



Educational Systems Scenarios Development in Modern Conditions

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ABSTRACT

The educational system is a set of nonlinear subsystems subjected by waves of exogenous and endogenous impacts. Due to the chaotic nature of the educational processes the management of the educational system's development is significantly complicated. This article aims to develop aspects of the theory of scenario modeling in educational systems and processes. The authors highlight systemic patterns that determine the processes of development of educational systems and establish corridors of possible variability of processes, while maintaining a positive dynamics. The basic criteria for the development of alternative scenarios of educational systems, structures and processes allowing develop scenarios of educational systems' development in an unstable external and internal environment are allocated. The types of scenarios for the development of educational systems and their possible categorical interaction are given. This article is intended for heads of educational institutions, senior managers, researchers involved in modeling and development of educational systems.

Keywords: Educational Systems, Educational Processes, Management of Development, Scenarios

JEL Classifications: H11, I21, I28

1. INTRODUCTION

1.1. Background

Presentation of the educational system as a complex dynamic system consisting of nonlinear subsystems (Yzerman et al., 1994; Avdeeva et al., 2007; Pylkin et al., 2012; Shaidullina et al., 2015), subjected by waves of endogenous and exogenous impacts is the most realistic model. This is due to the following provisions:

- The potential of the educational system to a large extent depends on the type of interaction of its elements.
- Educational systems are characterized by a high degree of instability, where "cause" and "effect" can be interchanged.
- The educational system can maintain stability by countering with external and internal conditions.

- Structural stability of the education system is determined by the stability of the weaker subsystem (Khairullina et al., 2016; Komelina et al., 2016; Aleksandrov et al., 2015).
- The cycle's length of the system's, subsystems' and their entities' development that include smaller elements have different periods, whereby these cycles in a complicated manner are synchronized with each other (Gumerov et al., 2015; Priymak et al., 2015).
- The manifestation of instability or crisis of the educational system is observed in the external and internal environment.
- The efficiency of the educational system and its structure is significantly below 100%.

Reforming of the education system requires a new approach to solve the complex of strategic and tactical goals related to ensuring of its

sustainable development, that calls for a detailed description of the object with all its internal and external communications, as well as parts of the lower hierarchical level, review of the final results of operations as the results of cooperation between all the progress' and results' parties of this work and all the factors influencing it.

1.2. Status of a Problem

Development of full and accurate mathematical models for this class of systems is not always possible due to the complexity and uncertainty of the objects' behavior in the educational system (Novikov and Glotova, 2004; Levina, 2013; Ivanov et al., 2015; Mishchenko et al., 2014).

The main features of education systems are:

- Irreversible nature of development, i.e., the integral characteristics that define an "output" product of the system as a whole (result of education), as a rule, totally increase in development process (at the same time, individual elements of the system can evolve in different ways).
- The high level of correlation dependence of the educational system from other systems (economic, social, etc.).
- The difficulty of the system's boundaries defining, ranging in the process of its development and significantly changing the scale of the system.
- The complex nature of the system's control, assuming the existence of a sustainable productive model and governance mechanisms.
- The need for advanced development, which is defined by significant resources and time expenses to develop educational systems.
- The extreme instability of the system defined by the significant impact of individual elements' functioning and their interactions on the functioning of the educational system in general.
- The system's management subject are educational processes and human potential of all the system's elements, combining into a single field of educational activities.
- The control objects consist of large groups of people.

1.3. The Research Hypothesis

We believe that the governance mechanisms and the development of educational systems must include analysis and modeling structures, allowing to generate and to analyze alternative development scenarios for rational strategic decisions' determination. Development and analysis of scenarios is one of the methods to predict the behavior of any system. Here the forecast is a reasonable hypothesis (scientific, praxeological, logical, mathematical justification, etc.) on the likely state of the system and its objects and indicators characterizing this state. The prediction in its turn as a system of scientific assumptions about the directions of development of the object's future state is a fundamental basis of managerial activity in any field when performing inherent functions is an important component in the feedback management process (Muhametzyanova, 2005; Shamova, 2005; Novikov, 2009; Levina and Shcherbakov, 2014).

