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DIGITAL TECHNOLOGIES AS AN INNOVATIVE RESOURCE FOR THE DEVELOPMENT OF INCLUSIVE EDUCATION IN EDUCATIONAL INSTITUTIONS

Abstract. The article presents a scientific and methodological analysis of digital technologies in the context of inclusive education in general secondary education institutions. The theoretical and methodological foundations for the use of digital technologies within the system of psychological and pedagogical support for children with special educational needs are revealed. The functional purpose of digital tools of corrective and developmental orientation is substantiated, their main groups and pedagogical potential are identified. Emphasis is placed on the methodological features of implementing digital tools in corrective and developmental activities, and the specifics of their effective application are outlined.

The purpose of the study is, based on a content analysis of psychological and pedagogical literature and familiarization with the experience of general secondary and preschool education institutions, to theoretically substantiate and describe the educational potential of digital technologies as an innovative resource for the development of inclusive education.

The objectives of the study are to analyze scientific approaches to the problem of digitalization of inclusive education; to clarify the essence and content of the basic concepts of the research; to determine the pedagogical possibilities of digital technologies in ensuring accessibility and individualization of inclusive education; and to outline the main directions for the use of digital technologies in the practice of educational institutions implementing inclusive education.

It is emphasized that digital technologies act as an innovative resource for the development and optimization of inclusive education due to the following factors: ensuring accessibility of educational content; implementation of the principles of individualization and universal design for learning; increasing the effectiveness of pedagogical support; and expanding opportunities for interdisciplinary interaction. It is proven that the purposeful use of digital tools contributes to the individualization of the educational process, increases motivation, and enhances the effectiveness of corrective and developmental work in an inclusive educational environment. Their systematic and pedagogically balanced implementation creates conditions for a qualitative transformation of the inclusive educational environment aimed at improving educational outcomes for students with special educational needs.

Keywords: inclusive education, corrective and developmental work, digital tools, special educational needs, individual development program.

ЦИФРОВІ ТЕХНОЛОГІЇ ЯК ІННОВАЦІЙНИЙ РЕСУРС РОЗВИТКУ ІНКЛЮЗИВНОГО НАВЧАННЯ У ЗАКЛАДАХ ОСВІТИ

Анотація. У статті здійснено науково-методичний аналіз цифрових технологій в умовах інклюзивного навчання закладів загальної середньої освіти. Розкрито теоретико-методологічні засади використання цифрових технологій у системі психолого-педагогічного супроводу дітей з особливими освітніми потребами. Обґрунтовано функціональне призначення цифрових інструментів корекційно-розвиткової спрямованості, визначено їх основні групи та педагогічний потенціал. Акцентовано увагу на методичних особливостях упровадження цифрових інструментів у корекційно-розвиткову діяльність та окреслено особливості їх ефективного застосування. Мета дослідження: на основі проведеного контент-аналізу психолого-педагогічної літератури, ознайомлення з досвідом роботи закладів загальної середньої і дошкільної освіти, теоретично обґрунтувати та описати освітній потенціал цифрових технологій як інноваційного ресурсу розвитку інклюзивного навчання.

Завданнями дослідження є: проаналізувати наукові підходи до проблеми цифровізації інклюзивної освіти, уточнити сутність і зміст базових понять дослідження, визначити педагогічні можливості цифрових технологій у забезпеченні доступності та індивідуалізації інклюзивного навчання, окреслити основні напрями використання цифрових технологій у практиці роботи закладів освіти з інклюзивним навчанням. Наголошується, що цифрові технології виступають інноваційним ресурсом розвитку та оптимізації інклюзивного навчання завдяки таким чинникам: забезпеченню доступності освітнього контенту, реалізації принципів індивідуалізації й універсального дизайну навчання, підвищенню ефективності педагогічного супроводу та розширенню можливостей міждисциплінарної взаємодії. Доведено, що цілеспрямоване використання цифрових інструментів сприяє індивідуалізації освітнього процесу, підвищенню мотивації та ефективності корекційно-розвиткової роботи в інклюзивному освітньому середовищі. Їх системне та педагогічно виважене впровадження створює умови для якісної трансформації інклюзивного освітнього середовища з метою підвищення освітніх результатів здобувачів освіти з особливими освітніми потребами.

Ключові слова: інклюзивне навчання, корекційно-розвиткова робота, цифрові інструменти, особливі освітні потреби, індивідуальна програма розвитку.

INTRODUCTION

The problem formulation. The contemporary education system operates under the simultaneous influence of two powerful transformational processes: the digitalization of education and the institutionalization of inclusive learning. Despite the active implementation of digital technologies in the educational process, their potential as an innovative resource for ensuring accessibility, individualization, and adaptability in inclusive education is still realized in a rather fragmented and unsystematic manner.

