

Digital transformation and methodological aspects of education

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Abstract. The article studies the conceptual characteristics of education such as informatization, the impact of digital technologies on the goals, objectives and learning outcomes, the components of teacher's professional activity. The modern education system should be innovative marked by continuous education throughout life and self-education and the ability to update its structure in accordance with the requirements of society. New forms of education, in particular, those that implement "lifelong education", are in demand in modern knowledge society, and the need for methods of educational and cognitive activities of educational subjects and their interaction in the information and educational space is increasing. Since the development of the lifelong education system implies the development and expansion of its constituent parts and the components of the methodological system of education through interaction with the content of the information and educational environment, education must develop and become informationally qualitative, corresponding to the level of the information society. The article emphasizes that in the digitalization and informatization educational system, goals, content, forms, and methods of teaching academic disciplines should be changed. The task of the methodology of education is to study the qualitative and quantitative impacts of digital technologies on the content of the information and educational environment, student's personality and socioculture of the subject of education. The readiness of a teacher for professional and pedagogical activities in the information and educational environment is considered as professionally and personally significant qualities and ICT competencies. The teacher should creatively solve problems that arise in the educational and cognitive activities of students, be ready for qualitative changes in society and education influenced by digital technologies

1 Introduction

With the development of the IT technology industry and global mass communications, qualitative changes are taking place in the production area, global markets and in sociocultural relations, in the social and informational interaction. Digitalization and informatization as technical and technological innovations have changed the life, worldview, lifestyle and culture of people, science, and industries. The development of the digitalization industry, automation and robotization of production processes, and the digital transformation involve the development of highly intelligent systems, Artificial Intelligence and Big Data systems. The degree of satisfaction of person's information needs is increasing, and the share of knowledge becomes decisive, which requires advanced education and improvement of the content of education.

The National Program "Digital Economy" emphasizes the need to create and implement approaches

to assist citizens in mastering the key competencies of the digital economy, ensuring mass digital literacy and personalization of education [1]. The digital economy and end-to-end technologies (artificial intelligence and neurotechnologies; distributed registry systems; quantum technologies; new production technologies; industrial Internet; robotics and sensor components; wireless communication technologies; virtual and augmented reality technologies) are in demand. Therefore, the digital transformation of education should overcome the technical gap and eliminate the technological (digital) gap in providing subjects of education with open electronic educational resources.

The digital transformation of education involves:

- development of the digital infrastructure of education, ensuring the continuity of the reproduction of knowledge and electronic educational resources;
- development of electronic educational resources as educational and methodological support, tools and

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services, including educational applications for mobile devices;

- development and dissemination of new forms, methods and models of teaching and educational and cognitive work;
- development of a mechanism for protecting information and educational resources from computer attacks to protect these resources from computer attacks or unauthorized access.

Shared goals, priorities, principles, universal methods of educational and cognitive activity and technologies should be clearly expressed to implement the learning goal and support for the digital transformation and developed control and evaluation materials to overcome the new digital divide.

The transformation into digital reality has been completed; this transition is referred to as the new industrial or technological (digital) revolution [2], although there is still an interpretation of the digital revolution from a technological point of view.

In the digital era, there is a need to improve the mechanisms of knowledge exchange, to create an information and educational environment and open educational resources, provide unlimited opportunities for access to digital tools, materials, and services, implement traditional and electronic forms of education. The integration of information and pedagogical technologies in education and the presentation of information and information resources as educational and methodological support for educational and cognitive activities should contribute to the most productive use of the didactic potential of both information and pedagogical technologies in IT education. This task becomes especially difficult, but extremely relevant.

Practice has shown that against the backdrop of COVID-19, when most educational institutions implemented distance learning in an emergency mode, there was a didactic and methodological understanding of a new form of using the information and educational environment and open educational resources as components of the educational space.

