

PEDAGOGICAL FACTORS OF THE INFORMATIZATION OF EDUCATION IN THE CONTEXT OF DIGITAL TRANSFORMATION

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ABSTRACT. This article examines the pedagogical factors that determine the effectiveness of the informatization of education under the conditions of digital transformation. While the technological dimension of digitalization has been extensively studied, the specifically pedagogical conditions that make digital tools genuinely transformative for teaching and learning remain insufficiently systematized. The purpose of the study is to identify, classify, and substantiate the pedagogical factors of educational informatization and to reveal their interrelationship within a holistic didactic model. The methodological basis of the research includes theoretical analysis, comparative-typological analysis, and systematization of scientific and normative sources. The results demonstrate that the pedagogical effectiveness of digital transformation in education depends not on technology as such, but on a complex of interrelated factors, including teachers' digital-pedagogical competence, the didactic design of digital learning content, the psychological readiness of participants in the educational process, and the institutional culture of the educational organization. The article concludes that sustainable digital transformation of education requires a shift of emphasis from technological equipping toward pedagogical modernization.

Keywords: digital transformation, informatization of education, pedagogical factors, digital competence, digital didactics, e-learning environment, teacher readiness.

ANNOTATSIYA. Ushbu maqolada raqamli transformatsiya sharoitida ta'limni axborotlashtirish samaradorligini belgilovchi pedagogik omillar tahlil qilingan. Tadqiqotda axborotlashtirishning pedagogik omillari tasniflangan, ular orasida pedagoglarning raqamli-pedagogik kompetentligi, raqamli ta'lim kontentining didaktik dizayni, ta'lim jarayoni ishtirokchilarining psixologik tayyorligi hamda tashkilot madaniyati alohida ajratib ko'rsatilgan. Natijalar shuni ko'rsatadiki, raqamli transformatsiyaning pedagogik samaradorligi texnologiyaning o'zi emas, balki ushbu omillar tizimining uyg'unligiga bog'liq.

Kalit so'zlar: raqamli transformatsiya, ta'limni axborotlashtirish, pedagogik omillar, raqamli kompetentlik, raqamli didaktika, elektron ta'lim muhiti, o'qituvchi tayyorgarligi.

АННОТАЦИЯ. В данной статье анализируются педагогические факторы, определяющие эффективность информатизации образования в условиях цифровой трансформации. Систематизированы педагогические факторы информатизации, среди которых особо выделены цифро-педагогическая компетентность педагогов, дидактический дизайн цифрового образовательного контента, психологическая готовность участников образовательного процесса и институциональная культура организации. Результаты показывают, что педагогическая эффективность цифровой трансформации зависит не от самой технологии, а от согласованности данной системы факторов.

Ключевые слова: цифровая трансформация, информатизация образования, педагогические факторы, цифровая компетентность, цифровая дидактика, электронная образовательная среда, готовность педагога.

INTRODUCTION

Contemporary society is undergoing a profound transformation associated with the large-scale penetration of digital technologies into all spheres of human activity, including education. The term "digital transformation" denotes not merely the introduction of new technical devices, but a qualitative change in the way institutions, processes, and human relationships are organized. In the field of education, digital transformation implies a reconsideration of the goals, content, methods, and organizational forms of the pedagogical process, rather than a simple technical upgrade of classrooms.

The informatization of education has been widely discussed in scientific literature primarily from a technological and infrastructural perspective, focusing on the availability of computers, internet connectivity, learning management systems, and digital devices. However, numerous studies and practical observations indicate that the mere presence of digital infrastructure does not automatically guarantee an improvement in the quality of education. Many educational institutions equipped with modern technical means continue to demonstrate limited pedagogical efficiency, whereas some institutions with modest technical resources achieve considerable pedagogical results through well-organized methodological and didactic approaches. This contradiction points to the necessity of identifying and systematizing the pedagogical, rather than purely technological, factors that determine the success of educational informatization.

In the Republic of Uzbekistan, the digital transformation of education has become one of the priority directions of state policy. The "Digital Uzbekistan – 2030" strategy, together with a range of normative and legal documents on the development of general secondary, vocational, and higher education, has created a solid legal foundation for the digitalization of the educational sphere. At the same time, the practical implementation of these strategic documents largely depends on the readiness of pedagogical personnel, the quality of digital educational content, and the degree to which digital tools are pedagogically, rather than merely technically, integrated into the educational process.

The relevance of the present study is determined by the need to move scientific discourse beyond the technological dimension of educational digitalization and toward a systematic pedagogical understanding of the factors that ensure its genuine effectiveness.

