

Main elements modeling of the educational process in the conditions of digitalization

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Abstract. The article deals with the issues of improving the efficiency of the educational process in higher education institutions by introducing it into the educational process. The formation of the digital economy is a global trend that dates back to the late 90s of the twentieth century, when for the first time global communication networks formed the market for digital products and services. From chain stores, contactless payment systems and remote communication, the world has moved to virtual reality and the digital sector of the economy in the context of digitalization, it is the basis for subsequent decisions. The resulting concept should be gradually implemented in various types of management of an educational organization with the widest possible use of IT services. The emerging multi-user environment involves the interaction of participants in the educational process: system administrators, teachers, students, involved persons (consultants) in a single network with an accessible interface. The network nature of the organization makes it possible to ensure the self-improvement of the proposed system and bring it to the level of artificial evolution, which will avoid the need for constant modernization and the inevitable delays and errors associated with the adoption and debugging of the upgraded system. The evolutionary scenario allows to improve the system in the process of its operation without the need to change the generations of services, retrain employees, making do with minimal support and maintenance. The effectiveness of the proposed system is ensured by the modern educational motto of digital development “improvement at work”.

1 Introduction

The polyparadigmatic nature of modern education and the competence-based approach to educational activities involve the modernization of the modern educational environment of higher education institutions with the involvement of the capabilities of information systems and technologies. According to G. Gref, information technologies of the modern world are of exceptional importance for the economy and society: “Data, information models, and knowledge are the new oil”.

Based on the works of N. V. Desyaeva [1], A. Y. Kibanov [2] M. Yu. Kovalenko [3], it can be noted that the modern didactic environment of education will be effective when instrumental computer modules acquire the properties of preceptive activity. They are like

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receptors that provide independent and self-organizing mastery of competencies, knowledge, skills and abilities [4].

The experience of the United States of America and other countries of the European Union [5, 6, 7] shows an extensive transition of the educational environment to modular digital education.

The activity of the instrumental information modules in this regard is provided by modeling the phenomena and processes of nature in an interactive mode. It is the interactive mode (control mode, change mode) that transforms the model from a means of reproductive learning into a means of productive cognition. O. Gaibaryan [8] defined the model as “such a material or mentally represented object, which in the process of cognition (study) replaces the original object, while retaining some of its typical features for the study”.

In the world of global digitalization it is impossible to carry out educational activities effectively without information technologies (IT) and information and communication technologies (ICT).

Modern IT services are used to model the entire architecture of an educational institution, including the management system and the educational process. Modeling plays an important role, as it creates the appearance and structure of the system, its framework [5,7,8].

It is the digital transformation, the constant improvement of IT, the development of ICT that changes the approaches to the construction of the educational process, it requires the creation of new information models, i.e., the information representation of the educational process.

Information models of the educational process have a certain systematization: ontological/conceptual, architectural/graphic, mathematical, composite/hybrid, etc. These information models relate to the stages of the life cycle.

Prototypes of information models exist in the form of knowledge and data, then at the development stage they are consolidated into conceptual models, and they develop into executable models at the design stage.

An information description of the educational process is formed at the implementation stage – a model and documentation “how it was done”. When implementing the educational process, its models exist and are applied, supported in the format “as it is”. A necessary condition for the functioning of information models is constant watching and monitoring.

The improvement of the models consists in entering the observational data first into the “how it was done”, and then into the current “as it is” model.

The goal is unification and compactness, integration of elements of the educational process and management in the conditions of digitalization on a single platform. The task is to develop information models of the educational process, to provide a basis for practical application, to prepare the basis for the preparation of documentation “how it was done”, by an educational organization.

2 Materials and methods

Modeling the main elements of the educational process starts with the collection of initial data necessary for the introduction, effective application and conditions for the continuous improvement of information technologies in the educational organization (university). Qualitatively selected initial data will allow us to assess the digitalization of the educational process and develop specific requirements for it, as well as define the initial concept, in accordance with which the work on the introduction of information technologies will be carried out [9].

It is necessary to present the composition and sequence of its components to model the main elements of the educational process of a higher educational institution:

- 1) ontology of the educational process, mission, necessity, scope of application
- 2) life cycle
- 3) requirements
- 4) components of the educational process and their architectural models:
- 5) functions
- 6) elements
- 7) concept
- 8) documentation

The sequence of modeling work with the components of the educational process is shown in Figure 1.

