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## THE USE OF INFORMATION AND COMMUNICATION TECHNOLOGY IN THE DEVELOPMENT OF 21ST CENTURY SKILLS

**Abstract.** In the digital era, the integration of Information and Communication Technology (ICT) with education has emerged as a pivotal force in cultivating 21st-century skills among learners. As societal and economic landscapes evolve at an unprecedented pace, there is a heightened demand for individuals equipped with competencies that transcend traditional academic knowledge. These 21st-century skills, which encompass critical thinking, communication, collaboration, creativity, digital literacy, and problem-solving, are essential for success in the modern world. This study aims to systematically review the existing scientific literature on the use of ICT in the development of these vital skills. Adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, a comprehensive bibliographic search was conducted using the Scopus database. 11 articles were selected for detailed analysis. The findings underscore the transformative potential of ICT in education, highlighting its capacity to enhance learning experiences and equip students with the necessary skills for the 21st century. However, the successful integration of ICT into educational practices requires addressing significant challenges, including equitable access to technology, educator training, and the development of effective pedagogical strategies. This study provides valuable insights into how ICT can be leveraged to foster 21st-century skills, offering recommendations for educators to maximize its benefits and prepare learners for future challenges and opportunities.

**Keywords.** Information and Communication Technology, education, 21<sup>st</sup> century skills, review, development, educational practices.

### Introduction.

In the modern era, the fusion of Information and Communication Technology (ICT) with education has become increasingly prominent, offering transformative potentials in fostering 21st-century skills among learners. The rapid evolution of technology and its pervasive integration into everyday life necessitates a reevaluation of the skills required for success in the 21st century. Traditional academic knowledge, while still important, is no longer sufficient on its own. The modern world demands a broader set of competencies, often referred to as 21st-century skills, which include critical thinking, communication, collaboration, creativity, digital literacy, and problem-solving abilities.

These competencies are essential for navigating the complexities of contemporary life and the global economy. Critical thinking enables individuals to analyze information and make reasoned decisions. Communication and collaboration are vital in an increasingly interconnected world where teamwork and effective exchange of ideas are crucial. Creativity drives innovation and adaptability, allowing individuals to develop novel solutions to emerging challenges. Digital literacy is fundamental in a world dominated by technology, and problem-solving skills are necessary for addressing the multifaceted issues that arise in various contexts.

*The aim of this study* is to systematically review the scientific evidence on the use of ICT in the development of 21st-century skills. This review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, ensuring a rigorous and

comprehensive approach to identifying and analyzing relevant literature. A bibliographic search was carried out using the Scopus repository, resulting in a final sample of 11 articles that were included in the review.

Our analysis highlights the multifaceted role of ICT in education. ICT provides various tools and platforms that can enhance the teaching and learning process, making education more interactive, engaging, and accessible. For instance, digital tools can facilitate collaborative projects, enable real-time feedback, and offer personalized learning experiences. Online resources and educational software can support the development of digital literacy and other essential skills. Furthermore, ICT can help bridge the gap between theoretical knowledge and practical application, allowing students to apply what they have learned in real-world contexts.

The integration of ICT into education also presents several challenges that need to be addressed to maximize its benefits. These challenges include ensuring equitable access to technology, providing adequate training and support for educators, and developing appropriate pedagogical approaches that effectively incorporate ICT. Additionally, there is a need for robust assessment strategies to evaluate the impact of ICT on the development of 21st-century skills.

Drawing upon theoretical provisions and methodological tools from modern areas of scientific knowledge, our research endeavors to elucidate the multifaceted relationship between ICT and the cultivation of essential competencies required for success in the 21st century.

Within this scholarly pursuit, our research delineates several key objectives:

- Analysis of Theoretical and Methodological Toolkit. We aim to undertake a comprehensive analysis of the theoretical and methodological toolkit underpinning research on ICT and 21st-century skills development within the scientific literature. This entails scrutinizing diverse conceptual frameworks, pedagogical models, and methodological approaches utilized to explore the intersection of ICT and skill acquisition.

- Review of Scientific Articles. Through a comprehensive review of scientific articles dedicated to the study of ICT's role in 21st-century skills development, we aim to draw insights into the challenges and opportunities associated with leveraging technology for educational purposes. By critically analyzing existing literature, we seek to identify emerging trends, best practices, and areas for further inquiry, thereby contributing to a deeper understanding of the transformative potential of ICT in education.

