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THE IMPACT OF DIGITAL TECHNOLOGIES ON CHILDREN WITH LEARNING DIFFICULTIES

Abstract. This study examines the influence of digital technologies on the education of children with learning difficulties, emphasizing their effects on academic performance, cognitive engagement, and socio-emotional development. Grounded in Vygotsky's socio-cultural theory, Piaget's model of cognitive growth, and the Universal Design for Learning (UDL) framework, the research argues that technology plays a crucial role in fostering inclusive, adaptive, and student-centered learning environments. Tools such as assistive software, interactive whiteboards, and adaptive learning platforms enable teachers to personalize instruction and respond to the diverse needs of learners. The findings suggest that properly integrated digital resources enhance motivation, concentration, and self-confidence by providing multisensory and interactive learning opportunities. Gamified tasks, visual simulations, and speech-to-text technologies support understanding and retention, while collaborative platforms encourage communication and peer interaction. These benefits contribute not only to academic improvement but also to emotional resilience and social inclusion. However, the study also acknowledges significant challenges, including unequal access to digital devices, insufficient digital literacy among educators and parents, and the risk of excessive screen exposure or distraction. Addressing these issues requires comprehensive strategies that balance innovation with ethical responsibility and developmental awareness. In conclusion, the research emphasizes that effective implementation of digital technologies in special and inclusive education must combine pedagogical innovation, continuous teacher training, infrastructural investment, and parental engagement. When used purposefully, digital tools can bridge learning gaps, promote equity, and empower children with cognitive or developmental difficulties to achieve greater independence and lifelong learning success in the digital age.

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Keywords: Digital technologies; learning difficulties; inclusive education; adaptive learning; personalized instruction.

INTRODUCTION / ВСТУП

Statement of the problem / Постановка проблеми. In today's globalized information society, marked by accelerated breakthroughs in technological progress and innovation, the integration of innovative digital and information-based technologies into education systems not only reshapes but also redefines the format and content of teaching. It also generates profound and transformative opportunities to enhance the effectiveness of educational participation and the realization of potential among learners with diverse cognitive characteristics, individual needs, and developmental levels. Within this context, the practical adoption of inclusive pedagogical principles—particularly for children with specific neurological and psychological challenges such as learning disabilities and the influence and implications of digital tools on their overall educational attainment and learning outcomes carry fundamental significance [9].

Therefore, addressing the limitations of conventional instructional approaches applied in education in the education of children with specific academic and developmental challenges and exploring compensatory strategies have become strategically important for improving educational quality and ensuring social equity.

The concept of learning disabilities refers to a broad spectrum of specific neuropsychological impairments that lead to variations in the development of cognitive skills such as reading, writing, mathematics, and attention. These differences often hinder the effectiveness of standardized teaching models in meeting the unique needs of such students. In contrast, innovative digital and information-based technologies offer adaptive and multimodal instructional possibilities that can help mitigate these challenges.

Moreover, the use of innovative digital and information-based technologies within inclusive educational frameworks to ensure the full integration of students with learning disabilities and support their academic achievement is gaining increasing traction in pedagogical and practical contexts. This trend necessitates a re-evaluation of teaching methods and calls for enhanced knowledge and competencies among teachers, parents, and education policymakers. In this regard, a scientifically grounded assessment of the influence and implications of innovative digital and information-based technologies on students with learning disabilities and the development of strategies for their effective implementation in instructional settings has become a matter of considerable urgency [1].

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Analysis of (major) recent research and publications / Аналіз (основних) останніх досліджень і публікацій. Recent academic discourse has placed considerable emphasis on the integration of innovative digital and information-based technologies in the education of children with learning difficulties. Over the past decade, researchers have explored both the pedagogical potential and practical challenges associated with the use of such tools in inclusive education.

According to recent studies [1], the main advantage of digital learning technologies lies in their ability to individualize instruction and increase learner engagement through adaptive and interactive environments. Their findings demonstrate that when properly implemented, digital tools can significantly improve literacy and cognitive skills in students with specific learning needs. Building on this foundation, other researchers [2] emphasize the crucial link between teachers' digital competence and effective technology integration. They argue that sustained professional development and institutional support are vital to overcoming contradictions and barriers in compulsory education systems.