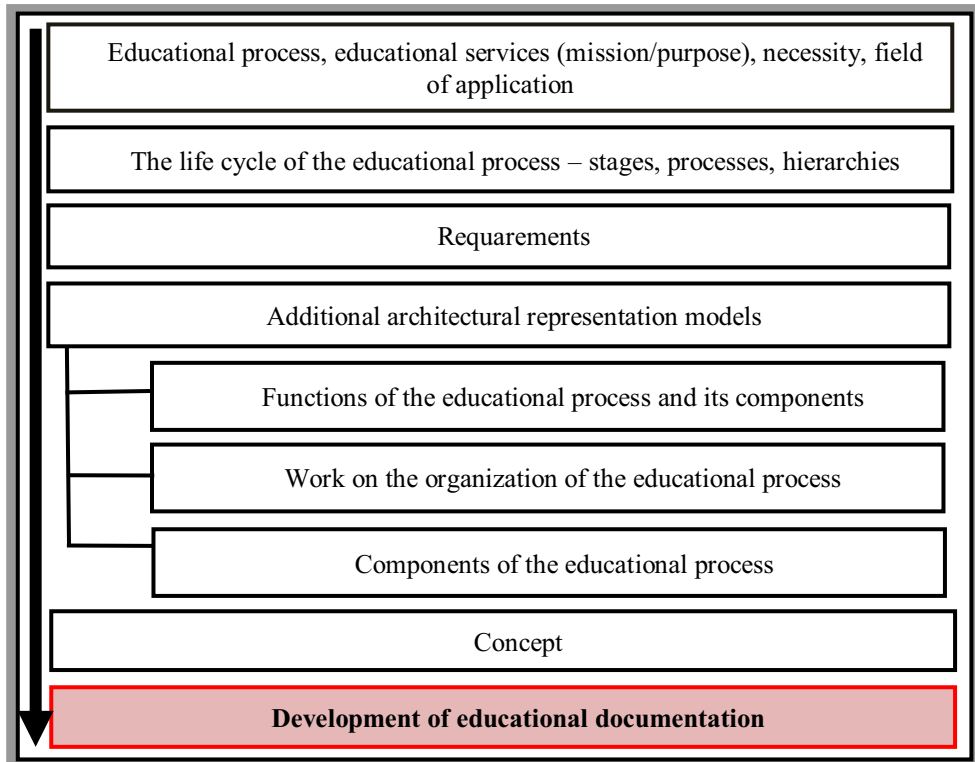


Fig. 1. Sequence of modeling activities

Modeling of the educational process begins with the definition of terms and concepts of the subject area. The main task of the ontology is to prepare a set of terms and a conceptual description of the subject area. As a result, a special dictionary of terms and concepts and their explanatory definitions is formulated.

Here are the main terms and definitions.

The educational process is a purposeful activity for the provision of educational services. In the process of education, students of higher educational institutions master the skills of professional activity by learning the existing experience in the field of study, theoretical knowledge, practical skills, they also form personal qualities.

Educational services are the result of the educational process of a higher educational institution in the form of knowledge, skills, and information that are used to meet the numerous needs of a person, society, and the state [10-12].

Mission – is the main purpose of the educational process.

Concept – is a model, some idea of the educational process, its mission, its life cycle, components, architectural models and the concept of implementation.

Architectural models – models of requirements, components, and relationships between them.

Requirements – a detailed description of the educational process, first formed by consumer requirements, and then supplemented by regulatory, system and physical requirements, where the limitations of both the external and internal environment are taken into account.

Documentation is an informational description of the educational process, including in digital format, focused on the use of both the teaching staff and the students of the higher educational institution.

In practice, it is possible to use various techniques of ontological engineering. In this paper, the original description format is a dictionary.

There are possible ways to represent the ontology in the following forms:

- in text format, i.e. separate documents, textbooks, books;
- in the form of hypertext-text descriptions with links to dictionary terms;
- the matic collections of hypertext.

It is assumed that as a result of the work, the dictionary of terms will be placed as a section at the beginning or end of the developed regulations (document) which will describe the requirements for the information models of the elements of the educational process

The life cycle of the educational process (LCEP) of a person accompanies him/ her all life. However, we will highlight those stages that are characterized by gaining professional knowledge, skills and abilities in a specific field, as well as the "student-teacher" system, i.e. the teacher and the student interact with each other.

The main stages of the (LCEP) are shown in Figure 2.

