THE ROLE OF INFORMATION AND COMMUNICATION TECHNOLOGIES IN STUDENTS' ACADEMIC ACHIEVEMENTS

O PAPEL DAS TECNOLOGIAS DE INFORMAÇÃO E COMUNICAÇÃO NO DESEMPENHO ACADÊMICO DOS ALUNOS

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Abstract. The article examines the impact of using information and communication technologies (ICT) on students' academic achievements. ICTs play a key role in modern education. They change the methods of teaching and interaction during the learning process. The paper summarizes the results of previous studies and analyzes the positive and negative aspects of ICT's impact on student performance. Further research perspectives and recommendations made for practical use are discussed in order to optimize the use of ICT in education and improve students' academic performance. In addition, the study discusses the importance of developing digital literacy among students and teachers as a key element of the successful integration of ICTs into the educational process. Additionally, the article emphasizes the importance of taking into account the aspects of the socio-cultural and economic environment when considering the impact of ICT on students' academic achievement. The paper stresses the importance of a balanced approach to using technologies. Such an approach takes into account both positive aspects and potential negative effects. Furthermore, the study discusses ethical and security issues related to using ICT in education. The authors have carried out an experimental study on the introduction of various types of ICTs into the higher education system on the example of future specialists of preschool education institutions and presented its results. The paper also discusses the possibilities of modern educational technologies in the context of global knowledge sharing and intercultural interaction. The authors emphasize their role in creating a global educational community.

Keywords: information and communication technologies; educational process; interactive learning platforms; learning effectiveness; adaptive educational technologies; preschool education, training of specialists for preschool education institutions.

Resumo. O artigo examina o impacto do uso das tecnologias da informação e comunicação (TIC) nos resultados acadêmicos dos estudantes. As TIC desempenham um papel crucial na educação moderna, mudando os métodos de ensino e interação durante o processo de aprendizagem. O artigo resume os resultados de estudos anteriores e analisa os aspectos positivos e negativos do impacto das TIC no desempenho dos alunos. São discutidas outras perspectivas de pesquisa e recomendações práticas para otimizar o uso das TIC na educação e melhorar o desempenho acadêmico dos estudantes. Além disso, o estudo analisa a importância de desenvolver a alfabetização digital entre alunos e professores como elemento chave para a integração bem-sucedida das TIC no processo educacional. O artigo também destaca a importância de considerar os aspectos socioculturais e econômicos ao analisar o impacto das TIC no desempenho acadêmico dos estudantes. O documento sublinha a importância de uma abordagem equilibrada no

uso das tecnologias, considerando tanto os aspectos positivos quanto os possíveis efeitos negativos. Além disso, o estudo discute questões éticas e de segurança relacionadas ao uso das TIC na educação. Os autores realizaram um estudo experimental sobre a introdução de vários tipos de TIC no sistema de ensino superior, usando como exemplo futuros especialistas de instituições de educação infantil, e apresentaram seus resultados. O artigo também analisa as possibilidades das tecnologias educacionais modernas no contexto do intercâmbio global de conhecimentos e da interação intercultural, enfatizando seu papel na criação de uma comunidade educativa global..

Palavras-chave: tecnologias de informação e comunicação; processo educacional; plataformas de aprendizagem interativas; eficácia da aprendizagem; tecnologias educacionais adaptativas; educação pré-escolar, formação de especialistas para instituições de educação pré-escolar.

1. INTRODUCTION

Information and communication technologies (ICTs) have become an integral part of our daily lives, integrating into various fields of activity. When it comes to education, they play a vital role in influencing learning processes and student achievement. However, the role of such technologies in shaping students' academic achievements is the subject of intense research in modern pedagogical practice. The issue of using information and communication technologies in the context of students' academic achievements is becoming increasingly relevant in the era of educational digitalization and the information society. The rapid development of technologies leads to changes in teaching and knowledge assessment approaches. As the Internet, software, and mobile devices have developed, learning has become more accessible and interactive. However, the impact of ICT on academic performance remains a subject of active discussions and research. In this article, we will discuss both the positive and negative aspects of ICT in education. We will also analyze the latest research and data to better understand how these technologies affect student success in today's learning process.