Similarly, further investigations [3] highlight that teacher preparation for the digital age remains one of the most decisive factors determining the success of technology-enhanced learning. Their research confirms that pedagogical training programs should not be limited to technical aspects but must also incorporate psychological and methodological dimensions to ensure inclusivity and adaptability in classrooms. In this context, the OECD report [4] further stresses that continuous professional learning in digital pedagogies and the systematic development of digital competencies are indispensable for ensuring educational equity and supporting learners with cognitive or developmental challenges.

At the same time, the growing body of research – such as that presented in [5] and [7] – illustrates the transformative potential of artificial intelligence, virtual and augmented reality, and gamified learning tools in enhancing students' motivation, creativity, and self-regulation. These studies underline that multisensory and interactive technologies can strengthen memory retention and self-efficacy, thus improving both academic and socio-emotional outcomes. However, as noted in [6], digital inequality and disparities in technological readiness among schools remain critical barriers to achieving full inclusion.

Furthermore, recent studies [8] demonstrate that the rapid shift to online education during the COVID-19 pandemic revealed gaps in teachers' preparedness and institutional support structures. Their findings resonate with research in [9], who identify limited teacher readiness and insufficient infrastructure as persistent challenges, especially in developing educational

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contexts. Complementary to this, it has been emphasized in [10] that successful digital transformation in education requires not only technological resources but also the cultivation of supportive learning ecosystems that actively involve parents, educators, and policymakers.

Overall, the analysis of major recent studies confirms that innovative digital and information-based technologies serve as powerful instruments for promoting inclusive and adaptive learning among children with learning difficulties. Yet, their effectiveness largely depends on equitable access, teacher competence, and pedagogical design. Addressing the digital divide, strengthening educators' digital literacy, and ensuring ethical and psychologically safe use of technology remain key priorities for future research and policy development.

AIM AND TASKS / МЕТА ТА ЗАВДАННЯ

The primary ***aim*** of this study is to conduct a comprehensive and scientifically grounded analysis of the influence and implications of innovative digital and information-based technologies on the academic performance, cognitive functioning, and socio-emotional development of learners who experience persistent cognitive or developmental difficulties. Additionally, the research seeks to identify the factors that enhance or hinder the effectiveness of digital tools in this context.

To achieve this goal, the following ***objectives*** are defined:

- First, considering the role of innovative digital and information-based technologies in creating personalized learning environments and building adaptive instructional models, to what extent and through which mechanisms do these technologies influence the development of knowledge and skills in children with specific academic and developmental challenges?
- Second, what are the potential positive and negative effects of digital tools on children's motivation, self-confidence, and social integration, and within which pedagogical and psychological frameworks are these effects most prominently observed?
- Finally, what conditions, strategies, and methodological approaches are necessary for the more effective implementation of innovative digital and information-based technologies in the education system, in order to improve the quality of education for learners who experience persistent cognitive or developmental difficulties and to promote the development of inclusive education?

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THEORETICAL FRAMEWORK / ТЕОРЕТИЧНІ ОСНОВИ

In assessing the influence and implications of innovative digital and information-based technologies on children with specific academic and developmental challenges, several fundamental psychological and pedagogical theories provide the theoretical foundation. One of the most prominent is Lev Vygotsky's socio-cultural theory, particularly his concept of the Zone of Proximal Development (ZPD), which refers to the range of skills a learner can perform with guidance but not yet independently. Digital technologies can replicate this guided learning virtually, thereby enhancing the effectiveness of instruction [2].

Furthermore, Jean Piaget's theory of cognitive development emphasizes the importance of learning through active experience and trial-and-error processes. Digital learning environments that incorporate interactivity, gamification, and simulations expand these experiential learning opportunities and cater to developmental learning needs [3].