With the development of educational systems with high complexity and dynamism the uncertainty of long-term scenario actions

increases, consequently, there need to develop methodologies, technologies and tools to discover, explore and take into account the further emerging external and internal conditions, evaluate risks, and develop alternative future states appear.

2. MATERIALS AND METHODS

2.1. The Definition of Scenarios of Educational Systems' Development

The interpretation of the notion of scenario or scenario method is not finally formed (Bourgeois, 1998). Scenarios are understood as: "A coherent, rational description of the future" (Porter, 1998; Schoemaker, 1993); "ways of managing with uncertainty" (Ringland, 2008); "harmonization of views on future actions" (Schwartz, 1991). As the base a definition by Kahn is taken (Kahn and Wiener, 1967), understanding the scenario as "a hypothetical sequence of possible events that is focused on causal relationships between events and decision points that can change the course and trajectory of movement in time throughout the system in whole or its separate subsystems."

The scenario of educational system's development is assumed to consider a model describing the process of transformation of the system's state caused by the emergence of social, economic, pedagogical, psychological, etc., phenomena or processes that influence the educational system, and defining basic parameters' changings of the system's functioning, i.e., the trajectory of the system's development (changes of state and relations of the component) in a given time space (Kononov et al., 2007; Zarubin and Nachkin, 2015).

It is obvious that for the educational system there are alternative development scenarios, differing not only on targets, but also the criteria of productivity and risk (losses) of the system. On the basis of information predicting of this or that scenario it is necessary to build a formalized mathematical description and mathematically to carry out interpretation and evaluation of the effectiveness of a particular path of development, then, the received information to be used and to be translated as a control one (Levina and Gumerov, 2015).

2.2. The Advantages and Disadvantages of Educational Systems' Scenario Modeling

Possible scenarios' development formulation can significantly reduce the number of ambiguities in educational systems, structures and processes till a few the most likely alternative directions step by step approaching to the goal under conditions of high uncertainty of external and internal environment.

Scenario modeling provides the following advantage: The lowering of the complexity and uncertainty of scheduling, the reduction of variability in the external and internal conditions of educational systems' development and processes till a managed acceptable condition with the possibility of adjustment in each iterative step (approximation to goals).

Scenario modeling has the following disadvantages:

- The increasing complexity of the planning process: Time and resource expenses caused by the need for careful thinking of

possible variants of the state and development of educational systems and structures.

- Numerous conclusions about the possible state of educational systems and structures in the alternatives of a scenario development.
- The reliability of decision making to a greater extent depends on the probability of the external/internal conditions' occurrence of educational systems' or structures' development.
- A significant complication of managerial decision-making process, which consists in impossibility to give one answer to one question, the responses' quantity is determined by the availability of several scenarios of educational systems' or structures' development.
- Mostly qualitative effectiveness criteria for the development of scenario variants (logical reasoning, "soft" responses, the intuitive).

The estimation of probable alternatives of educational systems' and structures' development can help to create the actions' strategy for functioning's optimum parameters and the required level of resource potential at any state of the system or structure (under the influence of external/internal conditions), to adjust the actions at the point of decision making. All kinds of scenarios can be used as a basis for the formulation and selection of strategic issues of educational systems' and structures' development.

2.3. The Criteria Defining for Educational Systems' Controllability

We identify the following key criteria for alternative scenario of educational systems,' structures' and processes' development:

1. The availability of unequally possible alternatives' wide variety that occur under the influence of the qualitative/quantitative subjective/objective specific/latent factors.
2. The probability of occurrence and the realism of the scenario development in presented conditions and with the resources available.
3. Consistency and interconnectedness of states and processes of the educational system for each of the scenario alternatives.
4. The process dynamic state's taking into account, which is changed when there is an amplification of correlation factors' connection (state) of educational systems or processes.
5. Possibility of accurate planning of educational systems,' structures' or processes' multi-factor condition in a particular scenario of events.