The problem of how the use of information and communication technologies affects students' academic achievements requires careful analysis and identification of key aspects. In the modern educational process, there is an often-asked question of how to effectively use existing ICT tools to improve the learning process and improve students' academic performance. The ambiguous perception of ICTs in education is one of the main problems. On the one hand, ICTs provide unique opportunities to improve the accessibility of learning, personalize the educational process, and increase student motivation. On the other hand, there are concerns about possible distractions, lower quality of education, and development of technology dependence. Another critical issue is the heterogeneity of access to ICT and digital literacy among students. Unequal access to technologies and insufficient knowledge of how to use them can create barriers to learning and limit opportunities for certain groups of students.

Furthermore, there are concerns about evaluating the effectiveness of using ICT in education. For example, which specific types of technologies have the most positive impact on the learning process and student outcomes? How can we measure their contribution, and what research methods are most appropriate for assessing their impact? These issues require more in-depth research if we want to develop effective strategies for integrating ICT into the educational process and improve the quality of education for all students.

This article aims to analyze the impact of using information and communication technologies on students' academic achievement to identify the main factors that determine their contribution. In addition, the study proposes recommendations for the optimal use of ICT in the educational process.

The paper sets the following goals to achieve the goals mentioned above:

1. To review current trends in using information and communication technologies in education.

2. To analyze the positive and negative aspects of how ICTs affect students' academic performance based on current research and available data.
3. To study the factors that determine the effectiveness of ICT in education, including the accessibility to technologies, digital literacy of students, and teaching methods.
4. To evaluate different types of information and communication technologies and their impact on various aspects of the educational process using a case study.
5. To offer practical recommendations for optimizing the use of ICT in the educational process in order to improve students' academic achievement.

2. LITERATURE REVIEW

Slipchuk et al. (2021) consider the pedagogical skills and communication competence of university teachers in the learning process. Batsurovska et al. (2021) describe the technology of acquiring competencies by students within the digital communication environment. Spivakovskyi et al. (2022) study virtual space as a platform for student research practices. Slipchuk et al. (2020) describe innovative teaching methods at universities, including the use of information and communication technologies. Dotsenko (2023) describes the technology of creating educational content for open digital resources on general technical disciplines. Oliynyk et al. (2020) consider STEM education in the context of training future engineers within the information and educational environment. Dur-e-N. et al. (2021) investigate the interrelation between ICT use and academic performance of university students. Amarilis et al. (2020) examine the use of ICT based on formative research. Rubab (2022) evaluates the effectiveness of ICT use on student performance at the university level. The article (Communication and Information Technologies in Preparing Students for Research Work, 2019) analyzes the use of ICT in preparing students for research work.

Morgulets & Derkach (2019) discuss the quality management of university educational activities using information and communication technologies. Hasanova (2022) considers the role of communication technologies in perceiving information by students. Tashtoush et al. (2023) examine the impact of ICT learning on academic interest in mathematics. Bass and Wall (2020) describe information and communication technologies in the development context. Mâţă and Dobrescu (2022) discuss the benefits and challenges of integrating mobile technologies into academic learning. Lebedeva et al. (2020) evaluate the methodological effectiveness of using virtual and augmented reality as part of the educational process. Gudoniene & Rutkauskiene (2019) consider the application of virtual and augmented reality in education. Gurevych et al. (2021) explore the use of augmented reality technology in higher education. Pydiura (2020) describes the use of virtual reality and digital technologies to study folklore in Ukrainian educational institutions.

Ghaliya Al Farsi et al. (2021) give an overview of how virtual reality is used in education. Volynets (2021) describes the application of virtual reality technologies in education. Elmqaddem (2019) discusses the use of augmented and virtual reality in education. Karakus et al. (2019) conducted a bibliometric study on research in the field of augmented reality in education. Yassine & Hicham (2021) provide a literature review on the use of virtual and augmented reality in the context of schools.

