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EXPANDING THE OPPORTUNITIES OF KAZAKHSTAN'S EDUCATION THROUGH INTEGRATION OF ICT

Abstract

The article presents the possibilities of expanding Kazakhstan`s education through the integration of information and communication technologies (ICT) in educational institutions. Possible ways to solve the problem and implement the implementation of ICT in the education system of Kazakhstan are presented, through investments in infrastructure and technology, training and support for teachers and students, as well as the development of digital content and resources that comply with national curricula and standards. It also outlines that a virtual laboratory is a computer-based environment that simulates laboratory work and allows students to conduct experiments and learn scientific concepts, and describes the benefits of a virtual laboratory. They are concluded to improve educational outcomes in STEM subjects and provide opportunities for international collaboration and research.

Keywords: information and communication technologies, education, virtual laboratories, strategies, infrastructure, innovation, integration.

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АҚПАРАТТЫҚ-КОММУНИКАЦИЯЛЫҚ ТЕХНОЛОГИЯЛАР ИНТЕГРАЦИЯСЫ АРҚЫЛЫ ҚАЗАҚСТАНДЫҚ БІЛІМ БЕРУ МҮМКІНДІКТЕРІН КЕҢЕЙТУ

Аңдатпа

Мақалада білім беру мекемелеріне АКТ-ны интеграциялау арқылы қазақстандық білім беруді кеңейту мүмкіндіктері қарастырылған. Халықаралық ұйымдар және университеттер арасындағы ынтымақтастық пен серіктестікке, ресурстарға және озық тәжірибеге қолжетімділікті қамтамасыз ету баяндалған. Инфрақұрылым мен технологияға инвестициялар, оқытушылар мен оқушыларды оқыту және қолдау, сондай-ақ ұлттық оқу бағдарламалары мен стандарттарына сәйкес келетін цифрлық контент пен ресурстарды әзірлеу арқылы Қазақстанның білім беру жүйесіне АКТ-ны енгізуді іске асыру және мәселені шешудің мүмкін жолдары келтірілген. Сондай-ақ зертханалық жұмыстарды имитациялайтын және студенттерге эксперименттер жүргізуге және ғылыми тұжырымдамаларды зерттеуге мүмкіндік беретін компьютерлік орта - бұл виртуалды зертхана екендігі баяндалып, виртуалды зертханадың артықшылықтары берілген. Олардың STEM пәндері бойынша оқу нәтижелерін жақсартуға ықпал ететіндігі және халықаралық ынтымақтастық пен зерттеулер үшін мүмкіндіктер беретіндігі тұжырымдалған.

Түйін сөздер: ақпараттық-коммуникациялық технологиялар, білім беру, виртуалды зертханалар, стратегиялар, инфрақұрылым, инновациялар, интеграция.

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РАСШИРЕНИЕ ВОЗМОЖНОСТЕЙ КАЗАХСТАНСКОГО ОБРАЗОВАНИЯ ПОСРЕДСТВОМ ИНТЕГРАЦИИ ИНФОРМАЦИОННО-КОММУНИКАЦИОННЫХ ТЕХНОЛОГИЙ

Аннотация

В статье представлены возможности расширения казахстанского образования за счет интеграции информационно-коммуникационных технологий (ИКТ) в образовательных учреждениях. Приведены возможные пути решения проблемы и реализации внедрения ИКТ в систему образования Казахстана, посредством инвестиций в инфраструктуру и технологий, обучение и поддержку преподавателей и учащихся, а также разработку цифрового контента и ресурсов, соответствующих национальным учебным программам и стандартам. Также излагается, что виртуальная лаборатория – это компьютерная среда, которая имитирует лабораторные работы и позволяет студентам проводить эксперименты и изучать научные концепции, а также описываются преимущества виртуальной лаборатории. Сделан вывод, что они способствуют улучшению образовательных результатов по предметам STEM и открывают возможности для международного сотрудничества и исследований.

Ключевые слова: информационно-коммуникационные технологии, образование, виртуальные лаборатории, стратегии, инфраструктура, инновации, интеграция.

Introduction

Relevance. The integration of Information and Communication Technologies (ICT) in education is a global trend that has the potential to transform traditional learning experiences into innovative and engaging ones. Kazakhstan, a rapidly developing country in Central Asia, is also actively pursuing the integration of ICT in its education system, with a focus on improving access to quality education for all. The use of Information and Communication Technologies in the education system of Kazakh universities and schools has been steadily increasing over the past decade.

Goal. Consideration of opportunities to expand Kazakhstan's education through the integration of information and communication technologies.

