

Methodology of a Strategy Formation for Innovative Development of the Educational Complex in the Information Society

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Abstract. The article is devoted to the management of innovative development of complicated socio-economic systems. Such a system is the educational system and its institutional forms, united into the concept of "educational complex". Models and tasks of implementing the innovative development of the non-state (commercial) and budget (state) sectors of educational complexes are shown in this work. The following principles are proposed as the basis of the concept of innovative development of education in the conditions of the information society: the maximum usage of opportunities, which are provided by the information society; assistance in the formation and development of a single information and communication space. As an example of analysis of the quality of innovative processes occurring in educational complexes, a mathematical model of a distance educational system, which is based on the methods and means of the theory of self-organization – synergetics, is proposed. It is concluded that the implementation of the methodology for managing the innovative development of the educational complex creates the prerequisites for building a quality management system for the educational process.

1 Introduction

The practical implementation of the methodology for managing the innovative development of complex socio-economic systems in the information society in relation to the educational complex (EC) begins with a study of the conditions for its formation and development, as well as an assessment of innovative potential.

The main goal of EC modernization is to increase the accessibility and quality of education for the general population of the country.

A significant drawback of the education modernization and development strategy, which is currently implemented and generally complies with the five "I" concepts

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(institutes, infrastructure, investments, innovations, intelligence), is the absence of a clause regarding the introduction of innovative organizational technologies into the educational system.

The level of education depends mainly on the moment, how harmoniously all services, units and departments of EC are developing. With particular urgency there is a need for the development and consistent implementation of a unified strategy for the modernization and development of EC as a necessary condition for the rational use of resources allocated by society for education, overcoming manifestations of disunity, fragmentation and inconsistency of actions of state, municipal and private structures responsible for resolving issues of education of the country population.

The main factor which improves the socio-economic efficiency of EC functioning in the context of each country movement towards the information society is the use of opportunities provided by the producers of educational services and educational goods with advanced information and communication technologies. The process of the formation of an integrated information and communication educational space as a form of the existence of relations that develop in the course of the implementation of educational activities by EC subjects using advanced information and communication technologies is proceeding at an accelerated rate [1].

With the expansion of the presence of EC entities in the information and communication space, the pace of social institutionalization is accelerating. Social institutionalization arises and develops on the basis of the following premises:

- the formation in the terms of globalization and democratization of social needs for the free access to information, which is related to the education of people in all aspects of activity;
- the formation and development of the necessary organizational structures (search engines, information resources, specialized portals and web-sites, etc.), as well as the associated value standards and social norms, regulators of human behaviour and social groups;
- the appearance of social conditions and opportunities, which correspond to the process of person's socialization, the internationalization of new values and norms that could form the necessary system of individual needs, value orientations and expectations in the sphere of education;
- the integration of electronic information and educational resources (EIER) into the structure of the Russian education system, which needs to perform new socially significant functions being the condition for its further development.

One of the main opportunities provided by the information society is the qualitative improvement of the education system. New information and communication technologies increase the effectiveness of the educational process, make the knowledge available widely, and create the basis for training by any subject, wherever he is. A necessary condition for the high efficiency of information support of the educational process is the formation of an integrated information and communication educational space (IICES).

Together with the expansion of the presence of subjects of education in the Internet, the process of social institutionalization and – the organization and coordination of social interaction of people, the emergence of its standardized and regularly reproduced elements accelerates.

2 Methods

The methodology for modelling the innovative development of EC in the information society is an adaptation of the methodology for modelling the innovative development of complex socio-economic systems.

For the non-governmental sector of EC, the most relevant models are the models of the Germeyer type, which are designed to solve the following problems:

- the optimization of the ratio of the volumes of funds received by EC from three sources: the state (the main goal of the state is effective investment), business entities (the main goals of all business entities are consumption and effective investment) and the population (the main goal is consumption) (the main (global) purpose of the system "state – business entities of EC – population");
- the redistribution of funds of state extra-budgetary social funds;
- the financing of development and strengthening of the material and technical base of EC organizations (regardless of their organizational and legal form and form of ownership of their property) from the budgets of all levels and funds allocated by business entities engaged in entrepreneurial activity in the market of educational services and goods (the global goal of the system - improving the quality of education of the population);
- strengthening the role of associations of EC organizations, associations and public organizations of teachers in the educational management.

For the public sector, in terms of the theory of active systems, the following tasks could be formulated, in particular:

- improving the management efficiency according to the scheme: “the territorial body of education management – reporting entity”;
- development of methods for an integrated assessment of the performance of services, units and departments of EC;
- increasing the efficiency of the functioning of the support system for state and municipal EC organizations;
- improvement of licensing and accreditation procedures of educational subjects;
- improving the reliability of the results of examination of the quality of education;
- development of methods for assessing the quality of educational services;
- improving the certification procedures for educational and related services;
- improving the quality of training for teachers and lecturers;
- increasing the efficiency of managing the development of priority areas of educational science and technology;
- increasing the functioning effectiveness of the educational-social monitoring system.