This underlines the relevance of investigating the outlined problem, which is determined by a combination of social, pedagogical, and technological factors. Notably, inclusive education is a priority area of educational policy in both Ukraine and the European educational space, aiming to create a barrier-free educational environment for individuals with special educational needs. Meanwhile, the rapid development of digital technologies such as adaptive platforms, assistive technologies, artificial intelligence, and digital educational resources opens qualitatively new opportunities for personalizing learning, yet requires scientifically grounded pedagogical implementation. The importance of this issue is further amplified under the current realities of martial law and contemporary educational challenges (remote and blended learning, wartime conditions, migration processes), which significantly intensify the need for flexible digital solutions in educational institutions capable of ensuring educational equity for all categories of learners.

Thus, the study of digital technologies as an innovative resource for the development of inclusive learning is both scientifically and practically significant, as it aims at modernizing the educational process and enhancing its social impact.

Analysis of recent research and publications. The issue of applying innovative digital technologies in inclusion has been explored by researchers such as V. Bondar, V. Zasenko, L. Prokhorenko, N. Yarmola, and others. The socio-pedagogical challenges of educating students with special educational needs have been partially addressed in studies by O. Budnyk, R. Vaynoli, H. Vasyanovych, O. Dzhus, A. Kapska, Z. Leniv, N. Seyko, I. Chervinska and O. Chekan, who emphasize critical aspects of this problem and highlight the necessity of a holistic and systematic approach to organizing social and psycho-pedagogical support for such learners in the inclusive environment of contemporary educational institutions.

The problem of integrative processes regarding the application of information and digital technologies in the practice of educational institutions with inclusive programs is intensively investigated. Well-known scholars in the field of educational digitalization, including V. Bykov, Yu. Nosenko, M. Mariotti, and N. Morse, propose ways of integrating digital elements into the work of teacher assistants and develop software solutions for digital technologies in inclusive learning. Noteworthy are H. Davidenko's contributions concerning approaches to creating digital inclusion.

International research on inclusive education is reflected in the works of D. Cameron, D. Chambers, M. Friend, L. Kincadec, and P. Sarah, focusing on the study of various models of inclusivity, support mechanisms, and socio-cultural characteristics of different countries. However, despite the existing body of research, the issue of digitalization in inclusive education requires more profound scientific investigation.

THE AIM AND RESEARCH TASKS

Aim: Based on a content analysis of psycho-pedagogical literature and an examination of the practices of general secondary and preschool educational institutions, to theoretically substantiate and describe the educational potential of digital technologies as an innovative resource for the development of inclusive learning.

Research tasks. To analyze scientific approaches to the problem of digitalization in inclusive education. To clarify the essence and content of the basic concepts of the study. To identify the pedagogical possibilities of digital technologies in ensuring accessibility and individualization of inclusive learning. To outline the main directions of using digital technologies in the practice of educational institutions with inclusive programs.

RESEARCH METHODS

To achieve the research objectives, a set of general scientific and special pedagogical methods was employed, including: analysis, synthesis, and generalization for processing scientific sources on the research problem; comparison and systematization for contrasting approaches to the use of digital technologies in inclusive learning; terminological analysis to clarify the key concepts of the study; and structural-logical analysis to determine the interrelation between digital technologies and the inclusive educational environment.

RESULTS OF THE RESEARCH

In the contemporary educational space of Ukraine, the topic of implementing digital technologies in inclusive learning is gaining increasing significance due to growing societal demands for equal access to quality education. Implementing the fundamental principles of inclusive education implies creating conditions under which students with special educational needs (SEN) can learn alongside their peers within educational institutions.

The use of digital technologies allows for the expansion of such conditions by enabling differentiation, adaptation, and individualization of learning trajectories. For example, studies by Ukrainian educators demonstrate that using digital technologies in the inclusive process for Grades 1–4 of the New Ukrainian School increases both accessibility and educational quality.

In recent years, there has been a significant growth in research investigating the role of digital technologies in ensuring inclusion, including both empirical studies and systematic reviews/meta-analyses that attempt to outline effective practices and barriers. The integration of digital technologies into the educational process rapidly transforms traditional learning models into innovative ones, necessitating a comparison and analysis of international and national approaches to their application in organizing inclusive education for students with SEN.

Contemporary studies on educational digitalization emphasize that digital technologies increasingly permeate human activity and learning, positively influencing all aspects of life. The relevance of digitalization processes in European society is evidenced by the "Digital Europe" program (2021–2027), in which Ukraine has been involved since 2023 (Agreement, 2023).