3. METHODS

The following methods can be used to study the impact of using information and communication technologies (ICTs) on students' academic achievement:

Questionnaires. Surveys among students and teachers to collect data on their experience of using ICT in the educational process, their perception of the effectiveness of technologies, and their impact on the learning process.

Observation. Systematic observation of classes where ICT is used to assess its impact on student engagement with learning material, motivation, and level of engagement.

Comparative analysis. A comparison of students' academic performance in ICT-enabled learning with that of traditional methods to identify differences in achievement.

Experimental research. Controlled experiments where groups of students are provided with different ICT-based learning methods and then evaluated for their performance and learning effectiveness.

Quantitative data analysis. This involves analyzing qualitative and quantitative data on student performance, the use of ICT in the learning process, and other factors that may affect academic outcomes.

Meta-analysis. A review and analysis of the results of previous research on a topic to identify common trends, contradictions, and shortcomings and formulate recommendations for further research.

4. RESULTS

A review of current trends in using information and communication technologies (ICTs) in education allows us to understand the current state of technology integration into the educational process and identify the main development directions in this area. Let us take a look at several key trends.

1. *Development of online education.* In recent years, online education has become increasingly popular and widely available. Online courses, massive open online courses (MOOCs), and webinars allow students to get an education from anywhere in the world and on their own schedule.
2. *Personalized learning.* The use of ICTs allows for the creation of learning materials and tasks adapted to the individual needs and level of knowledge of each student. Adaptive educational platforms and programs help to optimize the learning process.
3. *Use of mobile technologies*. With the development of mobile devices and programs, learning is becoming more flexible and mobile. Mobile programs allow students to study materials anytime and anywhere.
4. *Virtual and augmented reality*. Virtual and augmented realities open up new opportunities for education. Virtual laboratories, simulators, and excursions allow students to immerse themselves in the learning material and gain practical skills in a virtual environment.
5. *Cloud technologies.* Cloud technologies make it easier to access learning materials and collaborate on projects. Cloud storage and collaboration services allow students and teachers to share information and work on tasks in real-time.

All these trends demonstrate how modern information and communication technologies are transforming education, making it more accessible, flexible, and effective for students and teachers. However, it is important to remember that successful ICT integration into education requires a comprehensive approach and constant updating of pedagogical practices.

Figure 1 shows statistical data on trends related to using information and communication technologies in education at the beginning of 2022.