As a foundational hypothesis, we propose that while research on ICT and 21st-century skills has proliferated in recent years, there remains a lack of consensus regarding its theoretical underpinnings and practical implications. This hypothesis is predicated on the notion that despite the growing body of literature in this field, there exists a need for greater coherence and alignment between theoretical frameworks and empirical research findings.

To test this hypothesis, we employ a multifaceted methodological approach, which includes Bibliographic Method. Leveraging bibliographic Method, we seek to identify clusters of influential research in the field of ICT and 21st-century skills development. By visualizing citation networks and discerning seminal works, we aim to elucidate prevailing paradigms, theoretical perspectives, and research trajectories, thereby advancing our understanding of the evolving discourse in this domain.

#### *Literature review.*

The intersection of Information and Communication Technology (ICT) with the development of 21st-century skills has been a subject of considerable scholarly inquiry in recent years. An analysis of existing scientific data reveals a burgeoning body of literature that underscores the transformative potential of ICT in shaping the acquisition and cultivation of essential competencies required for success in the modern world.

Chalkiadaki A. [1] conduct a literature review on the discussion of 21st-century skills within the context of primary education. The analysis revealed a particular interest among researchers in skills and competencies associated with the conditions of information and

communications technology (ICT) development, globalization, and the imperative for innovation. The review highlights the significance of ICT literacy, global awareness, cultural competence, and creativity as essential components of 21st-century skills in primary education settings.

Of interest is a review article by a group of scientists [2] that underscore the importance of aligning education with the demands of the 21st-century knowledge society. The study highlights the need for continued efforts to develop and refine strategies for integrating 21st-century skills into the curriculum, adopting innovative teaching methods, and leveraging ICT to personalize learning experiences. Additionally, the study emphasizes the importance of research into effective assessment practices and personalized learning approaches to ensure that students are equipped with the skills needed for success in the modern world. The study delved into themes related to the incorporation of 21st-century skills into the curriculum, teaching methodologies, assessment instruments, and the role of ICT in personalized learning.

Rutkowski D., Rutkowski L., & Sparks J. [3] investigate the relationship between school-based support for information and communications technology (ICT) integration and the use of ICT in pedagogical practices aimed at developing 21st-century skills. Using data from the 2006 Second Information Technology in Education Study survey, authors analyzed the relationship between school-based support for ICT use and the implementation of ICT in teaching activities across 18 national education systems —South Africa, the Russian Federation, and Thailand. The analysis focused on identifying whether school-based support for ICT was consistently associated with the likelihood of using ICT in conjunction with 21st-century teaching activities in the classroom. These findings challenge common assumptions about the relationship between school-based support and ICT integration for 21st-century skills development, highlighting the complexity of pedagogical change in relation to ICT adoption.

Mikre F. [4] examine the roles of Information Communication Technologies (ICT) in education, addressing their potential benefits, existing promises in developing countries, and key limitations and challenges associated with their integration into education systems. Through a comprehensive review, the study seeks to answer three central questions: (1) What are the benefits of ICTs in education? (2) What are the existing promises of ICT use in education systems of some developing countries? (3) What are the limitations and key challenges of ICTs integration into education systems? The review identifies numerous benefits of ICTs in education, including their potential to enhance teaching and learning processes, facilitate access to information, and promote collaborative and interactive learning experiences. Additionally, the study highlights the promises of ICT use in education systems of developing countries, such as increased access to educational resources and opportunities for innovative teaching practices. However, the review also underscores key limitations and challenges of ICT integration, including issues related to infrastructure, access, digital divide, and pedagogical transformation.

The literature reviews the benefits, promises, and challenges of ICT integration in education, particularly in developing countries. While ICTs can significantly enhance teaching and learning, provide access to information, and promote interactive learning, challenges such as infrastructure, access disparities, and the digital divide persist. Addressing these challenges is vital for realizing the full potential of ICT in education and ensuring equitable access to the benefits it offers.

### **Materials and methods.**

The study employs a literature analysis methodology (PRISMA), which involves systematically identifying, analyzing, and synthesizing relevant publications from the Scopus database.