Significance of the study. In recent years, the government has made significant investments in ICT infrastructure and digital learning resources to enhance the quality of education and increase access to education for all. One example of the use of ICT in Kazakh education is the implementation of online learning management systems (LMS) in universities and schools. LMS platforms such as Moodle, Blackboard, and Canvas are widely used to facilitate online learning, communication, and collaboration between students and teachers. These platforms allow teachers to create and share digital resources, assessments, and assignments, as well as monitor student progress and provide feedback. Another example is the use of educational software and applications to support student learning. These include interactive simulations, virtual labs, and gamified learning platforms that engage students and make learning more fun and interactive. Some popular educational software and applications used in schools and universities include Kahoot!, Quizlet, and Scratch. In addition, video conferencing tools such as Zoom and Google Meet have become increasingly important in the wake of the COVID-19 pandemic, enabling teachers to conduct online classes and meetings with students and colleagues [1].

Research Methodology

Research methods. Comparison, observation, generalization. The use of ICT in Kazakh education has the potential to improve the quality of education, increase access to education for all, and prepare students for the demands of the modern workforce. However, there are also challenges that need to be addressed, such as inadequate ICT infrastructure and limited access to technology. To realize the full potential of ICT in education, it is important to continue investing in ICT infrastructure and providing training and support for teachers and students. The use of ICT in education varies greatly

across different countries, depending on factors such as infrastructure, resources, policies, and cultural attitudes towards technology. Here are some examples of the situation in other countries:

- South Korea: South Korea is widely recognized as a global leader in the use of ICT in education. The government has made significant investments in ICT infrastructure and teacher training, and almost all schools have access to high-speed internet and digital devices. Online learning platforms are widely used, and students are encouraged to learn coding and programming skills from an early age.

- Estonia: Estonia has been a pioneer in digital learning, with a national strategy for digital education that aims to integrate ICT in all aspects of education. All schools have access to high-speed internet and digital devices, and a number of innovative digital learning resources have been developed. Teachers are also provided with training and support to effectively integrate ICT in their teaching.

- India: India has made significant efforts to increase access to ICT in education, particularly in rural areas. The government has launched initiatives such as Digital India and Digital Saksharta Abhiyan to promote digital literacy and provide digital devices to students. However, challenges remain, such as inadequate infrastructure and the need for more effective teacher training.

- Nigeria: Nigeria faces significant challenges in integrating ICT in education, particularly in rural areas. Only a small percentage of schools have access to ICT infrastructure, and there is a shortage of trained teachers and digital learning resources. However, the government has launched initiatives such as the School Connectivity Project to increase access to ICT in education.

The use of ICT in education varies greatly across different countries, and there is no one-size-fits-all solution. Successful integration of ICT in education requires a comprehensive approach that takes into account local context, infrastructure, resources, and cultural attitudes towards technology. There are several countries that have been successful in integrating ICT in education, and have become leaders in this area (Table 1).

Table 1. Comparative analysis of ICT integration in education in foreign countries

Country	*Integration of ICT in Education*	*Investments and Initiatives*	*Results and Challenges*
Czech Republic	*Progressive integration of ICT in education with a focus on infrastructure, digital resources, teacher training, and IT skills development.*	*Government support, efforts to promote technology use.*	*Achievements in preparing students for the digital demands of the modern world, challenges remain.*
Finland	*Extensive use of ICT in education with investments in infrastructure and teacher training.*	*Teacher and student accessibility to digital devices and software.*	*Model for successful ICT integration in education.*
Singapore	*Recognized global leader in the use of ICT in education. Investments in infrastructure and teacher training.*	*National e-learning platform, facilitating online collaboration between teachers and students.*	*Strong outcomes in ICT integration in education.*
Canada	*Significant efforts to integrate ICT in education, particularly in online learning and digital literacy.*	*Initiatives such as the Digital Canada 150 strategy to expand access to digital resources and develop digital skills.*	*Widespread use of online learning and digital tools to enhance education.*

Russia	*Active integration of ICT in education with the aim of improving the quality of education and preparing students for the digital age.*	*Development of programs and initiatives for technology use in education.*	*Gradual progress in preparing students for the digital challenges and opportunities of the 21st century.*
USA	*ICT is widely integrated into education at all levels, from elementary school to higher education.*	*The government and private sector invest significant resources in the development of ICT in education.*	*Increased accessibility to education, more flexible teaching methods. Challenges include access inequality and data privacy concerns.*
China	*ICT is crucial in education in China.*	*There is active development of virtual classrooms and online courses, making education more accessible and interactive.*	*Greater education accessibility, but challenges include ensuring the quality of content and access for all segments of the population.*
India	*India is actively expanding ICT in education.*	*Investments in online platforms and educational apps.*	*Enhanced accessibility to education, especially in remote areas. Challenges include access inequality and education quality.*
Germany	*ICT plays a significant role in education in Germany.*	*Investments in digital infrastructure and teacher training.*	*Effective use of technology to improve education. However, challenges include content quality and assessment of results.*