The Universal Design for Learning (UDL) model provides a framework for adapting teaching to individual needs by offering multiple means of engagement, representation, and expression. This model ensures the full inclusion of children with specific academic and developmental challenges in the holistic process of teaching, learning, and knowledge acquisition through the multimodal presentation of learning materials [8].

These theoretical approaches serve as the foundation for the effective integration of innovative digital and information-based technologies into educational practices and support further research into their application and optimization.

The Impact of Digital Technologies on Children with Learning Disabilities: A Scientific Analysis of Positive and Negative Aspects

In the modern era, the integration of innovative digital and information-based technologies into the field of education is considered a significant turning point, particularly in terms of creating adaptive and multimodal learning environments that address the individual needs of learners who experience persistent cognitive or developmental difficulties. These technological tools not only eliminate the shortcomings of traditional teaching methods but also, by considering individual differences, create revolutionary opportunities to enhance students' self-confidence, boost their motivation, and support their social integration. Thus, digital platforms and software not only offer educational content adapted to students' individual pace and abilities, but also reveal their strengths and weaknesses, thereby allowing for the personalization of pedagogical interventions. This is of vital importance for enhancing the academic

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performance of children with specific academic and developmental challenges and supporting their socio-emotional development [2].

On the other hand, the use of innovative digital and information-based technologies also positively implication the psychosocial development of learners who experience persistent cognitive or developmental difficulties. Specifically, digital environments such as interactive games, virtual reality, and social networks improve children's self-expression and collaboration skills, thereby supporting their social adaptation processes. As a result, the risk of isolation for these children within inclusive educational settings is significantly reduced [9].

In addition, the adaptive programs provided by innovative digital and information-based technologies—such as artificial intelligence-based systems—evaluate the user's performance in real time and personalize the lesson content and tasks accordingly. In this way, specific attention is given to learners' weaknesses, and their independent learning skills are fostered [4].

This type of personalized learning environment increases students' self-regulation and active engagement in the holistic process of teaching, learning, and knowledge acquisition, thus improving their chances of overall educational attainment and learning outcomes.

However, the implementation of innovative digital and information-based technologies also presents certain negative aspects and limitations, which—if not taken into account—may create additional problems for ensuring educational quality and social equity for learners who experience persistent cognitive or developmental difficulties. For instance, limited access to technology and socioeconomic disparities may deepen digital inequality, thereby negatively affecting the principles and goals of inclusive education. Furthermore, the improper or pedagogically unsupported use of technologies may lead to negative outcomes such as attention deficits, technological dependency, and weakened social communication skills among children, which can negatively influence and implications their overall development [8].

Therefore, for the successful and purposeful use of innovative digital and information-based technologies, it is essential that pedagogical staff and parents acquire the necessary skills for effectively using these new teaching tools. A lack of digital competencies among teachers and difficulties in adapting teaching methods may limit the effectiveness of these technologies and result in the failure to meet the individual needs of learners [10].

At the same time, active parental involvement in the holistic process of teaching, learning, and knowledge acquisition, their supportive role in technology use, and the establishment of a conducive learning environment at home serve as critical factors in ensuring the academic and social development of learners who

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experience persistent cognitive or developmental difficulties.

In conclusion, innovative digital and information-based technologies in the education of learners who experience persistent cognitive or developmental difficulties offer both great potential and certain risks. Therefore, their effective use requires not only the availability of technological tools but also a systematic consideration of pedagogical, social, and psychological aspects. This also necessitates conducting comprehensive and interdisciplinary research in the field to contribute to the development of inclusive and high-quality education systems.

Future Perspectives and Recommendations for the Use of Digital Technologies in the Education of Children with Learning Disabilities

The rapid development observed in recent years regarding the integration of innovative digital and information-based technologies into the education of learners who experience persistent cognitive or developmental difficulties has led to the emergence of innovations in both scientific-practical practices and pedagogical concepts. This demonstrates the need for complex and systematic approaches in the future to effectively utilize the existing opportunities in this field. Continuous advancement in technology and the implementation of innovative methods will serve to further expand inclusion and individualized instruction in education, as well as to improve the social adaptation and quality of life of children with specific academic and developmental challenges [7].