Digitalization as an objective factor in the development of society and its social and information environment is aimed at the development of society, its resources, activities, and culture. Moreover, it focuses on informatization (in its objective and fundamental meaning) of the processes of cognition and is realized in the process of digital transformation. These changes are occurring in education; therefore, we define informatization of education not only as a process of digitalization of the educational environment, but as a process of solving the problems of information-cognitive and educational-cognitive activities, information interaction of subjects, which involves the development of digital technologies in all areas of the educational process.

The holistic, system-integrated subject of education as a cognitive system is an open and developing system with invariant, regular relationships between its

components. The methodology of education is presented in the structure of educational subjects and methods of teaching; it helps adapt and shape the educational process of personality-oriented learning based on the integration of information and pedagogical technologies.

2 Purpose of the Study

The aim of the study is

- to identify internal and external factors that have qualitative and quantitative impacts of digital technologies on the content of education;
- to describe the nature and results of the impact of the electronic digital environment and its elements on the educational process and subjects of education;
- to present the qualitative impact of the electronic digital educational environment on student's personality through the quantitative impact of its resources;
- to determine the degree of influence of digital technologies on the teacher, that is, on the content of the components of his professional activity in the digital era.

3 Research Problem

In the study, the basic (initial) provisions of the problem field were determined:

- the digital transformation has acquired a large-scale character and sociocultural significance that goes beyond the technological component, that is, it has changed the worldview and human consciousness;
- in the information and digital era, pedagogical and information technologies are integrated into the educational process focusing on the development of the individual and the formation of his information culture and subculture;
- the globalization of education is occurring, the information and educational space is being formed as a part (component) of the cyberspace;
- the development of e-learning as an application of IT technologies in education. A greater certainty in the implementation of distance learning as a sociocultural phenomenon, concept and phenomenon is required; and, its conceptual model with essential conceptual features and their descriptions is needed. The model can become the basis for creating a logical-semantic model of formal, non-formal and informal teaching of subject systems, a methodological system of subject teaching using digital technologies.

Several contradictions have been identified between the new conditions and requirements in education, due to the digitalization of society, and the theory and practice of using digital technologies in education:

- between the intensive nature of digitalization of society and education and the insufficient level of

scientific and methodological support for the digital transformation of education;

- between the high rate of development of IT learning technologies and the reasonable use of their didactic potential by teachers, methodologists, and IT specialists.

4 Research Methods

The following research methods were used in the study:

- Content analysis of philosophical, scientific, psychological-pedagogical and educational-methodical literature;
- general scientific methods of cognition: analysis, synthesis, comparison and comparison, generalization, systematization, etc.;

The main scientific and methodological approaches used in this study are:

- the system-activity approach, both the requirement of the Federal State Educational Standard, and the most perfect form of the method of cognition of the surrounding world, phenomena, and reality.
- the integrative approach as a combination of real, augmented and virtual components of the developing IEE, which ensures the implementation of various forms and technologies of education in their balanced combination based on the dialectical unity of electronic and traditional forms of education.
- the meaningful approach aimed both at the adequate expression of the content of education in electronic digital forms, and the presentation of the electronic digital forms in the content of education and systems of subject education, in the methodological system of subject education.
- the socio-cultural approach aimed at the development of socio-culture and culture of interaction, the formation of readiness for comfortable activities in the constantly changing socio-cultural environment.

5 Educational Space in the Digital Age

Education involves an educational process and its results; the process includes training and personal development. Education is, therefore, the transfer, perception, and personal “appropriation” of experience (knowledge, skills, culture) of previous generations by a new generation implemented in a variety of intersubjective and subject-object relations for the subsequent use and expansion in accordance with social goals. Education is the most effective channel of communication between generations for the reproduction and transfer of knowledge, cultural and educational values, etc.

The educational space is a broad and multifaceted concept, an ordered representation of a real system; it exists and is implemented in a variety of forms and structures (general education, secondary education, higher education, advanced education). These are various forms of self-education and additional education.