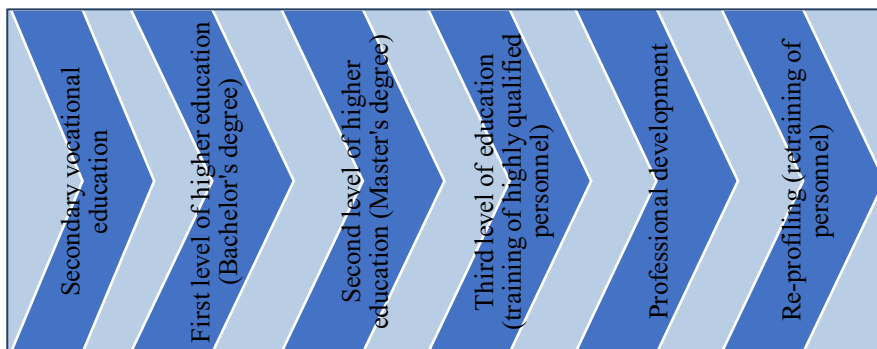


Fig. 2. Life cycle of the educational process

The requirement for the educational process is what the educational process must meet and the restrictions that must be observed. Systematization of requirements for educational activities is quite a time-consuming process and requires a detailed study, or even a separate study. In our opinion, at the initial stage, it is enough to identify interested persons as an educational process. These are students and their parents, an educational organization and all its participants, enterprises, industries, and the state [13-15]

It is advisable to use the Requirement Breakdown Structure (RBS) to represent the requirements for the educational process, which shows hierarchically ordered components, specific requirements for the educational process.

Modeling the representation of functions in the educational process consists of describing the content of these functions and building models. In general, the task of modeling is to structure the processes of educational activity, i.e., to demonstrate the

structure of stable orders for the implementation of the educational process in standard notations.

Due to the fact that an educational organization is characterized by a very large number of functions, we will first present the root model of the top-level processes. The root model of processes demonstrates the initial enlarged content and typologies of the processes in an educational organization:

- main processes-educational services and the educational process;
- educational organization management;
- supporting processes.

The root model of university processes is shown in Figure 3.

In this paper, we use the Function Breakdown Structure (FBS) as a modeling tool for detailing the functions of the educational process. We will build the FBS model for the main process – the educational process – professional training. As a notation for the FBS model, we choose the table (Table 1).

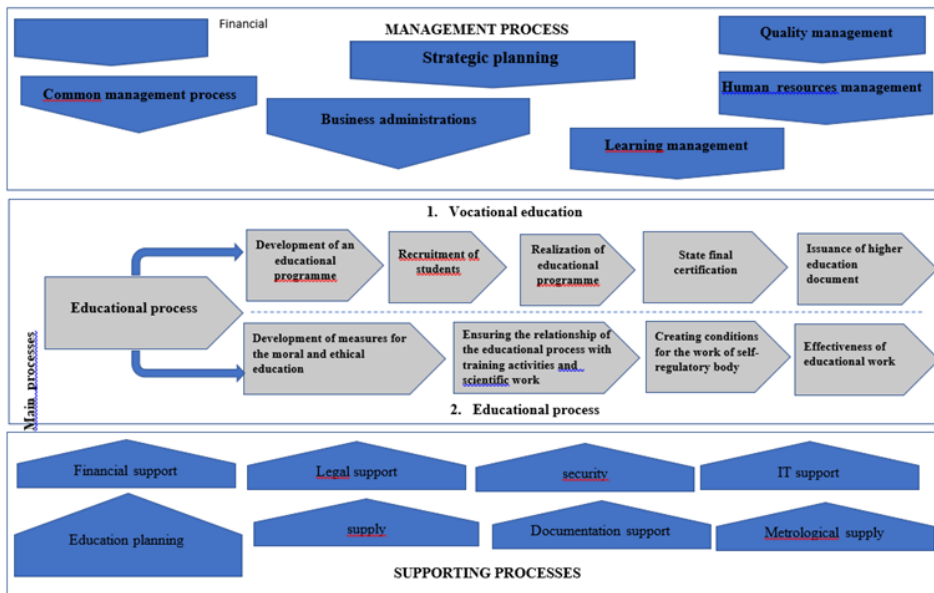


Fig. 3. Root model of university processes

Table 1. FBS Process Model: Vocational education

	1 process level	2 process level
Educational process-professional training	Development of an educational program	Making a decision about the educational programme (EP)
		Description of an EP
		Development of the curriculum
		Consideration of the EP at the Academic Council and approval by the Rector
		Verification, registration, and storage of EP
		Formation of documents in EP (calendar curriculum, work programs of disciplines (modules), practice programs, final certification programs, evaluation and methodological materials