At the legislative level, the implementation of digital technologies and innovations in Ukraine is regulated by laws such as the Law of Ukraine "On Education", "On Innovative Activity", "On the Concept of the National Informatization Program", and "On the National Informatization Program", among others (Ovcharuk O. & Malytska I., 2019).

Modern digital technologies in education constitute a combination of digital tools, platforms, and resources (online services, electronic educational resources, assistive and adaptive technologies) that ensure the organization, support, and improvement of the educational process.

In the context of inclusive education, inclusive learning requires special approaches to creating conditions that foster the development of social skills in learners with diverse educational needs. A complex of digital technologies (hardware and software solutions) enables the creation of an interactive educational space that optimizes learning and facilitates effective socialization of all participants in the educational interaction. Therefore, inclusive learning refers to the organization of the educational process in which all learners, regardless of individual characteristics and educational needs, study in an environment that considers the principles of barrier-free access, learning accessibility, equality, and non-discrimination for all participants.

In its broadest sense, inclusion is defined as "the process of increasing the degree of participation of all citizens in society, which entails the development and implementation of specific solutions that allow every individual to participate equally in academic and social life" (Pryhodyi M., 2024).

At the current stage of inclusive education development in Ukraine, the active integration of digital technologies across all components of the educational process is evident. The issue of using digital tools in corrective and developmental work with children with SEN is particularly relevant, as traditional psycho-pedagogical methods do not always ensure the required level of individualization and educational effectiveness.

Researchers I. Batsurovska & V. Kurepin emphasize that "current trends in education have significantly changed learning approaches, particularly in special and inclusive education. Digital technologies play a key role in ensuring accessibility and quality of learning for higher education students with special educational needs. By integrating digital tools, an inclusive educational environment is created, where each student can realize their potential regardless of physical, cognitive, or emotional barriers" (Batsurovska I. & Kurepin V., 2024).

The effectiveness of digital tools in corrective and developmental work is ensured when combined with traditional pedagogical methods, clearly defined corrective objectives, controlled time allocation for using digital tools, and systematic result analysis. Integrating digital tools into individualized development programs and coordinating the actions of all team members of psycho-pedagogical support is essential.

The innovative potential of digital technologies in inclusive learning is primarily due to their ability to overcome accessibility barriers physical, communicative, cognitive, and social. The application of electronic educational platforms, specialized software, assistive and adaptive technologies creates conditions for equal access to learning content, regardless of diagnosis, level of functional limitations, or pace of material acquisition. Consequently, digital technologies facilitate the implementation of Universal Design for Learning (UDL) principles, a key methodological orientation in inclusive education.

An important aspect of the innovativeness of digital technologies is their capacity to optimize the educational process through individualization and differentiation of learning. Adaptive learning environments, electronic textbooks with varied formats of information presentation (text, audio, video, interactive modules), and alternative and augmentative communication (AAC) programs allow for consideration of sensory, intellectual, speech, and motor impairments. This contributes to increasing learning motivation, cognitive activity, and academic success of learners with SEN.

Yu. Zaporozhchenko argues that "the current range of digital tools and resources enables the design of diverse pedagogical strategies for teaching children with special needs" (Zaporozhchenko Yu., 2013). Digital tools open new possibilities for implementing corrective-developmental tasks, providing access to learning content, adapting

educational methods to the individual capabilities and needs of school learners with SEN, and systematically monitoring their developmental progress.

Accordingly, there is a need for a scientific understanding of the potential of digital tools as an innovative resource for inclusive learning. Under the described circumstances, the use of digital resources and tools in inclusive education plays a critical role in ensuring the quality of the educational process for learners with SEN. Key examples and their impact on the quality of special and inclusive education include:

Virtual classrooms and online platforms (Google Classroom, Microsoft Teams, Moodle) provide learners with SEN access to educational materials and enable communication with teachers and peers, ensuring equal conditions for all participants regardless of location or physical limitations.

Assistive technologies (screen access programs such as NVDA, JAWS that convert text to audio; screen magnifiers and software for font enlargement and contrast adjustment; speech synthesizers and text-to-speech programs; automatic speech recognition tools facilitating written communication; digital alternative and augmentative communication systems for children with speech disorders). Abbott C. and other researchers note that the provision of educational services through assistive technologies is based on medical indicators (Abbott C., 2007).

Computers for assistive technology use are equipped with specialized keyboards, mice, and devices that allow computer operation through eye tracking. They facilitate the participation of learners with physical or cognitive impairments in educational interaction. These digital technologies enable the adaptation of digital content to the individual needs of each learner, significantly enhancing learning effectiveness.

