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DIGITALIZATION AND SUSTAINABILITY IN THE TRANSFORMATION OF THE EDUCATIONAL ENVIRONMENT

Digitalização e sustentabilidade na transformação do ambiente educacional

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ABSTRACT

The purpose of this study is to analyze how modern pedagogical technologies, driven by the spread of information and communication technologies (ICTs), contribute to the sustainable transformation of the educational environment. The research applies a theoretical analysis of scientific literature, document review, and global best practices to identify trends, challenges, and opportunities in integrating ICTs into education. Results indicate that ICT-based innovations enhance interactivity, collaboration, and adaptability in learning processes. They enable personalized learning, broaden access to knowledge, and support the development of competencies aligned with labor market needs. However, challenges remain, including teacher resistance, psychological barriers, health considerations, and the risk of excessive technocratization. Balancing traditional pedagogical approaches with modern innovations is essential for effectiveness and long-term sustainability. The study concludes that the integration of ICTs can serve as a strategic driver for sustainable educational development when implemented with attention to stakeholder readiness, interdisciplinary collaboration, and value-based teaching practices.
Keywords: Pedagogy, Technology, Innovation, Quality, Technologization

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Digitalization and sustainability in the transformation of the educational environment

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RESUMO

O objetivo deste estudo é analisar como as tecnologias pedagógicas modernas, impulsionadas pela disseminação das tecnologias da informação e comunicação (TICs), contribuem para a transformação sustentável do ambiente educacional. A pesquisa aplica uma análise teórica da literatura científica, revisão de documentos e melhores práticas globais para identificar tendências, desafios e oportunidades na integração das TICs à educação. Os resultados indicam que as inovações baseadas em TICs aumentam a interatividade, a colaboração e a adaptabilidade nos processos de aprendizagem. Elas possibilitam a aprendizagem personalizada, ampliam o acesso ao conhecimento e apoiam o desenvolvimento de competências alinhadas às necessidades do mercado de trabalho. No entanto, ainda existem desafios, incluindo a resistência dos professores, barreiras psicológicas, considerações sobre a saúde e o risco de tecnocratização excessiva. Equilibrar as abordagens pedagógicas tradicionais com as inovações modernas é essencial para a eficácia e a sustentabilidade a longo prazo. O estudo conclui que a integração das TICs pode servir como um impulsionador estratégico para o desenvolvimento educacional sustentável quando implementada com atenção à prontidão das partes interessadas, à colaboração interdisciplinar e a práticas de ensino baseadas em valores.

Palavras-chave: Pedagogia, Tecnologia, Inovação, Qualidade, Tecnologização

INTRODUCTION

The current stage in the development of the education system in the Kyrgyz Republic is marked by a technological challenge posed to current educational concepts. Traditional pedagogical technologies are gradually replaced by more innovative ones at all levels of education. This trend is global. Analyzing cutting-edge experience in educational reforms in developed countries, we find that diversified learning formats, which greatly affect the technologization of learning, are being actively developed.

The direction in which education is developing is associated with rejecting the traditional Knowledge, Skills, and Abilities paradigm as the result of learning. The work of teachers is changing on a fundamental level. The systemic-activity educational paradigm takes center stage. The current agenda of pedagogical theory and practice includes the issues of transforming the traditional concept of education into a process of qualitative personality change. This difficult task requires considering the initial level of training, the existing educational needs, and age-related psychological characteristics. No less important is the choice of technology, which depends on the goals and content of specific technologies.

The development and establishment of the information society and the rapid spread of digital technologies have had a considerable impact on the emergence of innovative educational formats. Digitalization greatly expands the borders of the educational space for educational organizations. These transformations lead to changes in the concepts of education and upbringing, their goals and content, and sometimes attitudes to the regulatory framework for the educational process. New technologies make students less dependent on time and space. This statement is supported by the dynamic development of online learning, which makes it possible to receive the necessary educational information and achieve the required pedagogical result of education remotely. These circumstances necessitate a scientific comprehension of the topical problems of utilizing modern technologies.

The goal of the study is to analyze topical issues in the introduction of modern pedagogical technologies.

1 METHODOLOGICAL FRAMEWORK

Our data are substantiated by a theoretical analysis of scientific literature, document analysis, and an analysis of the best international pedagogical experience.