Under the influence of global informatization and universal digitalization, the information state has become a property of education, and all components of the education sector have become information and educational. In view of the exceptional importance and demand for knowledge and education, information society is characterized as “knowledge society”. Therefore, the real education system with all its components and abstract information models is implemented electronically in the virtual world. “The spatial representation of education is informational and part of the information space of the social information environment” [3]. “Modern educational space is a participant in the new global community” [Volkova 4, p. 182].

According to Novikov, the educational space is “the totality of all subjects and objects directly or indirectly participating in educational processes, interested in them, or influencing them” [5]. When considering education in the context of the fundamental systemic approach, “it is necessary to present it as a single multifunctional integrated system that combines the processes of education and informatization and digitalization” [6].

The educational process is expressed in the continuous information and cognitive interaction of various subjects and objects: teachers, students, educational information, teaching aids, etc. Planning, streamlining, optimization of this process can be carried out through the discrete and formalized representation in the form of a system of relations.

Being an open developing social-cognitive system, education is a differentiated system realized through representations in the structure of educational subjects. Education is characterized by systemic patterns:

- (a) the educational process is implemented through educational interaction that develops its content and forms of implementation;
- (b) educational interaction is expressed through the implementation of the educational process;
- (c) educational interaction is an element of the educational sphere, educational processes and subject-subject and subject-object relations are integrated [6].

In modern education, these concepts converge; however, these are natural and invariant relations of the educational system considered as an information structure both in content and in form, namely, the methods of formalization and digital formatting with a certain degree of abstract-logical modeling and systematization educational information make them more constructive, rational, and understandable. Systemic laws of education are necessary for its representation in cyberspace as a single system with shared goals, requirements, principles for implementing the information and educational environment and educational activities.

5.1 Goals, objectives, and results of education in the context of digital transformation

In terms of content, education can be understood as the process of forming personal images of knowledge, skills, competencies, and culture. Functionally, education is an educational process that generates information, resources, and educational and cognitive relations. The educational process is based on educational activities carried out in the educational interaction of subjects and in a variety of intersubjective (multi-subject) processes.

The results of education are personal images adequate to the educational information and knowledge transmitted by the educational process, creating the opportunity for the owners of these images to perform creative work and develop (self-development, self-education). The personal image formed by education is a tool of development. These results of education are realizations of its purpose. But this is only a semantic-pragmatic interpretation of the concept of education.

The results of education are determined by its goals. The abstract results of education are a structural and meaningful representation of its goals in knowledge, skills, competencies, personal properties transferred.

Personal results of education are student's perception of the abstract results of education in personal knowledge and skills, competence, motivation for learning, personal culture.

Goals are determined by society and its invariant state, social goals, conditions and requirements; social order expressed in educational standards (FSES, doctrines) and the concept of education, the development trends, the educational environment, pedagogy.

The main objectives of education are as follows:

- to ensure the continuity of reproduction of society throughout life-long education;
- to ensure the continuity of existence and development of society through the reproduction of educational resources and knowledge as a process without which it is impossible to ensure the historical security of society, that is, the intellectual resources and knowledge of society lose their value without being appropriated by new generations;
- to develop a personality capable of solving socially significant tasks and ready for further development and self-development, for education and self-education, i.e., education should be directed to the future;
- to develop a harmonious personality capable of perceiving and developing social culture, intellectual and spiritual values of society (aesthetic, physical and other qualities, interests, needs, general culture);
- to develop an ability to adapt to changing social conditions.

These goals are implemented in the educational process. In every educational process and in every local educational interaction, these general educational goals are expressed or should be expressed.

General educational goals are complemented by local goals of the system components of education, systems of subject education, forms of education. Local educational goals are formulated at the level of tasks for the

implementation of general educational goals or are their specific representations.

