotovky fakhivtsiv v umovakh yevrointehratsiinykh protsesiv. [A design of professional preparation of specialists is in the conditions of eurointegration processes]. Zhytomyr. 304 p.[in Ukranian].

Received: September 17, 2020
Approved: October 18, 2020