		Consideration and approval of EP at a meeting of the department and the faculty Council.
		Placement of EP documents in the educational environment of the University
		EP update
	Students recruitment	Campaign work
		Organization of the admission campaign
		Accepting applications
		Competitive selection
		Matriculation
	Realization of educational programme	Training in disciplines (modules)
		Organization and implementation of practices
		Conducting electives
		Conducting current and interim certification
	State Final Certification	Preparing for the final state exams
		State exams
		Final research work defense
	Certificates of higher education (diploma)	Formation and printing of the diploma
		Diploma registration
diploma		
Note: in the resulting model, the processes are not reflected in full, which is typical of a higher educational institution, but only the main part without detailed information.		

To represent the elements of the educational process of the university, we use the Requirement Breakdown Structure (WBS), which shows the hierarchically ordered components (Table 2).

Table 2. RBS model - elements of the educational process

	1 process level	2 process level
Elements of the educational process	EP	Description
		Curriculum
		Calendar curriculum
		Work programs of disciplines (modules), practice programs, final certification programs
		Evaluation materials
		Methodological materials
		Employers' reviews of EP
	Teaching staff	Professors
		Associate Professors
		Senior teachers
		Assistants
		External part-time employees (managers and / or employees of enterprises attracted by the University)

	Infrastructure	Training facilities
		Accommodation facilities
		External comfort
		Transport
		Sports facilities
		Public catering facilities
		Engineering infrastructure
	Material and technical support	Computer equipment
		Software
		Library fund
		Furniture
		Equipment and technical means
	Information and educational environment	University website
		Information and educational environment
		Local area networks
		Modern professional databases and information reference systems
		Social network
	Messengers	
	<p>Note: in the resulting model, the processes are not reflected in full, which is typical of a higher educational institution, but only the main part without detailed information.</p>	

The model of the concept of the educational process should contain the source data, the mission, all the elements, and show the relationship between them. The concept focuses on the fact that it is possible to design the educational process as a whole based on the available source data.

The development of the model in the educational process is implemented on the basis of architectural modeling. The method of applying conceptual design based on architectural models is shown in Figure 4.

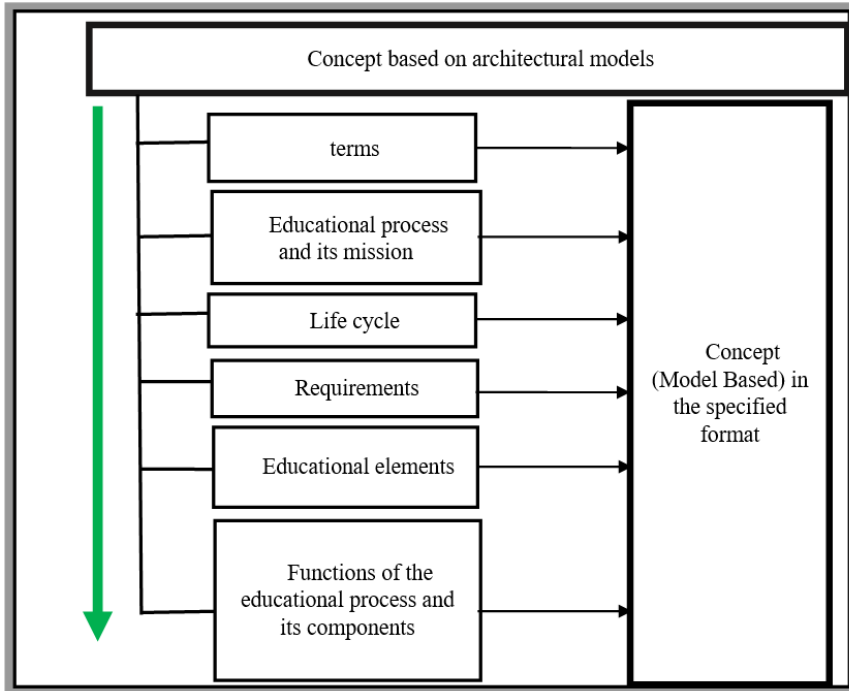


Fig. 4. Method of conceptual design based on architectural models

The model of the concept in the educational process is shown in Figure 5.