The tasks of education express its goals, are generated by them. The goals of education are aimed at the integrated development of the educational sphere and the sphere of educational interaction, pedagogical activity, and the infrastructure of education, technological and electronic communication sphere. Therefore, the tasks of education can have pedagogical and non-pedagogical aspects. At the adjacent local levels, the teacher can engage in non-pedagogical activities. But the teacher should be engaged in the pedagogical activity. Any educational task should be set by teachers in accordance with the knowledge and methods of pedagogy.

The general educational task can be solved at the level of entire education; its solution at each local level is of general educational significance. These are, for example, knowledge and skills of meta-disciplines such as mathematics, computer science, biology, chemistry, and foreign languages, which are at the center of interdisciplinary communication [7].

The general educational goals correspond to the general educational tasks that implement them:

1. Providing the education sector with the infrastructure contributing to the solution of organizational and other problems.
 - Informatization of education and the information and educational environment, its resource base, IER and EER, digital communication sphere.
 - insurance of the transition of education and all systems of subject education to media education and learning, SMART education and learning [7, p. 36];
 - implementation and development of all forms of education to ensure its continuity for each subject, safety of the educational process and information and educational interaction;
 - development of distance learning.
2. Insurance of the required quality of educational reproduction of a person and society in accordance with the concept of its imagery;
 - identification of an optimal amount of knowledge and experience for adequate educational reproduction.
 - development of an optimal subject-educational structure of educational reproduction, providing its necessary completeness.
3. Personal development of subjects of education, turning into self-development.
 - development of subject and meta-subject competencies, motivation of subjects for cognitive and socially significant activities.
 - insurance of information and psychological security of subjects of education.
4. Development of personal social and information culture, culture of knowledge and cognition, information outlook.

5. Development of the subject of education in the unity of spiritual, intellectual, and physical aspects.
 6. Development of the social and legal competences, knowledge of the social and legal norms of the information environment.
- development of the ability to navigate in the information and cognitive environment, conscious legitimate and safe consumption of information products in accordance with educational activities, and personal cognitive interests.

The goals of education are focused on educational outcomes. These results are expressed at a conceptual level present in the components of education and in educational subjects in a variety of abstract and objective results. Each task of education is directly aimed at a specific result, which can be structured, having an abstract, objective expression and a personal, subjective representation.

General educational tasks correspond to structured general educational results. Any abstract result of subject education is significant for education. The results are determined by the goals and achieved through them.

Achieving the goal is an activity approach to the implementation of the methodology and content of education, which are projected onto abstract, objective-subjective learning outcomes, which are supposed to achieve the planned learning outcomes as the quality of education.

Abstract subject learning outcomes are a structured semantic description or an information logical-semantic model of planned learning outcomes in accordance with existing programs. In this capacity, the component "Learning Outcomes" has the opposite effect on the goals, content, and methodology (due to their interconnection and interdependence).

Subject results correspond to the purpose of teaching a particular subject, are within the cognizable area in this subject.

Meta-subject results relate to the scope of teaching a particular subject, express possibilities of this application in interdisciplinary communication, education, and self-education.

Personal results characterize the accumulated potential of the subject as a self-developing and self-governing system of cognition. This is a value attitude to education and its results, awareness of cognitive needs, direction to the solution of socially significant tasks.

Objective-subjective, personal results of education and subject education are the realization of their abstract results on the "front line" of the educational process and pedagogical activity. This is a mapping into personal systems:

- presentation of abstract results in accordance with intellectual, psychological properties as self-determining information systems, an age level;
- verification of the degree of adequacy of abstract results to a particular subjective learning system, adaptation to specific conditions in accordance with differentiated and individual methodological approaches;

- direct connection and feedback of this representation in the transmission-reception, control, evaluation, and adjustment.

In modern education, the assessment of educational results, which previously existed in a variety of local expressions, has become systemic, systematized due to its technologization and unification of the content. Having become a unified system, the evaluation of educational results has become an independent component of pedagogy and education, requiring methodological justification, development, formation, implementation, and evaluation of its own results.