From a future-oriented perspective, the development and deeper application of advanced technologies such as artificial intelligence and machine learning will enable the creation of adaptive learning systems tailored to the individual characteristics of learners who experience persistent cognitive or developmental difficulties. This will provide a basis for implementing personalized and optimal support mechanisms within the holistic process of teaching, learning, and knowledge acquisition. Moreover, the integration of virtual and augmented reality technologies into teaching will offer new opportunities to enhance children's practical skills and experiential learning, thereby increasing their motivation and accelerating their adaptation to real-life scenarios [5].

Additionally, the broader application of innovative digital and information-based technologies in the creation of inclusive educational environments in the future should be reflected not only in their social and pedagogical improvements but also in educational policies and legislation. Special programs should be developed and implemented to enhance the digital competencies of both teachers and parents. Such a comprehensive approach, by fully realizing the potential of digital tools, can further reinforce the overall educational attainment and learning outcomes and social integration of learners who experience persistent cognitive

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or developmental difficulties [6].

On the other hand, ethical and social responsibility aspects of innovative digital and information-based technologies will remain a priority topic in future research and implementation. Issues such as data security, privacy rights, and healthy technology usage among children should be seriously considered during both the development of technological solutions and their application in teaching, aiming to protect children's physical and psychological well-being. Furthermore, the question of whether technologies reduce or exacerbate social inequality still requires continuous research so that strategic measures can be taken to eliminate disparities in access to digital resources [9].

In conclusion, the anticipated directions and prospective outlooks for innovative digital and information-based technologies in the education of learners who experience persistent cognitive or developmental difficulties necessitate the complex and interrelated development of various areas, including enhancing adaptability, ensuring social and pedagogical compatibility, personalizing learning resources, training teachers and parents, and incorporating ethical considerations. This, in turn, establishes the foundation for creating innovative educational environments and strengthening inclusion, ultimately transforming education systems into more equitable, effective, and responsive structures that meet the diverse needs of children.

RESEARCH METHODS / МЕТОДИ ДОСЛІДЖЕННЯ

In this study, a mixed-method approach was employed to scientifically examine the influence and implications of innovative digital and information-based technologies on the education of learners who experience persistent cognitive or developmental difficulties. Specifically, a systematic review of the existing literature and semi-structured interviews conducted with children using digital tools in various educational institutions, as well as with their teachers, were used to collect empirical data. The literature review covered the period between 2010 and 2024 and included international and regional sources on the application of innovative digital and information-based technologies in inclusive education, including academic journals, conference proceedings, and reports from ministries of education. The interviews aimed to explore how teaching methods are implemented in real-life settings and to identify the challenges and achievements experienced by children in using digital tools. The data collected were analyzed using thematic content analysis and statistical methods appropriate to the topic, allowing for a detailed assessment of both qualitative and quantitative aspects of the influence and implications of innovative digital and information-based technologies on education.

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RESEARCH RESULTS / РЕЗУЛЬТАТИ ДОСЛІДЖЕННЯ

The research results revealed a multidimensional impact of innovative digital and information-based technologies on the education of children with learning difficulties. The analysis of empirical data, supported by literature review and semi-structured interviews, demonstrated that the integration of adaptive and assistive technologies leads to measurable improvements in students' academic performance, motivation, and socio-emotional development.

First, the majority of teachers and learners participating in the study reported that digital tools—particularly adaptive learning platforms, interactive whiteboards, and speech-to-text software—significantly increased engagement and comprehension during lessons. The use of multimedia resources, gamified tasks, and visualization tools allowed children with cognitive challenges to grasp complex concepts more effectively through multisensory learning experiences. These findings correspond with prior studies emphasizing the value of differentiated instruction and multimodal learning environments.

Second, digital technologies were found to play a crucial role in promoting self-confidence and social inclusion. The interactive and collaborative features of online platforms encouraged peer communication and cooperative learning, helping students overcome social isolation commonly associated with learning difficulties. Teachers noted that such digital environments fostered not only cognitive progress but also emotional resilience and positive self-perception among learners.