The controlled conditions' availability of the scenarios of educational systems,' structures' and processes' development at each time control step. The need for scenario management is determined by the appearance of uncertainty when making strategic decisions on the operation or development of educational systems, structures or processes either in the implementation of pedagogical or management innovations. This arising "integration for the future," i.e. the union of different trajectories' movement to the future and continuous conditions' planning leads to step by step adjustment of managerial actions (decisions) within the selected development scenarios. Despite the rather complicated predictability of events for educational

systems, implementation of the scenario method allows us to consider the factors influencing the system in a variety of interpretations and give new information for management decisions' making.

3. RESULTS

3.1. Identification of Scenarios' Types for Educational Systems' Development

Thus, the scenario of educational systems' development represents a description of conditions' set (preconditions) that reduces the uncertainty in the system and its elements' open connections, allowing maintain control. Since there are only a finite number of scenarios adequately described in economics and they depend on the forces' interaction, it is important to consider them in relation to the educational system.

3.1.1. The "time" category

3.1.1.1. Type of scenario "evolution"

For the educational system the implementation of this type of scenario is similar to any other transformation of the social system and entails significant gradual changes of the entire structure. As an example can serve information technology that have passed the path from object of study till the learning environment in the educational systems.

3.1.1.2. Type of scenario "revolution"

Despite the fact that the educational system is very susceptible to the influence of various external and internal factors, from the point of view of revolutionary changes, this system maintains the highest sustainable form, and to a lesser extent is subjected to transformation by revolutionary changes. However, the results of the "revolution" (consequences) have the most long-term development in educational systems and possess a high inertia. For example, the results of the crisis in the educational system in the 90 of the last century greatly affect the capabilities of modern experts 25 years later.

3.1.1.3. Type of scenario "cycles"

Cyclical nature of educational systems significantly differs from other socio-economic systems. The recession phase of the cycle can be caused as by external conditions - Dissatisfaction with the results of education consumers (educational agents: The state [low educational level of citizens]; business [mismatch of educational institutions' graduates to the employers' requirements and the current state of manufacture, technologies and equipment development]; personality [requirements to forms, methods, technologies or training variability], etc.), so by internal conditions, for example, the information technologies' implementation in education has changed significantly the didactic requirements to the training.

The peculiarity of the educational system is in a plurality of cycles (periods of study) that are reporting for the system: The system (pre-school, school, vocational and higher education); periodic (quarter, term, year of study); training (concept, subject, course, field of study).

3.1.2. The category “economic development”

3.1.2.1. Type of scenario “raw materials future”

Such a scenario for an educational system requires the training of special categories specialists for processing industries, the level of training of whom must be sufficiently high, and their number should not be too much. The demand for technicians and workers engaged in the processing industries will be high even at high automation.

3.1.2.2. Type of scenario “catching up modernization”

There is a growing demand for specialists engaged in the organization, development and management of industrial potential (managers), specialists engaged in normative documentation and distribution of enterprises’ profits, evaluation and capital gains (lawyers, economists, financiers). There is a significant need for additional education for existing domestic experts engaged in the production, demand knowledge of a foreign language. There is a significant need for additional education for working domestic experts engaged in the manufacture and knowledge of a foreign language is in demand.

3.1.2.3. Type of scenario “local leadership”

For the educational system, this means the need in industrial clusters’ development, in the integration of education science and industry, in the training of specialists of all levels in accordance with the latest scientific developments, the employers’ requirements and deadlines.

3.1.2.4. Type of scenario “the cognitive society”

For education this scenario represents the transition from the service system into a management one predominantly, when the educational system is considered a priority sphere of the state, creating the life conditions for the population, determining knowledge and level of education of citizens as the most important national resource.

3.1.3. The category “reaction of the educational system”

3.1.3.1. Type of scenario “limitless opportunities”

It is poorly applicable to the educational system of any category, since their capabilities are significantly limited by social, political, economic and financial factors, as at the moment the education is a service system for other systems.