5.2 Methodology for developing components of the methodological system of information education

The methodology for the formation of individual components of the methodological system of information education is well developed on both general and principles of education. The methodological system of subject education is expanding both in terms of its structure and content. This happens due to

- complex development of information and legal competences and information culture;
- personal development and socialization;
- individualization of education.

This methodological basis is relevant to each university subject. This also applies to Computer Science and ICT, since it forms the foundations of information and information-legal competence, information culture and media culture.

According to Korotkov, the interaction of subjects in the educational space becomes social which should be reflected in each active system, in each subject" [8]. Socialization of the education sector is realized through the digitalization of education and implementation of the information and educational environment, considering social and legal aspects.

The study of the methodology of subject education, socialization, and personal development of subjects of higher education focuses on methods, content, forms, learning outcomes in terms of intellectual and spiritual development, self-development, mutual influence of internal and external factors, internal components, and corresponding components of the external environment. When considering the problems of socialization and personal socio-legal, socio-cultural development of students, one should focus on

- the goals, methods, content of training, learning outcomes in terms of intellectual and spiritual development and self-development of student's personality.
- the mutual influence of internal and external factors of education, its internal components and components of the external environment, the IEE of the university, the media environment.

Define the following learning principle:

The principle of interconnection. Implementation of the systemic relationship of external and internal factors that affect the components of education in terms of the personal development and the external environment, IEE of the university, media environment, educational cyberspace.

Media education is a feature of e-learning and the entire modern educational sphere; it is aimed at the formation of skills for the conscious and responsible perception of information from the social information environment, including media information; therefore, media education should solve the problem of understanding own information needs, developing skills for working with information sources, critically assessing reliability of media messages [9].

“The concept of the media educational environment is designed to combine opportunities for the accumulation, assimilation and transfer of knowledge necessary for personal development and effective professional training of students in the conditions of screen culture and information society” [10].

However, electronic-digital learning involves the qualitative expansion of the concept and content of media education:

- media education as an educational area is aimed at developing skills, media competences necessary to work with media information and media tools.
- media education as education involves the productive use of media information and media tools based on the existing knowledge, skills, and competences.

The direct and indirect impact of media information is reflected in the personal development and socialization of the subjects of education; the level of subject competence and media competence is increasing, and the personal media culture of the subjects of education is developing. The level of information competence and information culture is developing. The media competence and media culture of the subjects of education act both as products and as intellectual means of education (media education) that are necessary for productive self-learning, self-education, and self-development: “Media culture is a phenomenon with a multi-vector modality that considers media culture as the art of possible in the field of human subjectivity in the era of media” [11].

A tablet, a mobile phone, and many other similar devices are SMART tools that embody a combination of a SMART device and SMART technology. These technologies based on “smart” devices with a “friendly interface” are independent intelligent electronic digital systems (with built-in intelligence). They form a separate category of SMART systems in the trinity of SMART information, SMART technologies, and SMART communication. SMART systems are multifunctional devices compatible with computers in general informatization processes. Mobile devices and technology provide users with unlimited contextual access to a wide range of information resources [12]. This influence is manifested in the growing importance for the individual [13], blurring the distinction between

reality and virtuality; they turn a new reality into digital, intellectual one as a phenomenon of new Smart technologies. However, SMART-technologies and SMART-systems, determining the possibilities for the transition of the educational process to a new quality, do not contribute to this transition. They contribute to the acquisition of new qualities by education and society.

The principle of interconnection also implies the principle of consistency implemented through the definition of system connections, invariant relations, and systematization.

The principle of system modeling is of great importance in teaching. In the modern information environment, formalization and modeling are principles of the information approach to knowledge, society, man, and environment. Accordingly, they become the principles of information learning. Consequently, teaching involves the modeling of abstract information.

The basic methods of informational education are:

- system cognition, systematization, system modeling;
- methods of socio-cultural training and education.