Assistive technologies are innovative digital tools and software solutions designed to overcome deficits and compensate for specific functional impairments, ensuring full participation in the educational process. They are a core component of digital support for inclusive learning, providing accessibility for students with visual, hearing, motor, speech, or intellectual impairments and promoting the implementation of UDL principles.

Adaptive educational platforms are digital learning environments that automatically or semi-automatically adjust the content, complexity level, pace, and form of instruction according to the individual educational needs of learners. In inclusive education, adaptive platforms serve functions such as content personalization, compensation for individual developmental limitations, support for individual learning trajectories, and creation of conditions for independent and successful learning activities for students with SEN.

Technological Mechanisms of Adaptive Learning. Technological mechanisms of adaptive learning are implemented through adaptive platforms, which operate based on the integration of several technological components: a diagnostic module that determines the learner's level of preparedness, learning style, and pace of mastering the material; adaptive algorithms that adjust task difficulty and the format of information presentation; personalized recommendations generated based on learning outcomes; and analytical tools that track the dynamics of academic achievements. From a methodological perspective, it is crucial that adaptation occurs not only according to academic indicators but also considering the learner's psychophysiological characteristics. Digital adaptive platforms allow for the individualization of the educational process in accordance with learners' educational needs, learning pace, and cognitive abilities.

Mobile applications (Khan Academy, Duolingo, ClassDojo) designed for learning and development provide learners with the opportunity to study materials and complete tasks independently at their convenience. This is particularly important for learners with special educational needs (SEN), as they can learn at their own pace and according to their individual capabilities.

Interactive whiteboards (SMART Board, Miro, Popplet, Twiddla, Rizzoma, Scrumlr, Vyew, Educreations, WikiWall) facilitate the creation of interactive lessons in which learners actively engage in the educational process. This supports better comprehension of the material and the development of collaboration and communication skills.

Visualization software (Mindomo, Inspiration) assists learners with SEN in organizing their activities and structuring educational content, promoting better retention of information and enhancing learning efficiency.

Multimedia interactive presentations (Prezi, Google Slides, Haiku Deck, Apple Keynote, SlideRocket, SlideDog, Slides) optimize learning interaction and communication. Innovative digital technologies for assessing learners' performance are particularly valuable. These include online testing platforms (e.g., Quizizz, MasterTest, LearningApps, Online Test Pad, ClassMarker, Google Forms, Kahoot) and tools for evaluating written work (e.g., email, interactive worksheets, cloud storage). Tools for assessing oral responses include ZOOM, WizIQ, Google Hangouts, Skype, and PRUFFME (Batsurovska I., & Kuriepin V., 2024).

To optimize activities and assess the achievements of learners with SEN, online visualization tools can be employed, such as clusters, mind maps, timelines, SWOT analysis, and infographics. Digital platforms such as Sway, Portfoliobox, Mahara, and portfolio tools are recommended for summative assessment stages as effective means of evaluating learners' achievements (Ovcharuk O. & Malytska I., 2019). The integration of these digital tools into inclusive learning creates an inclusive educational environment where every learner can realize their potential. They enhance educational quality by ensuring an individualized approach to learning according to a defined personal development program and support learners with SEN.

Corrective-developmental work in the context of inclusive learning aims to overcome or compensate for psychophysiological developmental disorders, develop foundational academic and social competencies, and ensure the full participation of learners with SEN in the educational process. In this context, digital technologies serve as an innovative pedagogical resource that expands the possibilities of traditional corrective methodologies.

The use of digital technologies in inclusive education for learners with SEN is based on the principles of cultural-historical developmental theory, activity-based and competency-based approaches, the ideas of Universal Design for Learning (UDL), and the principles of individualization and differentiation.

Digital technologies in corrective-developmental work with school-age learners during inclusive education perform several interrelated functions:

Diagnostic function: identifying the level of development of specific mental functions in learners with SEN;

Corrective function: targeted intervention to address impaired functions;

Developmental function: stimulating cognitive, linguistic, and socio-emotional-volitional spheres of the growing individual;

Monitoring function: tracking the dynamics of personal development in learners with SEN.

The implementation of these functions ensures a systematic impact on the cognitive, linguistic, and socio-emotional-volitional spheres of development in learners with SEN. Digital tools supporting corrective-developmental work with learners with SEN can be categorized as follows:

Digital tools for speech and language correction. This group includes specialized digital programs and mobile applications aimed at developing phonemic awareness, articulatory motor skills, lexical-grammatical speech structures, and coherent speech. Their didactic potential lies in the combination of visual, auditory, and motor stimuli, repeated practice, and task difficulty individualization. These tools enhance the effectiveness of speech therapy and integrate corrective tasks into the educational process.