However, the study also revealed notable constraints that limit the full potential of technology-enhanced learning. A significant proportion of educators expressed concerns regarding the lack of digital competencies, inadequate infrastructural support, and unequal access to technological devices, particularly in public schools. These challenges often resulted in inconsistent implementation of digital tools and reduced pedagogical effectiveness. Moreover, excessive screen exposure and poorly monitored technology use occasionally led to attention deficits and reduced concentration among some students.

Despite these obstacles, the overall findings confirm that innovative digital and information-based technologies, when applied purposefully and supported by continuous teacher training, create inclusive and adaptive learning environments that enhance both academic and personal growth. The data underscore that success in digital inclusion depends not only on technological availability but also on comprehensive pedagogical strategies, ethical considerations, and active collaboration between teachers, parents, and policymakers.

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The Concept, Causes, and Types of Learning Disabilities

The term "learning disability" emerged in the mid-20th century alongside the advancement of neurological, psychological, and pedagogical sciences, and was first formally introduced by Samuel Kirk to describe specific learning barriers in educational contexts. This phenomenon refers to persistent difficulties in specific cognitive and academic domains—such as reading, writing, numeracy, and attention—that are not attributable to a child's general intelligence level.

The neurological basis of these difficulties is often associated with anomalies or functional differences in particular areas of the brain. Among the most prevalent categories of learning disabilities are the following:

- *dyslexia* – a disorder that significantly hinders word recognition and reading comprehension, thereby negatively affecting the development of reading skills and overall educational attainment and learning outcomes;
- *dysgraphia* – a condition involving challenges related to motor skills, language processing, and written expression, which impedes the development of effective communication abilities;
- *dyscalculia* – a specific difficulty in understanding mathematical concepts and performing arithmetic operations, which affects the perception of numbers and logical sequences.

The causes of these disorders are multifaceted, involving a combination of genetic, neurophysiological, and environmental factors. Accurate diagnosis typically requires a multidisciplinary approach. Traditional pedagogical methods often fall short in addressing the unique cognitive needs of these children, leading to significant challenges in educational achievement and social adaptation.

The Concept of Digital Technology and Its Application in Education

Digital technologies are defined as tools encompassing both hardware and software components, which are implemented in educational environments to enhance the dynamics and effectiveness of instruction in the contemporary information society. These tools are designed to facilitate interactivity, feedback, personalized learning, and student-centered approaches within the the holistic process of teaching, learning, and knowledge acquisition.

The most commonly used types of innovative digital and information-based technologies include:

- *Adaptive learning programs and platforms,* which dynamically adjust instructional materials and task complexity based on the learner's individual needs;
- *Assistive technologies,* such as text-to-speech software, screen readers, specialized writing programs, and related accessories, which support the

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educational activities of children with specific academic and developmental challenges by addressing their sensory and motor needs;

- *Multimedia resources,* including videos, animations, interactive whiteboards, and virtual reality, which enrich the learning process and accommodate diverse learning styles;
- *Mobile and cloud-based applications,* which enable learning to continue beyond the traditional classroom in terms of time and location.

The implementation of these technologies is considered a significant step toward applying the principles of Universal Design for Learning (UDL) and developing individualized learning strategies in education [1].

CONCLUSIONS / ВИСНОВКИ

The study revealed that innovative digital and information-based technologies have a significantly positive influence and implications on the education of learners who experience persistent cognitive or developmental difficulties. This influence and implications is manifested in areas such as the creation of adaptive learning environments, the implementation of personalized instructional programs, increased motivation and self-confidence among children, and improved social integration. At the same time, the research identified existing obstacles in the application of technologies, particularly economic and infrastructural problems, insufficient digital skills among teachers and parents, as well as psychological and social risks resulting from inappropriate use of technology. These factors were evaluated as key challenges that must be addressed in order to fully realize the potential of innovative digital and information-based technologies in education. Therefore, while the application of digital tools in the education of learners who experience persistent cognitive or developmental difficulties holds great promise, the study underscores the necessity of a comprehensive approach and multidimensional support to achieve successful outcomes.