The implementation of these methods should have a fundamental character. Consistency means certainty, order of relations and activities. However, this also entails responsibility, freedom of relations.

During the global informatization, when information and information processes express or implement any kind of activity, knowledge, research, learning, intersubject communications become information and inter-information relations. The principle of consistency is a requirement and tool for interdisciplinary communication, integrative processes in the field of cognition, science, and education.

5.3 Formal methods in education

Formal methods are needed to implement system and modeling methods. They contribute to the integration into a single systemic whole of the phenomenon of analysis and synthesis, deduction and induction, analytical and synthetic perception.

The method of projects has been widely used in information education

- as a way of acquiring knowledge and developing competences;
- as a way to implement the learning process.

It is also a form of socialization and personal development. The student develops a sense of responsibility for the means and resources of the environment used and for the results of work. His critical attitude to information, critical thinking, culture and ethics develop. The critical attitude to information is an important component of personal information culture, including media culture and culture of media security [14].

The critical attitude to information entails critical thinking, which is understood as the invariant ability of the subject to evaluate and analyze new information in

terms of its quality and reliability, ethical correctness, conformity with reality, socio-cultural and moral values.

The intellectual and imaginative thinking in the process of acquiring knowledge, searching for ways to solve problems, analyze and synthesize, and evaluate network, media information should contribute to the formation of information culture by ensuring security and eliminating possible negative impacts of information from the external environment. The development of critical thinking involves “the creation of a basic attitude towards oneself and the world, which implies a variable, independent, meaningful position. This position increases the reliability of education because it becomes conscious and reflective and increases the communicative potential of the individual” [15].

Critical thinking is a synthesis of conscious and reflective thinking, which develops the ability to use information effectively, rationally, and safely from the information environment, media environment, cyberspace. The critical attitude to information and critical thinking are derivatives. The level of information culture does not allow the subject to go beyond the ethical norms. The internal potential of the subject eliminates the possible negative impact of information from the external environment.

“Information culture characterizes the level of development of modern society in its transformation into the information one. It should manifest in every informational cognitive process, every informational interaction, every manifestation in the formation of the socio-cultural system-information approach” [16]. The principal thing is “a balanced correspondence between the information competence of the subject and his information culture, intellectual and spiritual levels of development” [17, p. 2]. It is necessary to develop the spiritual and intellectual culture in students.

When working on a project, a division of labor is necessary. Culture of interpersonal communication and a sense of collectivism are developing.

The “form of educational interaction” is of great importance. In modern education, the “monologue” of the teacher becomes less effective. This is especially important for universities; it is necessary to develop debatable forms of education, where everyone will have the right to express and defend his/her opinions.

Modern education aims to develop creative abilities, a social personality; it is necessary to pay more attention to the issues of self-knowledge of the subject of education as a self-governing and intellectual information system, culture of cognition and human thinking.

The requirements of fundamentality and depth in the development of information-legal competences and personal information culture in university students involve the interdisciplinary and meta-subject communications and activity-based learning.

6 Conclusion

The information society requires comprehensive, systemically interconnected subject education, logical

information education which should become qualitatively different.

The single information space of education is an open developing system in which all participants, subjects and objects of the educational process are involved and connected at the information and communication levels. The digitalization of information and the information environment entail a targeted digitalization of the education sector, which improves the efficiency of the educational process through the implementation of information and educational interaction, subject-object, and subject-subject relations.

The subject's critical attitude to information is an important component of personal information culture. It is necessary to develop the ability of the subject of education to evaluate information in terms of its quality and reliability, which will allow him to distinguish between positive and negative, meaningful and empty information.

Digitalization has changed the content of education, making it informational, part of the global cultural and educational space. Expressed quantitatively in electronic-digital forms, resources, technologies, systems, modern education exerts the intellectual and information-psychological impact on the subject of education. Due to this impact, the general educational level is raising, subject competencies, personal socioculture (moral, ethical, aesthetic), and information culture develop.

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