Digital cognitive process trainers. Designed to develop attention, memory, thinking, perception, and executive functions. Methodologically, the use of adaptive algorithms is important, allowing for the regulation of task pace, complexity, and duration according to the learner's individual capabilities. These tools are particularly effective for children with intellectual disabilities, Attention Deficit Hyperactivity Disorder (ADHD), or Autism Spectrum Disorders (ASD).

Gamified digital environments for corrective purposes. These environments reduce anxiety, foster positive motivation, and engage learners in systematic activities. Digital game-based platforms allow corrective tasks to be implemented in the form of educational games, which is especially significant for younger school-age children.

Digital tools for socio-emotional development. Used to develop emotional intelligence, self-regulation, and social interaction skills. They are effectively applied through digital social stories, interactive social simulations, and electronic emotion diaries.

The summarized results of the interaction between digital technologies and educational resources, as well as their impact on learners with various conditions, are presented in Table 1.

Table 1

Digital Technologies as a Resource for Inclusive Education

Digital Technology	Educational Resource / Function	Type of Disability (Nosology)
Speech synthesis and speech recognition software	Audio support of learning materials, alternative communication	Visual impairment, speech disorders
Adaptive e-textbooks	Individualization of learning pace and content presentation	Intellectual disabilities, learning difficulties
Augmentative and Alternative Communication (AAC) tools	Development of communication skills	Autism spectrum disorder (ASD), severe speech disorders
Online educational platforms	Distance and blended learning opportunities	Musculoskeletal disorders, chronic illnesses
Interactive digital simulators and trainers	Development of cognitive and practical skills	Hearing impairment, learning disabilities
Augmented and virtual reality technologies	Visualization of educational content, increased learning motivation	Hearing impairment, intellectual disabilities

Digital technologies also serve as an innovative resource for optimizing the activities of teaching staff and teams providing psychological and pedagogical support.

Research findings indicate that the essential digital competencies for a 21st-century educator include: the use of technical tools, digital instruments, and resources to foster critical thinking and creativity; the establishment of effective communication and organization of learners' educational activities, particularly in inclusive settings; the use of software for data visualization; the application of digital educational resources for sharing and disseminating learning information; the use of ICT for creating educational content; the organization of distance learning; and the provision of immediate feedback through digital technologies to assess learning outcomes (Budnyk O., Kondur O., & Diakiv I., 2020).

At the same time, many countries, especially in Eastern Europe, experience difficulties in implementing inclusion because of the inability of a modern school to respond timely and adequately to transient changes – to implement new content of education, innovative technologies, new strategies of pedagogical interaction based on humanization and personally oriented learning. The need for solving these and many other issues will highlight the development of appropriate strategies for teacher training and skills improvement to create an inclusive environment (Chervinska I. & Budnyk O., 2024)

The use of digital tools for monitoring students' individual progress, developing personalized learning programs, storing, and analyzing data enhances the validity of pedagogical decisions and facilitates interdisciplinary collaboration among specialists. Moreover, the digital environment expands opportunities for professional communication and the professional development of educators in the field of inclusive education.

CONCLUSIONS AND PROSPECTS OF FURTHER RESEARCH

Thus, digital technologies in inclusive education should be regarded as a comprehensive innovative resource that integrates technological, pedagogical, and social components. Their implementation contributes not only to the modernization of the educational process but also to the formation of an inclusive culture within educational institutions, oriented toward respect for diversity and the promotion of educational equity.

In summary, digital technologies function as an innovative resource for the development and optimization of inclusive education due to the following factors: ensuring accessibility of educational content, implementing the principles of individualization and Universal Design for Learning (UDL), enhancing the effectiveness of pedagogical support, and expanding opportunities for interdisciplinary collaboration. Systematic and pedagogically balanced implementation of these technologies creates conditions for the qualitative transformation of inclusive educational environments aimed at improving the educational outcomes of students with special educational needs. This necessitates a reconsideration of the professional training system for future educators and the retraining or professional development of teachers and teacher assistants working with students with special educational needs, through the application of innovative digital technologies.

Digital technologies in inclusive education within general secondary schools serve as a powerful innovative resource, providing accessibility, individualization, effective communication, and pedagogical support for students with special educational needs. Their targeted and pedagogically informed use promotes the realization of the principles of equality, social justice, and quality education.

Further research should focus on the empirical study of the effectiveness of specific digital tools in corrective and developmental work and the development of models for digital inclusive educational environments.

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