The purpose of the research is to identify, classify, and scientifically substantiate the pedagogical factors of the informatization of education under conditions of digital transformation, and to reveal the character of their interrelationship.

To achieve this purpose, the following tasks were set:

- to analyze scientific approaches to the concepts of "digital transformation" and "informatization of education";
- to identify and classify the pedagogical factors influencing the effectiveness of educational informatization;
- to examine the role of teachers' digital-pedagogical competence as a leading factor of digital transformation;
- to characterize the didactic requirements for the design of digital educational content and environments;
- to reveal the psychological and institutional conditions necessary for the sustainable digital transformation of education.

MATERIALS AND METHODS

The methodological basis of the research comprises the theoretical analysis, systematization, and generalization of scientific-pedagogical literature devoted to the digitalization and informatization of education, as well as normative-legal documents of the Republic of Uzbekistan in the field of education. The research employed the following methods: theoretical analysis of scientific sources; comparative-typological analysis, used to compare different scholarly approaches to defining pedagogical factors of informatization; the systemic approach, which allowed the identified factors to be considered as elements of an integral pedagogical system; and the method of generalization, applied to formulate the conclusions of the study.

The sources used in the research include works of local and foreign scholars in the field of pedagogy and educational technology, international frameworks concerning the digital competence of educators, as well as the authors' own prior research on the development of media and digital competence among future teachers. The logic of the research followed a deductive path, moving from general theoretical concepts of digital transformation toward the specific pedagogical factors that determine its effectiveness at the level of concrete educational practice.

RESULTS

3.1. The concept of digital transformation of education and its pedagogical dimension

Analysis of the scientific literature shows that the concept of "digital transformation of education" is often used interchangeably with the narrower concept of "informatization of education", although the two notions are not identical. Informatization is generally understood as the process of introducing information and communication technologies into the educational process, whereas digital transformation implies a deeper, systemic reorganization of the entire educational model, including its goals, content, pedagogical methods, and organizational culture.

Based on the analysis conducted, digital transformation of education can be defined as a comprehensive and continuous process of qualitative renewal of the educational system, in which digital technologies serve not as an auxiliary tool but as an integral element of pedagogical design, content delivery, communication, and assessment. Within this process, informatization of education represents the operational, practice-oriented component through which digital transformation is realized at the level of a specific educational institution, teacher, and student.

3.2. Classification of pedagogical factors of educational informatization

The results of the theoretical analysis allow the pedagogical factors of educational informatization to be classified into four interrelated groups.

- Personnel-related (teacher) factors — the level of teachers' digital-pedagogical competence, their motivation to apply digital tools in professional activity, and their capacity for continuous professional self-development in the digital environment;
- Didactic-methodological factors — the pedagogical design of digital learning content, the methodologically justified selection of digital tools in accordance with learning objectives, and the integration of active and interactive teaching methods into the digital environment;

- Psychological factors — the readiness of both teachers and students to work in a digital educational environment, their level of digital literacy, and their attitudes toward technology-mediated learning;

- Institutional-organizational factors — the availability of a coherent digitalization strategy at the level of the educational institution, administrative support for pedagogical innovation, and a favorable organizational culture that encourages experimentation and reflective practice among teaching staff.

These four groups of factors do not function independently; rather, they form an integral system in which the weakness of one group may substantially limit the positive effect produced by the others.

3.3. Teachers' digital-pedagogical competence as a leading pedagogical factor

Among the identified factors, teachers' digital-pedagogical competence occupies a central position, since it is the teacher who translates the technical potential of digital tools into concrete pedagogical outcomes. Digital-pedagogical competence should not be reduced to technical skills in operating computer programs; it also includes the ability to pedagogically design digital learning activities, to select digital resources in accordance with didactic objectives, to organize interaction in a digital environment, and to critically evaluate the reliability and pedagogical value of digital information sources.

International frameworks on the digital competence of educators generally distinguish several components of this competence, including professional engagement, digital resources, teaching and learning, assessment, empowering learners, and facilitating learners' digital competence. The results of the present analysis confirm that all of these components are pedagogically, rather than purely technically, oriented, which supports the conclusion that teacher training programs should prioritize the pedagogical application of digital tools over their purely technical operation.

3.4. Didactic design of digital educational content and environment

A further significant pedagogical factor is the didactic quality of digital educational content and the design of the digital learning environment as a whole. The mere digitization of traditional textbooks, without adaptation to the specific characteristics of digital perception and interaction, does not constitute genuine pedagogical innovation. Effective digital educational content should be structured in accordance with the principles of visualization, interactivity, modularity, and adaptivity, allowing learners to progress according to individual learning trajectories.