The rationale for the selection of the database was based on studies that comparatively analyze bibliographic data Google Scholar, Scopus, Web of Science [5-7]. Based on the findings

of the articles studied, we decided to use the Scopus base. Scopus is one of the largest abstract and citation databases of peer-reviewed literature, covering a wide range of disciplines. Scopus offers advanced search capabilities, allowing for precise keyword searches and filtering options to refine search results according to specific criteria, such as publication type, subject area, and date range. Articles were searched in the Scopus database with the condition that the following terms were included in the article title or keywords: «21st century skills», «ICT», and «education».

The bibliographic analysis is realized according to the PRISMA methodology. Its main stages are presented in Figure 1.

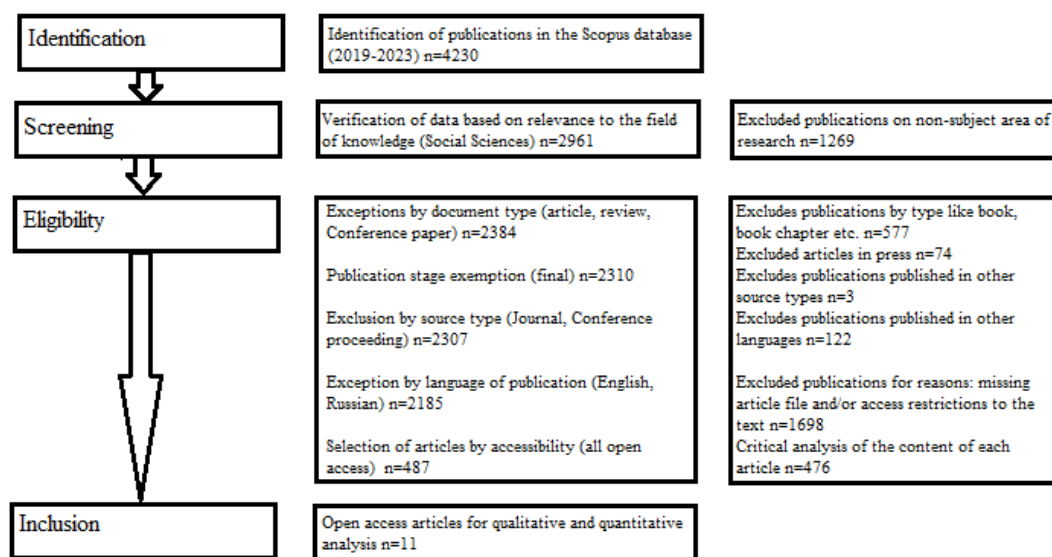


Figure 1 - PRISMA bibliographic analysis scheme

The search yields 11 publications that match the keywords and inclusion criteria.

The inclusion criteria:

- published in Russian or English;
- addressed the use of ICT in the development of 21st-century skills;
- included the terms «21st century skills», «ICT», and «education» in the article title, abstract or keywords;
- open publications;
- journal articles or conference proceedings.

Exclusion criteria:

- book chapters, books, theses;
- studies outside the educational context;
- publications with restricted access.

In the identification phase, an initial search retrieved 4230 records from the selected database. In the next phase, the screening phase, 1269 publications on non-subject area of research were excluded.

During the eligibility phase, the articles were reviewed based on the specified inclusion and exclusion criteria. This review found that 2950 documents did not meet all the criteria: 122 were published in languages other than English or Russian, 577 were excluded due to the type of document (doctoral theses, books, book chapter, communications, or technical reports), 74 were articles in press, 3 were published in other source types, and 1698 did not allow access to the full text.

In the final inclusion phase, 11 articles were selected as the final sample for this review.

### Results and Discussion.

Figure 2 shows a graph of documents by year, the results of a search of the Scopus database.

In 2019, there were 45 eligible articles on these topics in the Scopus database. By 2023, this number had more than tripled to above 140 articles. This upward trend indicates a growing interest and focus within the academic community on the intersection of ICT, 21st century skills, and education during this period.

Such an increase suggests that these areas have gained prominence in educational research and practice, likely reflecting their perceived importance in adapting education to the demands of the 21st century digital landscape. Researchers and educators are evidently paying more attention to how ICT can enhance the development of skills necessary for success in today's society.