For a qualitative analysis of the process of innovative development of EC, it is proposed to use the methods and tools of the theory of self-organization – synergetics.

3 Discussion and results

The innovative focus of modern organizational and economic processes in the educational field imposes special requirements on the content, organization, forms and methods of managing the innovative development of the education system [2], taking into account the ever-growing importance of non-material forms and qualitative non-traditional factors of economic growth in the information society [3], the emergence, formation and the development of the information and communication educational space as a form of relations in the implementation of an educational complex organizations of their core business, using advanced information and communication technologies and the phenomenon of transformation of higher education institutions through the implementation of business activity [4]. In this connection, the concept of the “triple helix”, which is proposed by H. Etzkowitz [5, 6] is worth noticing, with the entrepreneurial university as a core unit. In general, in the process of modernization of education, it is necessary to take into account that any reforms in this area should contribute to the spread of breakthrough of pedagogical and supporting technological innovations, but not hinder [7].

The basis of the concept of innovative development of education in the information society should be formed on the following principles:

- maximum utility of the opportunities, which are provided by the information society [8];
- the assistance in the formation and development of IICES;
- the application of a leading approach to learning, involving an orientation towards the predicted future of economic development [9, 10];
- the selection of areas of advanced training for the predicted future in accordance with the “blue ocean” strategy [11];
- the usage of proactive planning, which consists of predicting the future and preparing for it, including planning the needs of the country's economic complex for workers in certain specialties, including projected ones, and reflecting this in training programs [12];
- application of a participatory planning approach, which suppose direct involvement in the planning process of all participants of educational processes [13];
- the support of the integration of the forecasting / planning system in the field of education with the forecasting system in the field of science and technology and integrated forecasting of the country's socio-economic development [14];
- the development of strategic partnership of EC entities with business entities from the real sector of the economy [15];
- enhancing the participation of students, graduate students and postgraduates in the R&D works related to the areas of advanced education [16];
- the usage of intellectual management technologies for the governance of innovative EC development, including or based on the theory of functional systems by P.K. Anokhin [17];
- application of self-organization method while constructing an information system the governance of innovative EC development.

A special role in providing with an integrated information and communication educational space belongs to electronic and distance learning, which is an ideal testing ground for the try-out of the latest teaching methods and educational support tools. Distance learning technologies suggest the availability of not only computer-based training courses, which are focused primarily on active forms of organization of the educational process (using online courses; simulation programs for the studied processes and phenomena, including business computer games [18]; specialized software systems designed to solve specific management problems; systems for organizing information exchange between students, teachers and administration, etc.), but also good a well-thought-out system of current control and intermediate certification of students - in the form of complexes of tests, midterm controls, passes, exams. By actively developing and effectively using distance learning, it is possible to achieve individualization and high-quality training throughout the country with relatively low financial costs.

In the process of training, special attention should be paid to the formation of an obligatory component of modern education – information culture. It is necessary not only to teach them how to work with a computer and the Internet, but also to instil in them the necessity to expand and deepen their knowledge constantly [19].

It is proposed to conduct a qualitative analysis of the innovative processes taking place in IICES using methods and means of the theory of self-organization – i.e. synergetics [20].

Let us construct a mathematical model of the learning system. From the point of view of the theory of self-organization, education is a complicated, open, non-equilibrium and non-linear socio-economic system. All systems of this kind could exchange entropy with the external environment. The theory of self-organization proceeds from the fact that all functionally complicated phenomena that occur in socio-economic systems could be

described by fairly simple systems of equations. It is proposed to idealize any phenomenon under study in such a way that this idealization leads to a system consisting of two autonomous differential equations, a qualitative analysis of which is carried out on the phase plane (if further discrepancies between theory and practice are revealed, the original model can be complicated by introducing one more equation, etc.). When using qualitative methods of analysis, the main emphasis is done on the obtaining a qualitative result, determining the most characteristic features of the entire phenomenon in general, and on the predicting the future events.

Let us consider a group of students, which is characterized by a certain degree of disorganization, by an uncertainty of knowledge about the subject of study – entropy $S(t)$. (in a first approximation, we can assume that $S(t) = nS_1(t)$, where $S_1(t)$ – is entropy, average per student, n – is the number of students in the group). Let us denote by $H(t)$ the information related to the subject of study coming to the group from various sources - from teachers, from educational and scientific literature, from the global computer network Internet, from other members of the group, etc. In this information, one could distinguish, on the one hand, the information that reduces entropy, structurizes and organizes the knowledge of students about the subject of study (-), on the other hand, information that is not needed by students, incorrect, morally outdated (+).

The flow of information consumed by the group could be described by the equation:

$$\frac{dH(t)}{dt} = -p_1S(t) + p_2H(t), \quad (1)$$

where $-p_1S(t)$ and $+p_2H(t)$ – respectively, information flows of the first and second type.