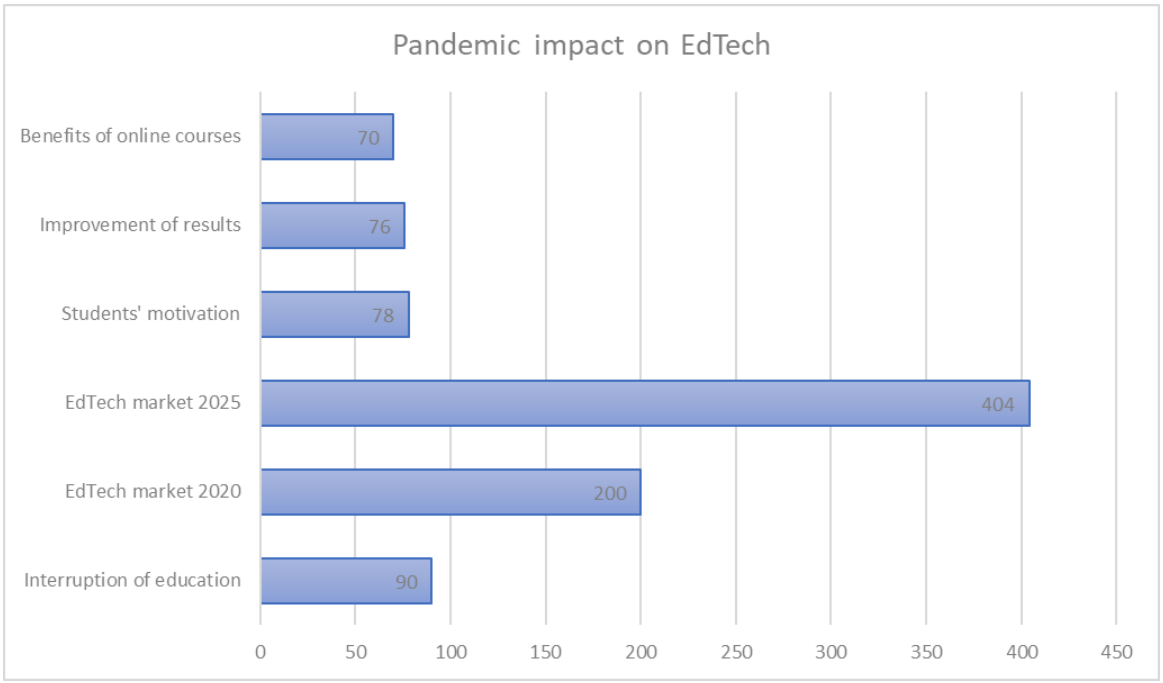

Figure 1. Current trends in using information and communication technologies in education at the beginning of 2022.

Figure 1 shows key data related to the impact of the COVID-19 pandemic on the education and educational technologies (EdTech) market. It illustrates the percentage of students who have faced pandemic-related school suspensions, the 2020 EdTech market valuation and projected 2025 valuation, and the rate of teachers and students who have noted the positive impact of technologies in education.

According to the United Nations Educational, Scientific and Cultural Organization (UNESCO), in 2020, more than 90% of students worldwide faced school suspensions due to the COVID-19 pandemic. This has led to the growth of online education and the use of various information and communication technologies. According to HolonIQ's Education Technology Market Review, the global EdTech market was valued at more than $200 billion in 2020, with an expected growth to $404 billion by 2025. A survey conducted by Pearson in 2020 found that 78% of teachers believe that the use of technologies in education has increased student motivation. In fact, 76% of teachers reported improved learning outcomes.

According to a study by Deloitte, more than 70% of university students in the United States said they would prefer at least one online class to have flexibility in their schedules or their choice of subjects. These statistics emphasize the significant impact of information and communication technologies on education and their role in the modern learning process.

Based on existing research and data, let us analyze the positive and negative aspects of the impact of information and communication technologies on students' academic performance (Figure 2).