The concept is an educational environment that is in the area of responsibility of the head of the educational organization. The educational environment, in this case, consists of a system of systems and their relationships. The first system is “consumer requirements – educational environment – specialists (university graduates)” reflects the main mission, which is to meet the needs of stakeholders and to train highly qualified specialists in various fields of activity. The educational environment includes elements of the educational process (Table 2). The mission is implemented through the system “management processes – main processes – supporting processes”. The main process is a system “life cycle of the educational process – a model of the functions in educational process” (Figure 1-Table 1). This system characterizes the main activity of the university, which is constantly monitored. Monitoring is conducted according to the criteria that characterize the quality of education and the satisfaction of stakeholders. Observational data are introduced into the educational process by correcting previously obtained models.

3 Results and discussion

The obtained models are used to develop a system for managing the educational process in the context of digitalization, which is the basis for subsequent decisions. Next, it is necessary to implement the resulting concept in various types of management of an educational organization gradually, if possible, with the widest possible use of IT services.

Effective modeling of the elements in educational process should be carried out using specialized software products that allow:

- create electronic models;
- use model visualization tools;
- export solutions from models to regulations automatically;

- implement the principle of complexity, simplification and acceleration of fixing changes – changes in one place of the model, automatically generate changes in other related components;

- provide communication and visual services to users.

In the digital economy, solutions for building educational management systems are supported by IT services and electronic regulations.

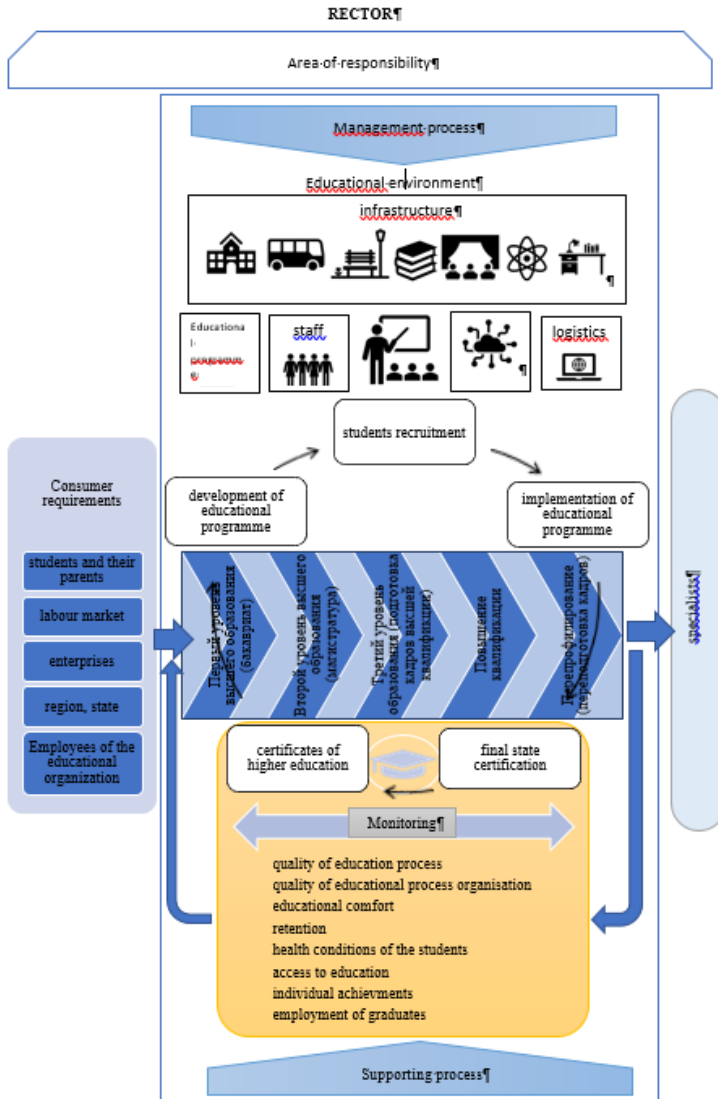


Fig. 5. The concept of the educational process of a higher educational institution

4 Conclusion

The presented information models assume the integration of each model into the information service.

The multi-user environment involves the interaction of participants in the educational process: system administrators, teachers, students, involved people (consultants) in a single network with an accessible interface.

The network nature of the organization allows to ensure the self-improvement of the proposed system and bring it to the level of artificial evolution, it allows to avoid the need for continuous modernization of educational processes and the inevitable delays and errors associated with the adoption of the upgraded system by users. The evolutionary scenario allows to improve the system in the process of its operation without the need to change the generations of services, retrain employees, doing with minimal support and maintenance. The effectiveness of the proposed system is ensured by the modern educational motto of digital development "improvement at work" [17].

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