Scientific sources provide no universal definition of the term "pedagogical technology". Each researcher gives this concept their own meaning. Generalizing different points of view, we can examine this phenomenon from a comprehensive, systemic, multilevel, and procedural point of view and, in some cases, from the perspective of the situational approach, which considers the features of the pedagogical situation and establishes the need for or absence of any stage of the technology. Based on various scientific standpoints, a pedagogical technology can be understood as a system of procedures (administrative, organizational, didactic, preventive, informational, upbringing, etc.) implemented in an appropriate sequence to obtain the required pedagogical result or effect.

2 RESULTS

The philosophical basis for pedagogical management of interaction in the system of teacher-student relations consists in the subject-subject interaction between the student and the teacher, in which the latter needs to obtain the maximum pedagogical effect in the form of personal development. This pedagogical impact is achieved specifically through technologies that scientifically substantiate the choice of forms of interaction to form a value attitude to learning (upbringing) activities. The essence of a pedagogical technology is manifested through a system of elements interconnected by a single internal logic. The subject's ascent to modern culture is ensured through a pedagogical requirement. In practice, it is not uncommon to witness pedagogical conflicts between the subjects of learning, which can be overcome using a pedagogical technique capable of strengthening or weakening the influence of other technological elements. With this approach, the normalized organization of the learning process or activity changes a student's personality and allows them to change on their own. Each pedagogical technology has limits of application and purpose. Hence, there are different grounds for their classification. The need to perform different activities determines the necessity of a particular pedagogical technology.

New technologies serve as a resource for teacher development. Because of varying levels of pedagogical experience, the utilization of the same technology can differ significantly from teacher to teacher. Generalizing pedagogical practice, we can draw attention to the fact that teachers' preferences are centered on reproductive technologies, while students favor subject-oriented and productive technologies. The traditional classroom system often clashes with new pedagogical technologies. The need for a flexible organization of the educational process may cause resistance among the more conservative members of the teaching staff.

Modern education is rapidly developing owing to innovative technologies that provide greater accessibility to education. These technologies improve the quality of education and are instrumental in adapting to students' educational needs and preparing them for the labor market requirements. Such technologies rely on a wide range of methods and tools that significantly improve the educational process. We can observe the widespread use of e-learning platforms with remote access to didactic materials, which allow teachers to monitor progress and provide timely feedback. Importantly, the opportunities offered by adaptive learning platforms enable students to work at their own pace, which greatly improves learning outcomes. Nevertheless, some studies point out that introducing new technologies causes resistance.

A separate group of problems in education are psychological issues associated with innovation. For instance, Rasulov (2018) highlights that the path of introducing innovations is burdened with numerous stereotypes that downplay the advantages of innovations and their role in education, suggesting that the situation cannot be changed fundamentally. These stereotypes put forward by opponents of innovation are backed up by strong arguments. Such attitudes toward innovative technologies are usually supported by a conservative mindset and thinking. In practice, this standardization of the internal image and consciousness of teaching staff usually leads to a decline in their creative potential. Bochkareva et al. (2017) point to a host of theoretical and practical problems. The researchers highlight the problem of a distorted understanding of pedagogical technology among teachers, wherein a technology is interpreted as encompassing all actions of teachers, who do not necessarily understand the essence of pedagogical technologies.

Today we can also witness an active spread of AR and VR, the capabilities of which make the educational environment interactive and provide for the improvement of practical skills based on simulation training and virtual laboratories. Technologies in this group allow developing practical skills in a safe and controlled environment. In assessing the organizational and pedagogical potential of such technologies, Digtiar (2024) emphasizes their significant ability to save time and labor costs. However, the widespread use of this group of technologies may raise the barrier to entry for educators in the future.

Assessing the pedagogical possibilities of AR/VR, researches highlight their significant didactic potential in working with primary school students. Particularly notable are virtual excursions (to a museum from out of town, the animal world, etc.) and electronic textbooks. The researcher emphasizes that the glowing screen can solve a problem that cannot always be worked out by the teacher in frontal instruction: retaining the attention of junior schoolchildren for a long time.