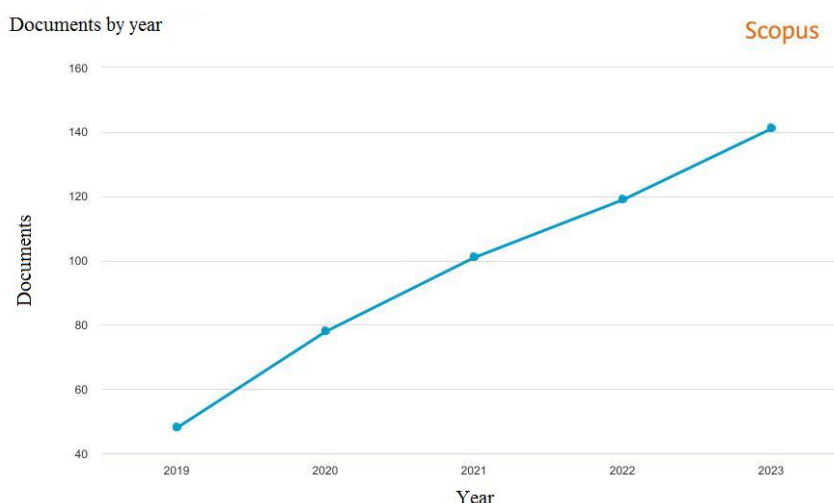


Figure 2 - The results of a search of the Scopus database

Table 1 presents a summary of the detailed analysis of the 11 articles selected for the review.

Table 1 - The summary of the detailed analysis

Article	Main Contributions	Cited
Graça et al., 2021 [8]	Investigates the potential of the digital educational platform Educaplay in the 1st and 2nd Basic Education Cycles. It shows that Educaplay enhances interdisciplinary learning and develops 21st-century skills among students. The study provides insights for teachers aiming to modernize their educational practices with digital tools.	3
González-Betancor et al., 2021 [9]	Explores digital inequality at home, amplified by the COVID-19 lockdown, focusing on socio-economic status (SES) and school ICT integration. Using data from 161,443 students in 21 European countries, it finds that family SES primarily affects ICT access at home, while school ICT integration influences ICT use. Thus, integrating ICT in schools can help reduce digital inequality.	41



Barquilla & Cabili, 2021 [10]	Demonstrates that an enhanced STEM module on Gas Laws significantly improves students' conceptual understanding, performance, and 21st-century skills. It recommends using the enhanced module in public schools and suggests creating integrated STEM lesson plans for better educational outcomes.	1
Haryani et al., 2021 [11]	Investigates how Indonesian vocational high school science teachers integrate 21st-century skills (creativity, critical thinking, collaboration, communication) into their instruction. It finds that teachers use various resources like professional development programs and teacher collaborations to support this integration. Teacher Professional Education (TPE) programs are highlighted as particularly effective, while curriculum guidelines are deemed less impactful. The study underscores the importance of supportive resources in enhancing 21st-century skill integration in science education.	12
Uğur & Sungur, 2021 [12]	Validates a tool to gauge Turkish middle school students' perceptions of 21st-century learning practices in science classes. It assesses how students view self-directed, collaborative, and ICT-supported learning, along with critical thinking, creative thinking, authentic problem-solving, and self-efficacy for knowledge creation. Results indicate moderate levels of 21st-century skill integration in science education according to student feedback.	1
Sulaiman & Ismail, 2020 [13]	Explores how teacher competence and 21st century skills are linked among 242 secondary school teachers in North Zone, Peninsular Malaysia. It finds a strong positive relationship between professional competence and these skills, identifying key factors like personal characteristics, pedagogy, ICT, and school management as significant contributors. This underscores the importance of teacher competence in advancing teaching quality aligned with modern educational standards.	21
Yunus et al., 2020 [14]	Explores improving vocabulary acquisition among low-proficiency primary school students in Malaysia using "GoPic with QR Code," a method blending word games with picture cards. Through two cycles of action research involving 64 students, significant vocabulary enhancement was observed, demonstrating the effectiveness of this student-centered approach with ICT integration.	8
Hadinugrahaningsih et al., 2020 [15]	The research integrated a Socio-critical and Problem-oriented approach with green chemistry to develop 21st century skills among grade X students in Jakarta, Indonesia. It used qualitative methods to assess skills like communication, collaboration, information literacy, ICT literacy, and social interaction. The approach effectively engaged students in solving environmental issues, highlighting its potential for meaningful skill development in real-world contexts.	1
Chiappe Laverde et al., 2020 [16]	Reviews 780 research reports on 21st-century education, focusing on improving current educational practices in developing countries. It identifies key ideas like personalized learning, research-based teaching, flexible digital curriculum, and lifelong learning as crucial for transforming education.	2