The design of the digital learning environment should also take into account principles of cognitive load management, ensuring that the multiplicity of digital tools

does not overwhelm learners but rather supports the gradual and structured formation of knowledge, skills, and competencies.

3.5. Psychological and motivational factors

The successful digital transformation of education largely depends on the psychological readiness of the participants in the educational process. Resistance to change, insufficient confidence in using digital tools, and anxiety related to technology can significantly reduce the pedagogical effectiveness of digital transformation, even in institutions with excellent technical infrastructure. Conversely, a positive attitude toward digital innovation, supported by appropriate pedagogical guidance, tends to increase learner motivation, engagement, and academic performance.

3.6. Institutional and organizational conditions

At the institutional level, the pedagogical effectiveness of digital transformation depends on the presence of a clear digitalization strategy that is understood and shared by the entire teaching staff, rather than being perceived as an externally imposed administrative requirement. Institutions in which school or university leadership actively supports pedagogical experimentation, provides opportunities for peer exchange of digital teaching practices, and allocates time for teachers' professional development tend to demonstrate a more coherent and sustainable process of digital transformation than institutions that focus exclusively on the acquisition of technical equipment.

DISCUSSION

The results obtained allow several important conclusions to be drawn regarding the nature of pedagogical factors in the digital transformation of education.

First, the findings confirm that technological infrastructure, although necessary, is not a sufficient condition for successful digital transformation. Pedagogical factors, particularly teachers' digital-pedagogical competence and the didactic design of digital content, play a decisive role in determining whether digital tools genuinely enhance the quality of teaching and learning or merely replicate traditional methods in a digital format.

Second, the classification of pedagogical factors into personnel-related, didactic-methodological, psychological, and institutional-organizational groups highlights the systemic character of educational informatization. These groups of factors interact dynamically, and a weakness in one group can significantly limit the positive effect of strengths in another. For example, high-quality digital content will produce limited pedagogical results if teachers lack the competence to integrate it meaningfully into the learning process, or if the institutional culture does not support pedagogical experimentation.

Third, the centrality of teachers' digital-pedagogical competence, as revealed in this study, is consistent with international research emphasizing that the successful digital transformation of education depends primarily on human, rather than purely technological, capital. This suggests that policies and strategies aimed at digitalizing education should allocate substantial resources not only to technical equipment but also to the systematic professional development of teachers, particularly in the area of pedagogical, rather than merely technical, application of digital tools.

Fourth, the psychological dimension of digital transformation, often underestimated in practice, deserves particular attention. Institutional strategies that neglect the emotional and motivational readiness of teachers and students risk provoking resistance to digital innovation, regardless of the quality of the available technology or content.

Comparative analysis with international experience indicates that countries that have achieved sustainable success in the digital transformation of education tend to adopt comprehensive strategies encompassing teacher training, curriculum redesign, and institutional support, rather than isolated technological interventions. This international experience further reinforces the conclusion that the digital transformation of the Uzbek education system should be approached as a comprehensive pedagogical process rather than a purely technical modernization project.

At the same time, several limitations and challenges should be acknowledged. The unequal distribution of digital infrastructure between urban and rural educational institutions, insufficient continuous professional development opportunities for teachers, and the still-limited availability of high-quality, pedagogically designed digital content in the state language represent significant obstacles to the full realization of pedagogically grounded digital transformation. Addressing these challenges requires coordinated efforts at the level of educational policy, institutional management, and teacher training programs.

CONCLUSION

The present study has demonstrated that the effectiveness of the informatization of education under the conditions of digital transformation is determined not by technology as such, but by a complex, interrelated system of pedagogical factors. These factors, namely teachers' digital-pedagogical competence, the didactic design of digital content and environments, the psychological readiness of participants in the educational process, and supportive institutional conditions, together form the foundation upon which the pedagogical potential of digital technologies can be realized.

The findings suggest that strategies for the digital transformation of education should shift their primary emphasis from technological equipping toward comprehensive pedagogical modernization, including the systematic development of teachers' digital-pedagogical competence, the design of methodologically sound digital learning content, and the cultivation of institutional cultures that support innovation.

Further research is recommended to empirically investigate the relative weight of each identified factor within specific educational contexts, as well as to develop practical methodologies for enhancing teachers' digital-pedagogical competence as the leading factor in the pedagogically effective digital transformation of education.

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