An important role in the contemporary educational process is also played by digital technology tools. There is a great variety of widely distributed platform solutions for videoconferencing, the potential of which allows for organizing lecture and seminar classes and working on group projects. Increasing popularity is gained by interactive materials, didactic applications, and electronic textbooks, which increase the accessibility of learning and interest in it. Significant didactic potential for the realization of educational projects is demonstrated by cloud technologies, which allow organizing group interaction. By enabling remote access, cloud technologies make didactic resources accessible to students from any part of the world. Furthermore, cloud technologies allow storing and distributing educational materials and even holding distance classes. In addition, cloud technologies are of great economic importance for educational organizations. On the one hand, they can provide stable access to didactic resources. On the other hand, they help save money on the infrastructure of the educational organization. A prominent example of such digital educational resources is the Kahoot service, the capabilities of which allow creating knowledge tests and organizing the learning process in the framework of distance learning. One advantage of this method is that it allows teachers to save a lot of time on checking homework and delegate the routine process of checking tests to automated processing with this program (Karpenia, Sulaberidze, 2021). Tiapugina et al. (2021) advocate the need to introduce electronic mobile education into the educational process, as they provide various teaching forms and methods. The researchers emphasize that mobile e-learning enables greater personalization of learning for high

school students (e.g., keeping a personal gradebook, compiling a matrix of tasks). One problem in implementing such technologies is posed by the system of sanitary norms and regulations, which impose restrictions on such technologies. The researchers stress that this technology cannot be a full-fledged alternative to traditional forms of learning.

A distinctive feature of the current stage in education development is the wide use of artificial intelligence capabilities in educational programs. AI provides a greater personalization of learning, which is bound to have a positive impact on academic performance. AI capabilities are widely used in pedagogical management to design adaptive curricula that accommodate educational needs. A special feature of their use is the ability of such systems to monitor achievements, justify pedagogical recommendations, and automatically solve administrative tasks (timetable, grading students' work, etc.). As emphasized by Amirov and Gilvanov (2015), a strong suit of these technologies is their ability to transform the teacher into a subject of education and increase the effectiveness of learning. The researchers conclude that excessive technocratization of the learning process deprives teachers and students of positive motivation to use innovative technologies. The main explanation for this lies in that these technologies are introduced into pedagogy rather than mastered by the subjects of the educational process willingly. This introduction is not voluntary, which leads to problems and conflicts. Thus, innovations are fraught with psychological risks. Therefore, an important aspect in implementing innovative technologies in education is their individualized use. As suggested by Sidorova and Chernikova (2021), such an approach will make these technologies a focus factor that will shine brightly against the backdrop of the basic traditional education system. The authors draw attention to innovative priorities, observing which shapes the motivation for using new technologies, which provides for active engagement in this activity. As emphasized by the researchers, the motive increases the meaningfulness of pedagogical work. The motive is influenced by the attachment of a value meaning to the teacher's activity.

A growing trend in current educational technologies is the spread of hybrid learning. Their implementation involves the integration of the opportunities offered by traditional forms of education with online formats, which allows students to manage their workload in a flexible way without being bound by class timetables. Such technological capabilities allow for the development of self-organization skills and independent learning abilities. For teachers, hybrid learning tools offer the opportunity to hold video conferences and utilize interactive platforms for collaborative forms of learning. Analyzing pedagogical practices, Bochkareva et al. (2017) conclude that in some cases, the teacher's adherence to a technology limits their creativity, because compliance with this technology does not always allow them to account for the changing pedagogical situation with students. An important point of reference in the teacher's choice of technologies is the focus on the capabilities and interests of students, which requires the teacher to think flexibly. From this follows the need for pedagogical management of the team of students, because it is virtually impossible to improve the educational process and integrate the technology into it without first studying children's readiness to the use of such technologies. Electronic educational resources and multimedia technologies undoubtedly bring variety to traditional lessons. However, these tools have a negative impact on health. Implementing innovative pedagogical technologies brings awareness to the need to integrate them with the capabilities of health-saving technologies. Implementing the latter preserves and improves health, reduces overwork, and positively affects the psychological climate of the team. The primary result of combining innovative pedagogical technologies with health-saving technologies is improved concentration and reduced anxiety and morbidity among students. This leads Bochkareva (2017) to conclude that modern pedagogical technologies are a complicated and controversial issue. These technologies become solid mediators of interaction between the subjects in the educational process and deprive them of the opportunities to interact, which ultimately leads to the loss of upbringing-related pedagogical components, leaving teaching as the predominant element. The natural outcome of such processes is the deterioration of the system of teacher-student interactions due to the lack of teaching technologies. A similar opinion is held by Baiborodova and Cherniavskaia (2023), who believe that there are many opponents of technologization in pedagogy who believe that teaching should be creative in nature, which naturally requires a complete rejection of technological algorithms. The researchers define the role of pedagogical technologies. According to Baiborodova and Cherniavskaia, technologies are designed to ensure more predictable pedagogical results, which should not depend on the teacher's experience. While sharing this point of view, we should acknowledge that technologization does not make exceptions for upbringing systems, as the choice of the means, methods, and forms of upbringing influence is important for the teacher. This leads us to the conclusion