Schmid & Petko, 2019 [17]	Examines how personalized learning, focusing on digital technology use, impacts 8th-grade students in Swiss schools. It finds that increased use of digital tools in open teaching environments improves students' self-reported digital skills and beliefs about ICT in learning. The research highlights the importance of integrating digital technologies effectively to foster 21st-century skills among students.	80
Turiman et al., 2019 [18]	The study evaluated 21st-century skill mastery among science foundation students from two colleges, finding generally high levels across digital literacy, inventive thinking, and effective communication. It also noted moderate levels in economic literacy, creativity, and interactive communication. Gender and former school location showed no significant impact on skill mastery. These findings underscore the importance of equipping students with essential skills for success in today's evolving job market and society.	6

The collection of studies broadly investigates the integration of digital tools and innovative educational practices to enhance learning and develop essential 21st-century skills among students. These studies focus on addressing digital inequality, promoting interdisciplinary learning, and fostering skills such as critical thinking, problem-solving, creativity, collaboration, and communication. They highlight the transformative potential of educational technology and the crucial role of teachers in implementing these advancements effectively. The research emphasizes the need for equitable access to digital resources and the importance of personalized and student-centered learning environments to prepare students for future challenges in an increasingly digital and interconnected world.

### Conclusion.

The research topics highlighted above collectively emphasize the critical role of digital platforms, innovative teaching practices, and educational technologies in fostering 21st-century skills. They address various educational levels, from primary to secondary education, and focus on reducing digital inequality, enhancing STEM education, and integrating essential skills into the curriculum. The overarching goal of these studies is to prepare students for future challenges by equipping them with the necessary skills to succeed in a rapidly evolving digital world.

Existing research on the role of ICT in building 21st-century skills is underpinned by a diverse array of theoretical frameworks and conceptual models. These frameworks draw upon theories of learning, cognitive development, and educational psychology to elucidate the mechanisms through which ICT facilitates skill acquisition. Common theoretical perspectives include constructivism, socio-cultural theory, and connectivism, which emphasize the importance of active, collaborative, and technology-mediated learning experiences in fostering skill development.

Studies have highlighted various pedagogical approaches and instructional strategies for integrating ICT into educational practices to promote 21st-century skills. These approaches include problem-based learning, project-based learning, inquiry-based learning, and flipped classroom models, among others. Research suggests that ICT-enabled learning environments offer opportunities for personalized learning, collaborative problem-solving, and authentic, real-world engagement, thereby fostering the development of critical thinking, communication, collaboration, creativity, and digital literacy skills.

The assessment of 21st-century skills in ICT-mediated learning environments poses unique challenges and requires innovative methodologies and evaluation metrics. Existing

research has explored the use of performance-based assessments, self-assessment tools, rubrics, and digital portfolios to measure students' proficiency in various skill domains. Additionally, studies have examined the role of formative assessment and feedback mechanisms in enhancing skill development and promoting metacognitive awareness among learners.

Despite the potential benefits of ICT in building 21st-century skills, several challenges and opportunities emerge from the existing scientific data. These include issues related to digital equity and access, teacher readiness and professional development, curriculum design and alignment, and the need for robust data privacy and security measures. Moreover, research underscores the importance of fostering a critical understanding of technology and promoting ethical and responsible use of digital tools among learners.

Looking ahead, future research directions in this area may focus on exploring innovative ICT tools and technologies, investigating the role of emerging technologies such as artificial intelligence and virtual reality in skill development, and examining the socio-cultural and contextual factors that influence the effectiveness of ICT integration. Moreover, there is a need for longitudinal studies and large-scale evaluations to assess the long-term impact of ICT interventions on students' academic achievement and career readiness.

In conclusion, the analysis of existing scientific data underscores the multifaceted role of Information and Communication Technology in building 21st-century skills. By leveraging theoretical insights, pedagogical innovations, and assessment strategies, educators can harness the transformative potential of ICT to prepare learners for the challenges and opportunities of the digital age. However, addressing the challenges and maximizing the benefits of ICT integration requires concerted efforts from stakeholders across the educational ecosystem.