Considering the education system regarding students and teachers from the standpoint of personal growth it can be considered that conventionally there are unlimited possibilities for improvement. An example can be the programs to support young scientists, grants, individual learning possibilities, inclusive education, supported by all educational agents.

3.1.3.2. Type of scenario “challenges and responses”

Any version of the scenario corresponding to the given type cannot be positively implemented in the educational system, except the global strategic objectives. For example, a State program of the Russian Federation “development of education” for the 2013-2020 period is the “response” of the educational system to the “challenges” of political and economic systems (the trends of globalization, internationalization, integration,

etc.). However, if the duration of the scenario is reduced at any version of the system’s development, except the educational projects’ implementation affecting only a small number of the system components, but devoted to a specific tasks’ solving it is impossible to obtain system’s response with positive results. Any changes in the education system require significant change in all its components, starting with personal motivation and ending with financial support for the implementation, adaptation and sustainable results performance of which requires time, thus the current result of the system’s activity would not meet the requirements of the system neither “old” nor “new” qualities.

3.1.4. The category “position of the agents of the system”

3.1.4.1. “Winners and losers”

Indeed, considering the educational agents from a position of personal (business) interests of each, it can be defined the existence of several conflicts of interest: The individual and society (personal development, and capital gains); society and the state (the right to free education and the complexity of its material support from the state); individual and state (opportunities of employment according specialty and the lack of state regulation of employment) and so on. Any of these conflicts affect the implementation of education policy at the current time.

However, when considering the educational system in general, any version of the “victory” of the educational agent in the future can be assessed positively. For example, the rigid standardization of education (contrary to personal development, individualization of learning, etc.) makes it possible to implement the ideas of integration and globalization of business, opening up additional employment opportunities; the problems with the lack of free places in University ensure the inflow of students in the vocational education institutions graduates of which are in demand by employers and others.

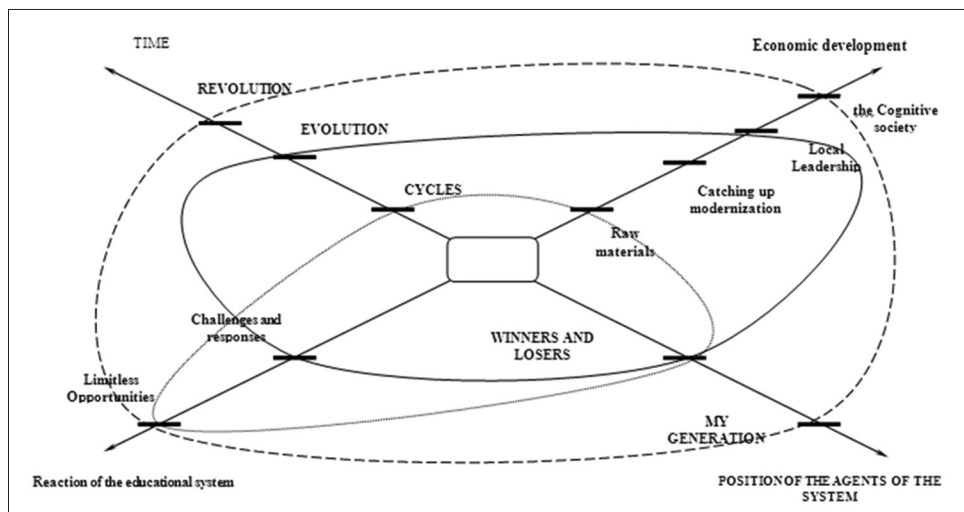
3.1.4.2. “My generation”

This type of scenario is essential for the educational system, which determines the foundations of cultural education of generations. Accepted social and moral values are reflected in the educational process, technology of training. An example of this scenario at the strategic level could be the transition to state-public management of education enshrined in the Act on Education.

3.2. The Scenarios’ Interaction of Educational Systems’ Development

Accurate boundaries of marked scenarios for educational systems are rather conventional and none of the scenarios exists in its “pure” form. However, the choice of the scenario categories and their typologies provide an understanding of the possibilities and development vector of educational systems (Figure 1).