that pedagogical culture is gradually becoming more instrumental while retaining its spiritual and moral values and having a regulatory impact. The most prominent manifestation of this is the fact that novelty increases motivation for cognitive activity.

The existing system of requirements for preparing to use such pedagogical technologies requires teachers to spend extra time preparing for lessons. This problem is solved by using computer simulators during lessons, whose capabilities allow teachers to save time and other resources required for practicing actions.

3 DISCUSSION

Modern pedagogical technologies are given great attention by many researchers. However, the issues of integrating pedagogical technologies with the information capabilities of digital technologies remain understudied. Thus, the experience of the successive introduction of these technologies into all spheres and levels of education requires scientific comprehension.

Sangadzhiev (2016) advocates the idea that each group of pedagogical technologies has a purpose and scope of application, which has a significant impact on their universality in the learning process. The present stage in the development of pedagogical technologies is marked by greater interactivity, which endows students with subjectivity.

As noted by Oleinikov and Mukasheva (2015), the use of information technologies in the educational process lays the foundation for developing professionally significant personal qualities in students. The researchers suggest that computers as teaching tools can raise the effectiveness of training. The authors believe that information and communications technologies increase the speed at which the required competencies are developed and boost motivation for independent learning. The ability to use computer systems in education is expressed in the need for education subjects to organize subject-cognitive, socially mediated, and communicative-developing activities (Oleinikov, 2006).

Salata and Batsula (2016) emphasize that modern educational standards are built on a personal-activity framework. In our view, traditional formats are insufficient to stimulate cognitive and creative activity. ICTs in the educational process help eliminate the monotony in the educational environment and the routine nature of the educational process.

Today, students actively use personal computers and mobile devices in the learning process to solve learning tasks, which indicates their popularity. Chapkin (2024) emphasizes that 2023 became a turning point for education because of the implementation of adaptive learning, which manifests in personalized learning programs. This translates into teachers' focus on students' experience, interests, preferences, and the prevailing pace and methods of mastering competencies, i.e., an orientation on the personality of the student as a subject of learning. A crucial condition for improving teaching effectiveness using new ICTs is to maintain a reasonable balance between traditional and innovative technologies. Ernazarov (2024) believes that the choice of these technologies is determined by the specific needs of student teams.

An important point of view in the context of using educational technologies is advocated by Klevtsova and Sukhodolova (2023). The authors stress the need to develop digital competencies among pedagogical staff. The possession of these competencies secures the quality of education. According to the researchers, the successful mastery of these competencies requires continuous training throughout teachers' careers.

CONCLUSION

We can argue that the capabilities of modern interactive technologies improve the effectiveness of the educational process, stimulating interest on the part of its subjects. These technologies allow the participants in the learning process to take an active part in it and manage this process through timely feedback. The analysis of global practices highlights the social and economic effectiveness of contemporary pedagogical technologies, improved quality of education, and high adaptability to educational needs.

Our theoretical analysis of scientific literature shows that the educational environment has majorly transformed due to the spread of ICTs. Nevertheless, the development and introduction of new technologies in education are not devoid of contradictions, as there are still many issues in this area. By successfully overcoming

these problems, the educational process can be made more interactive, collaborative, and adaptive, which will result in a decrease in the overall share of reproductive learning activities and less time devoted to independent and group work.

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