Prospects for further research in this direction / Перспективи подальших досліджень у цьому напрямі. In order to ensure the effective integration of innovative digital and information-based technologies in the education of learners who experience persistent cognitive or developmental difficulties, the following proposed guidelines and strategic considerations are proposed:

- *First*, educational policymakers and administrators should prioritize the development of digital educational infrastructure and the provision of equal technological opportunities. In line with the principles of social justice, it is

essential to guarantee that every child has access to digital tools and resources, regardless of their socioeconomic background.

- *Second*, regular professional development programs must be organized to enhance teachers' digital pedagogical competencies. Furthermore, educational curricula should be supplemented with methodological support related to the use of innovative digital and information-based technologies in inclusive learning environments.
- *Third*, awareness-raising and training initiatives should be implemented to promote the active participation of parents in the holistic process of teaching, learning, and knowledge acquisition and to support them in using digital tools at home. Such parental involvement is crucial for reinforcing children's learning outside the classroom and ensuring consistency between school and home environment.
- *Fourth*, to safeguard the psychological well-being of children during the use of innovative digital and information-based technologies, ethical principles and safety standards must be strictly applied. It is also necessary to ensure continued research in this area to address emerging risks such as screen addiction, attention deficits, and social isolation.
- *Fifth*, future studies should further investigate the long-term effects of innovative digital and information-based technologies and assess their effectiveness in diverse educational contexts. This will help build evidence-based strategies for scaling up the use of adaptive and inclusive digital learning solutions.

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ВПЛИВ ЦИФРОВИХ ТЕХНОЛОГІЙ НА ДІТЕЙ ІЗ ТРУДНОЩАМИ У НАВЧАННІ

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Анотація. У цьому дослідженні проаналізовано вплив цифрових технологій на освіту дітей із труднощами у навчанні, зосереджуючи увагу на їхньому академічному поступі, когнітивній активності та соціально-емоційному розвитку. Спираючись на соціокультурну теорію Л. Виготського, модель когнітивного розвитку Ж. Піаже та концепцію універсального дизайну навчання (UDL), автори доводять, що цифрові інструменти відіграють ключову роль у створенні інклюзивного, адаптивного та орієнтованого на учня освітнього середовища. Використання допоміжного програмного забезпечення, інтерактивних дощок і платформ адаптивного навчання дозволяє педагогам персоналізувати викладання та ефективніше реагувати на індивідуальні потреби учнів. Результати дослідження свідчать, що належне впровадження цифрових ресурсів підвищує мотивацію, зосередженість і впевненість у собі, забезпечуючи мультисенсорні та інтерактивні можливості для навчання. Ігрові завдання, візуальні симуляції та технології перетворення мовлення на текст сприяють кращому розумінню та запам'ятовуванню матеріалу, а колаборативні

онлайн-платформи стимулюють спілкування та взаємодію між однолітками. Ці чинники позитивно впливають не лише на академічні досягнення, а й на емоційну стійкість та соціальну інтеграцію дітей. Водночас дослідження виявляє низку викликів: нерівний доступ до цифрових пристроїв, недостатній рівень цифрової грамотності педагогів і батьків, а також ризики надмірного використання екранів і зниження концентрації уваги. Подолання цих проблем потребує комплексної стратегії, що поєднує інновації з етичними підходами та урахуванням вікових і когнітивних особливостей дітей. У підсумку підкреслюється, що ефективна інтеграція цифрових технологій в інклюзивну та спеціальну освіту має ґрунтуватися на педагогічних інноваціях, системній підготовці вчителів, розвитку інфраструктури та активній участі батьків. Цілеспрямоване використання цифрових інструментів здатне подолати освітні бар'єри, сприяти рівності можливостей і надати дітям із когнітивними або розвитковими труднощами змогу досягати більшої самостійності та успішно навчатися у цифрову епоху.

Ключові слова: цифрові технології; труднощі у навчанні; інклюзивна освіта; адаптивне навчання; персоналізоване навчання.

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