For each scenario, there are state indicators that show the development start of this or that scenario. Scenario modeling is a necessary link between the goal setting of the educational system and the development of its vision in the current environment and the formation of strategic development plans. Analysis of the created scenarios enables to evaluate the effectiveness and consistency of the accepted managerial decisions, evaluate their

Figure 1: Categorical interaction scenarios' types of educational systems' development

possible consequences within the boundaries of the system. Scenarios of education systems' development belong to the class of single-parent theme (information) models that can be formalized only with a certain error. The main application of these models is to determine the main quantitative characteristics of objects and subjects (entities) of the educational system.

3.3. The Possibility of Scenario Modeling Application to Manage the Development of Educational Systems

The use of scenarios enables to apply the method of multi-level strategic simulation (designing of "bottom-up" and "top-down"), i.e., in forward and reverse directions. In direct prediction the agents' hierarchy of the educational system, the considered focus, management entities, their goals and opportunities are determined and a lot of scenario alternatives are developed. When development planning (backward process) the elements of the system receive content filling: Vision, mission, goals, objectives, conditions, actions, processes of implementation, monitoring processes, time points, evaluation mechanisms. Cycle's multiple passing in forward and reverse direction defines possibilities to improve the development scenarios, identify key performance indicators, and the information field, reducing the uncertainty of the system and defining the type and possibilities of control impacts. The possibility of probable alternatives' estimation of educational systems' and processes' development allows form a strategy of actions, ensuring performance optimum parameters and the required level of resource potential at any state of the system or process (under the influence of external/internal conditions).

Scenarios' evaluation and tactics' choice can be supported by adaptive mechanisms operating on the development of the system and ensuring a positive effect of the management in case of step by step approach with the possibility of events' adjusting. Generated scenarios of the educational system's development are determined by the main processes' and factors' interaction operating in the system and changing its state (as reflected in the indicators of the system), the processes' interaction forms the network of the system with the cycles of direct and reverse linkages, and the cycles' interaction - Action of the system (resonance).

So, the scenario mechanism enables to forecast the development of the educational system or the trajectory of their movement on the basis of available information and expected state of external and internal factors. Information obtained during the scenario simulation is necessary for the development of strategic plans for development of the system. This plan, in turn, can be active and can be adjusted as the system develops and changes its states. Thus, especially important is the question of internal and external information obtaining for the scenario modeling, the scenarios' formation, optimal trajectories' choice and adequate management decisions' making. Scenario models' building (information and mathematical) provide opportunities for the target values' obtaining of the future based on the search of system's reference points and the constructing of development's various options, depending on the structural features and the possible results of its implementation. Scenario modeling of educational systems' development is caused by the need to find the most favorable conditions and steady-states of the system.

4. DISCUSSIONS

The issues of scenario analysis of educational processes are poorly studied due to the significant number of variables and numerous factors affecting the state of the system, from the personal to the political. Therefore, it is necessary to implement the mathematical description of processes and scenarios, to evaluate information models with the help of mathematical methods, since the experimentation on real objects is not possible.

The proposed mechanism of the scenario management of educational systems' development is a way of gradual reduction of uncertainty on the basis of information and a formalized description of the system, a method of study construction of the development's scenarios and mathematical models. The steps of successive (integrative) approximations that define the stages of scenario modeling of the system allows to build forecasts of the system's development under given or planned values of the parameters. The method is focused on the system's development management which is determined by the control impact, which, in turn, is based on information obtained in the course of construction, assessment and scenario analysis.

5. CONCLUSIONS

Scenario management enables the management of educational systems in conditions of high uncertainty, ensuring accurate implementation of the strategy and possible of its rapid adjustments by state's monitoring in risk assessment of events or actions. The formation of development's scenarios and implementation of change management in educational systems allows us to develop strategic, operational and preventive goals and methods to achieve them, to assess the consequences of implementation of innovations and possible risks of the state of educational system.

Scenario management in the context of educational systems' development can significantly reduce the number of uncertainties to a few of the most likely alternative directions at step by step approximation to the goal under conditions of high uncertainty external and internal environment.

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