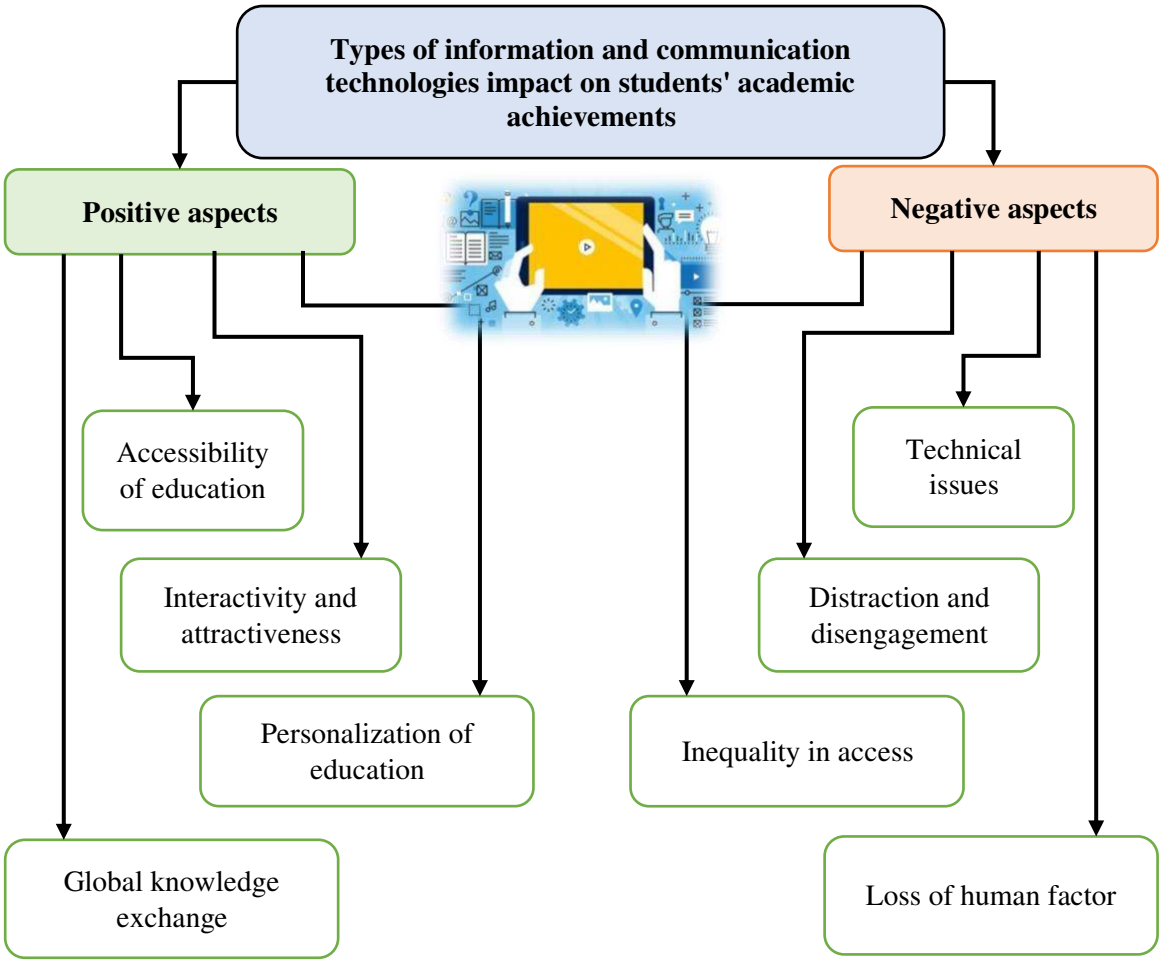

Figure 2. Positive and negative aspects of ICT impact on students' academic achievements

The diagram shows two angles of how technologies can improve the educational process and the potential problems that can arise out of their use.

As for the positive aspects, it can be noted that ICTs make education more accessible. They allow students from remote areas or with disabilities to attend classes and receive a high-quality education. Many educational programs and platforms use gaming elements and interactive teaching methods. This makes the learning process more engaging and motivating for students. ICTs allow for the creation of individualized curricula and materials and provide an opportunity for feedback and course corrections according to the needs of each student. Online platforms and social networks create opportunities for students to communicate and collaborate with colleagues and experts worldwide, which helps broaden their horizons and enrich their learning experience.

As for the negative aspects, the use of ICT in the educational process can lead to distractions and reduced concentration of students due to access to social networks or other entertainment content. A lack of infrastructure or poor interaction with the software can lead to interruptions in the learning process and negatively affect learning. Students from poor or remote areas may lack access to high-speed Internet or modern technology. This may lead to lower academic performance and a widening of the achievement gap. The use of technology can sometimes lead to less face-to-face interaction between students and teachers, which, in turn, can reduce the quality of education and support for students.

The analysis of the above mentioned aspects emphasizes the need to balance the use of information and communication technologies in education to maximize their positive impact on students' academic outcomes while minimizing the potential negative effects.

Below, we will take a closer look at the factors that determine the effectiveness of using information and communication technologies in education.

Accessibility of technologies. One of the key factors is the availability of appropriate technologies for students and teachers. This includes not only the availability of computers, Internet connections, and software but also access to modern educational resources and platforms.

Digital literacy. Effective use of ICT in education requires students and teachers to have skills in working with digital technologies. Digital literacy includes the ability to find, evaluate, and use information from the Internet, as well as the ability to interact effectively with educational platforms and tools.

Teaching methods. An important factor is the choice of appropriate teaching methods that maximize the use of information and communication technologies. This may include creating interactive learning materials, using online testing, adaptive learning platforms, and other innovative teaching methods.

Successful use of ICTs in education requires a comprehensive approach that includes not only the availability of appropriate technologies but also the development of digital skills of participants in the educational process, as well as the selection of appropriate teaching methods that maximize the use of modern technologies.