In this case, the balance of the entropy flow would correspond with the formula:

$$\frac{dS(t)}{dt} = -\mu_1S(t)H(t) - \mu_2S^2(t)H(t) + \alpha S^2(t) + \beta H(t) + \gamma S(t), \quad (2)$$

where $-\mu_1S(t)H(t)$ – is the decrease of the entropy as a result of the interaction of students with the information received in the learning process, $-\mu_2S^2(t)H(t)$ – is the decrease of the entropy due to the students' discussion of the information relevant to the subject of study, $\alpha S^2(t)$ – is the increase of the entropy, which is caused by unproductive contacts of listeners amongst themselves, $\beta H(t)$ – is the increase of the entropy due to contacts of listeners with excess information that they do not need, $\gamma S(t)$ – is the increase of the entropy during periods when students did not study (illness, unauthorized absence, etc.).

As a result, we obtain a system of nonlinear autonomous differential equations:

$$\begin{cases} \frac{dH(t)}{dt} = -p_1S(t) + p_2H(t) \\ \frac{dS(t)}{dt} = -\mu_1S(t)H(t) - \mu_2S^2(t)H(t) + \alpha S^2(t) + \beta H(t) + \gamma S(t) \end{cases}. \quad (3)$$

A quantitative assessment of the effectiveness of the educational process could be the value $Q = \frac{\tilde{H}}{\tilde{S}}$, where $\{\tilde{H}, \tilde{S}\}$ – being the equilibrium position of the considered system of equations. In the only meaningful equilibrium position of a given system, the quantities \tilde{H} and \tilde{S} are related by the relation $\tilde{H} = \frac{p_1}{p_2}\tilde{S}$. In this case, the value of \tilde{S} is determined by the formula:

$$\tilde{S} = \frac{(\alpha - \mu_1 Q) + \sqrt{(\alpha - \mu_1 Q)^2 + 4\mu_2 Q(\gamma + \beta Q)}}{2\mu_2 Q}. \quad (4)$$

From the point of view of synergetics, the main task of the educational process organizing is to develop managerial decisions, which are aimed at the enhancing of the influence in the equations of the model of the training system of members responsible for reducing entropy, and at the reducing the role of members responsible for its growth. Naturally, one need to start with improving the content of training. In the process of improving the content of training, we act on the members responsible both for the decrease in entropy, being the result of the interaction of students with the information received by them in the learning process ($-\mu_1 S(t)H(t)$), and for the increase in entropy due to students' contacts with the information which is unnecessary for them ($+\beta H(t)$).

Together with the development of distance learning technologies, the educational potential is growing; the degree of individualization of education is increasing. Each student gets the opportunity to study according to their own schedule, which is pre-agreed with the teacher. With the correct approach to the individual planning of the educational process from the synergetic model of the distance learning system, it is possible, in principle, to exclude the members, who are responsible for the increase of the entropy due to unproductive contacts between students ($\alpha = 0$), and for the increase in entropy during periods when they did not study ($\gamma = 0$):

$$\begin{cases} \frac{dH(t)}{dt} = -p_1 S(t) + p_2 H(t) \\ \frac{dS(t)}{dt} = -\mu_1 S(t)H(t) - \mu_2 S^2(t)H(t) + \beta H(t) \end{cases} \quad (5)$$

At the same time, it is necessary, in a targeted manner, to enhance the role of members, who are responsible for reducing entropy as a result of the acquisition of information related to the subject of study ($-\mu_2 S^2(t)H(t)$) (in the process of collective problem-solving, in the course of team business games, on problematic Internet forums, etc.). The necessity for students to communicate with teachers in distance learning is not decreasing, but, on the contrary, increasing significantly: the increased degree of individualization of education contributes to the exaltation of the role of the teacher's personality in the curriculum process. Repeatedly enhanced by the power of modern information and communication technologies, the unique intellectual potential of teachers is realized most effectively in this mode of work.

In the synergetic model of the distance learning system, the bifurcation is possible, the real content of which would be the fast-flowing (spasmodic) process of knowledge mastering in the process of preparation of students for current control - control works, midterm control and intermediate certification – tests and exams. The increased degree of the educational material formalization, which is the characteristic for the distance learning technologies, simplifies the organization of objective continuous systematic control of students' knowledge.

4 Conclusions

Thus, we can draw the following conclusions from the above:

- to identify and study the patterns that are in force in the systems of education, forecasting, planning and managing the educational process, it is necessary to use systemic economic and mathematical models that adequately reflect the processes occurring in them;
- together with the development of market relations in EC, the necessity increasing for an objective and regular improvement of the system of training and re-training of the personnel;

- it is proposed to study socio-economic processes, which occur in education systems and subsystems, using methods and means of the theory of self-organization – synergetics;
- it is possible to achieve individualization and high quality training of specialists throughout the country with relatively low financial costs with active development and effective usage of electronic and distance learning in the educational process;
- the advantages of using information and communication educational space are confirmed by the results of a qualitative analysis of the synergetic model of distance learning;
- comprehensive formalization of all processes in the IICES system creates the prerequisites for building a quality management system for the educational process.

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