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The authors declare no potential conflicts of interest regarding the research, authorship, or publication of this article.

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## **XXI ҒАСЫР DAҒДЫЛАРЫН ДАМУҒА ҮШІН АҚПАРАТТЫҚ-КОММУНИКАЦИЯЛЫҚ ТЕХНОЛОГИЯЛАРДЫ ҚОЛДАНУ**

**Андатпа.** Цифрлық дәуірде ақпараттық-коммуникациялық технологияларды (АКТ) білім берумен интеграциялау білім алушылардың XXI ғасыр дағдыларын қалыптастырудағы негізгі күшке айналды. Қоғам мен экономика бұрын-соңды болмаған қарқынмен дамып келе жатқанда, дәстүрлі академиялық білімнен тыс құзыреттіліктері бар кадрларға сұраныс артуда. Сыни тұрғыдан ойлау, қарым-қатынас, ынтымақтастық, шығармашылық, цифрлық сауаттылық және проблемаларды шешуді қамтитын XXI ғасыр дағдылары қазіргі әлемде табысқа жету үшін өте маңызды. Бұл зерттеудің мақсаты - аталған өмірлік дағдыларды дамыту үшін АКТ-ны қолдану туралы бар ғылыми әдебиеттерге жүйелі талдау жасау. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) ұсыныстарына сәйкес Scopus базасын қолдана отырып, кешенді библиографиялық іздеу жүргізілді. Егжей-тегжейлі талдау үшін 11 мақала таңдалды. Нәтижелер білім берудегі АКТ-ның трансформациялық әлеуетін көрсетті, бұл олардың оқыту тиімділігін арттыру және білім алушылардың XXI ғасыр дағдыларын дамытудағы маңыздылығын көрсетеді. Алайда, АКТ-ны білім беру практикасына сәтті интеграциялау - технологияларға тең қол жетімділікті қамтамасыз ету, оқытушыларды даярлау және тиімді педагогикалық стратегияларды әзірлеу сияқты күрделі мәселелерді шешуді талап етеді. Бұл зерттеу XXI ғасыр дағдыларын дамыту үшін АКТ-ны қалай қолдануға болатындығы туралы құнды ақпарат береді.

**Түйінді сөздер.** Ақпараттық-коммуникациялық технологиялар, білім беру, XXI ғасыр дағдылары, шолу, дамыту, білім беру тәжірибелері.

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## **ИСПОЛЬЗОВАНИЕ ИНФОРМАЦИОННЫХ И КОММУНИКАЦИОННЫХ ТЕХНОЛОГИЙ ДЛЯ РАЗВИТИЯ НАВЫКОВ 21 ВЕКА**

**Аннотация.** В цифровую эпоху интеграция информационных и коммуникационных технологий (ИКТ) с образованием стала ключевой силой в формировании у учащихся навыков XXI века. По мере того как общество и экономика развиваются беспрецедентными темпами, возрастает спрос на кадры, обладающих компетенциями, выходящими за рамки традиционных академических знаний. Эти навыки XXI века, включающие в себя критическое мышление, коммуникацию, сотрудничество,

креативность, цифровую грамотность и решение проблем, необходимы для успеха в современном мире. Целью данного исследования является систематический обзор существующей научной литературы по использованию ИКТ для развития этих жизненно важных навыков. В соответствии с рекомендациями PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) был проведен комплексный библиографический поиск с использованием базы данных Scopus. Для подробного анализа было отобрано 11 статей. Полученные результаты подчеркивают преобразующий потенциал ИКТ в образовании, указывая на их способность повышать эффективность обучения и прививать учащимся необходимые навыки для XXI века. Однако успешная интеграция ИКТ в образовательную практику требует решения серьезных проблем, включая обеспечение равного доступа к технологиям, подготовку преподавателей и разработку эффективных педагогических стратегий. Это исследование дает ценное представление о том, как можно использовать ИКТ для развития навыков XXI века, и предлагает рекомендации для педагогов, чтобы максимально использовать их преимущества и подготовить обучающихся к будущим вызовам и возможностям.

**Ключевые слова.** Информационно-коммуникационные технологии, образование, навыки XXI века, обзор, развитие, образовательные практики.

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