Table 1 provides an overview of different types of information and communication technologies (ICTs) and their impact on the educational process. It includes five main types of ICTs, their main features, and their potential impacts on various aspects of education.

Table 1. Different types of ICTs and their impact.

ICT type	Description	Its impact on the educational process
Interactive learning platforms	Distance learning platforms, web conferencing, and virtual classrooms.	Improves accessibility of education, and allows interactive communication between participants of the learning process.
Educational programs and applications	Mobile and desktop apps for learning and evaluation.	Increases students' engagement via interactive learning content and supports personalized learning.
Virtual and augmented reality	Application of VR and AR to create immersive learning experiences.	Provides hands-on experience and deep immersion into learning material, especially when it comes to technical and scientific disciplines.
Cloud technologies	Platforms for teamwork, data storage, and sharing.	Facilitates an access to learning resources and encourages teamwork, improves flexibility and scalability of educational processes.
Adaptive educational technologies	AI-based tools and programs for creating personalized curricula.	Improves learning efficiency by adapting to individual needs and abilities of students, as well as supports differentiated learning.

This table illustrates how different types of ICT can impact the educational process. This includes better accessibility, engagement, individualization of learning, and opportunities for teamwork and hands-on experience.

We conducted the research over a period of three years, from 2021-2023. We focused on how types of ICTs, such as interactive learning platforms, educational programs and applications, virtual and augmented reality, cloud technologies, and adaptive educational technologies, can influence the educational process. The experiment involved future specialists

of preschool education institutions in the second, third, and fourth years of study, totaling 1003 students.

We used the following formula to calculate an increase in the quality of knowledge of preschool education students based on using different types of ICTs over the indicated period:

Quality of knowledge$_{\text{year, ICT type}}$ = Basic quality + Permanent growth × (year - reference year) + Random growth.

Where:

- Basic quality – the initial level of knowledge of preschool education institutions' students before the introduction of ICT.
- Permanent growth means the annual increase in the quality of knowledge that is expected to occur due to the progressive introduction and usage of ICT.
- Random growth means a variable that adds a random fluctuation to the annual growth to reflect different factors that influence the effectiveness of the educational process.
- Year is a specific year for which the quality of knowledge of future specialists of preschool education institutions is calculated.
- Reference year means the year from which the countdown of ICT implementation begins (Table 2).

Table 2. Indicators of the knowledge quality of preschool education institutions' students during 2021-2023 by ICT types.

ICT type	Knowledge quality indicators		
	2021	2022	2023
Interactive learning platforms	75.665597	84.133105	91.001615
Educational programs and applications	79.814726	75.935619	88.905101
Virtual and augmented reality	80.867903	85.527270	89.883389
Cloud technologies	82.040860	86.199559	91.256344
Adaptive educational technologies	77.686234	81.851130	89.845870

According to the obtained results, it can be argued that the introduction of each type of ICT increases the quality of students' academic achievements every year. The results of calculating the increase in the knowledge quality by type of information and communication technologies (ICT) between 2021 and 2023 are presented in Table 3.

Table 3. Indicators of the growth in the knowledge quality of preschool educational institutions' students by ICT types.

ICT type	Indicators of knowledge quality growth		
	Growth in 2021-2022	Growth in 2022-2023	Total growth in 2021-2023
Interactive learning platforms	8.47 points	6.87 points	15.34 points
Educational programs and applications	-3.88 points	12.97 points	9.09 points
Virtual and augmented reality	4.66 points	4.36 points	9.02 points
Cloud technologies	4.16 points	5.06 points	9.22 points
Adaptive educational technologies	4.16 points	7.99 points	12.16 points

This data demonstrates that different types of ICTs have various levels of impact on the knowledge quality of future preschool education specialists, with the most significant overall increase in knowledge quality observed through interactive learning platforms. The data analysis of the increase in the knowledge quality caused by using different types of information

and communication technologies (ICT) between 2021 and 2023 allowed us to make several key conclusions.

As for interactive learning platforms, the largest overall increase in knowledge quality is 15.34 points. This type of ICT has had the greatest positive impact on the quality of students' knowledge. This may be explained by the high level of interactivity and flexibility when organizing the learning process. The introduction of educational programs and applications makes it possible to record a negative increase during the first period but high growth in the second: first -3.88 points, then 12.97 points. This result may indicate initial difficulties in adapting to new educational programs and applications. However, over time, students have achieved significant improvements in their knowledge. Virtual and augmented reality has a steady increase in the quality of knowledge: 9.02 points over the same period. A steady increase may reflect the effectiveness of virtual and augmented reality in providing practical skills and deep immersion in the learning material. The results of introducing cloud technologies indicate a gradual increase in the quality of knowledge - 9.22 points. Cloud technologies that simplify an access to learning materials and facilitate collaboration have demonstrated a positive impact on the educational process. Adaptive educational technologies have a significant increase in the second period. The total increase reached 12.16 points. The ability to adapt teaching materials to the individual needs of students contributed to the improvement of knowledge, especially in the second period.

The difference in the dynamics of knowledge growth by type of ICT emphasizes the importance of choosing the right technologies depending on the specifics of the learning process and students' needs. Interactive learning platforms stand out as the most effective in improving the quality of knowledge. This emphasizes their role in the modern educational space. In addition, the need for adaptation and the timing of adaptation can significantly affect the initial results of introducing new ICTs, as seen in the case of educational programs and applications.

Optimal use of information and communication technologies (ICT) in the educational process can significantly improve students' academic achievements. For this purpose, we suggest the following practical recommendations:

- Training of educators. Relevant training courses on the use of ICT in education will help teachers to effectively integrate technology into their teaching practices.
- The development of qualitative online courses. The creation of interactive, multimedia online courses adapted to different levels of knowledge and learning styles of students will help to improve understanding of the material and increase motivation to learn.
- Support for students. Students' access to technical support and advice on the use of ICTs will help them overcome possible technical issues and successfully use technology in their studies.
- The use of adaptive learning platforms. Implementation of adaptive learning platforms that can adapt learning material and tasks to the individual needs and knowledge level of each student will help to increase learning efficiency.
- Digital literacy training. Integration of digital literacy training into the curriculum will help students develop skills in working with information and communication technologies. This will make students more successful in the modern information society.

Such recommendations will help to optimize the use of information and communication technologies throughout the educational process and make it more effective in improving students' academic achievements.

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5. DISCUSSION

Some scholars discuss the benefits of ICT in education. They argue that ICT can lead to less face-to-face interaction between teachers and students, which can have a negative impact on learning. At the same time, others believe that ICTs provide unique opportunities to improve accessibility and individualize the learning process, which can lead to improved student achievement. There is also a discussion about the inequality of access to technology. A few scientists argue that it can exacerbate the gap in educational achievements between different groups of students. One of the main points of contention is the assessment of the effectiveness of ICT in education and the various methods that can be used to measure this impact. Some scholars emphasize the need to develop ICT integration strategies that take into account the positive aspects of technology while minimizing possible adverse effects and problems. They also discuss how the use of ICTs affects the structure and organization of educational institutions and what changes may be needed to adapt to modern learning requirements.

6. CONCLUSION AND FURTHER PROSPECTS

Overall, the use of information and communication technologies (ICTs) in education has both positive and negative aspects. Although ICTs offer unique opportunities to improve accessibility, individualize the learning process, and increase student motivation, there are concerns about possible distractions, inequality of access, and a decrease in learning quality. A comprehensive approach that includes teacher training, the creation of quality learning materials and programs, and ensuring equal access to technology for all students must be developed to optimize the use of ICT in education. An effective integration of ICT also requires an evaluation and monitoring system to assess the impact of technologies on the learning process and students' learning outcomes. Further research in this area is necessary to identify best practices and strategies for using ICT in education. Ultimately, the proper use of information and communication technologies can significantly increase the efficiency of the educational process and improve students' academic achievement.

For further research in the area of ICT in education, attention should be paid to studying the long-term effects of technologies' integration on student learning and performance. Also, the best strategies for using ICT for different age groups and subject areas should be explored.

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