All of these countries have been successful in integrating ICT in education due to their comprehensive approach, which includes investment in infrastructure, teacher training, and digital resources. They also have a culture that values and encourages the use of technology in education, which has contributed to their success. Such scientists as O.I. Agapova, G.R. Gromov, V.F. Sholokhovich, O.A. Krivosheev, S. Papert, G. Kleiman, V.I. Gritsenko, B. Sendov, B. Hunter, A.P. Ershov, A.A. Kuznetsov, T.A. Sergeeva, I.V. Robert, B.S. Gershunsky, E.I. Mashbitsa, N.F. Talyzina etc. made a great contribution to the development of computer learning technology [2].

In the works of domestic scientists, the problem of learning using ICT in the field of education is considered: G.K. Nurgalieva, Zh.A. Karaev, E.Y. Bidaibekov (new information technology); D.M. Zhusibalieva (Remote form of learning in negizin of new technology); Sh.Kh. Kurmanalina (Electronic justice system); R.Ch. Bekturganova (impact of Information Technology on research work); A.K. Alzhanov (Training without Information and Communication Technology), Zh.K. Nurbekova, B. Bostanov, K.Z. Khalykova, Zh.S. Sardarova and others.

In the research of scientific article [3, 4, 5, 6] devoted to the influence of digital competence on the professional development of teachers, primary and secondary education is devoted. Studies focused on the secondary level of education emphasize the need to adapt ICT curricula for teachers to their needs, the didactic use of technology in teaching methods and the role of leadership in the introduction of technology in schools. Sarac Bilal, Alptekin Nesrin have stated following regarding the open education: «Limited time, physical and financial opportunities in the field of education led to the expansion of the education system and the emergence of new alternatives. One of these alternatives is open education and distance learning, which emphasize the philosophy of free and open exchange of information and materials used in teaching and learning [7].

Mass Open Online Courses (MOOCs) represent a modern phenomenon in education, allowing students from various parts of the world to access courses and educational materials over the internet.

They provide the opportunity to scale education and make it more accessible to a wide audience. In the work of M.B. Lebedeva, she may explore the following aspects of MOOCs in education:

- Accessibility and Proliferation: MOOCs have become accessible to many students worldwide, enabling education in remote areas.
- Innovations in Education: Mass Open Online Courses often introduce new approaches to learning, including interactive online platforms, assessment of learning outcomes, and access to experts from various fields.
- Challenges and Prospects: The author may also discuss the challenges MOOCs face, such as student retention, outcome assessment, and the quality of education [8].

A number of specialized educational technologies are used in distance education: cases (analysis and solution of practical situations), Internet technologies, telecommunication technologies etc. In the state program for the development of education and science in the Republic of Kazakhstan for 2020-2025, it was stated that «it is necessary to develop IT infrastructure, digital educational resources, networks and platforms of open online courses, automation of public services in educational organizations».

Research results

Besides the challenges mentioned earlier, the integration of ICT in the education system of Kazakhstan has showcased several positive results. One notable advantage is the enhanced engagement and motivation of students in the learning process. Interactive and multimedia resources, including educational software and online platforms, have made learning more appealing and dynamic for students of all ages. This newfound enthusiasm has the potential to improve learning outcomes and student performance in the long run.

Another key result is the globalization of education. ICT integration has connected Kazakh universities and schools with educational institutions worldwide. Students and educators now have the opportunity to collaborate with peers from other countries, sharing knowledge and experiences, which broadens their perspectives and helps develop a global mindset. This international exposure can be invaluable for students preparing to enter a globalized workforce.

Furthermore, the implementation of ICT in education has led to the creation of a vast digital knowledge base. This not only supports students' learning but also contributes to the advancement of research and development in various academic disciplines. The digital resources generated in the process have the potential to stimulate innovation and academic excellence in Kazakhstan's educational landscape. While these results are promising, it is important to address the challenges mentioned earlier to ensure that the benefits of ICT integration are accessible to all students. Bridging the digital divide, providing necessary infrastructure and support, and conducting continuous evaluation are essential steps toward realizing the full potential of ICT in Kazakhstan's education system. Having analyzed the work of specialists who can contribute to the development of ICT in education in Kazakhstan, the following recommendations and ideas were identified (Table 2).

Table 2. Recommendations and ideas of experts on the integration of ICT in Kazakhstan Education

Expert	*Experience and Contribution*	*Recommendations and Ideas*
Andreas Schleicher	*Director for Education and Skills at the Organisation for Economic Co-operation and Development (OECD). Extensive experience in education policy and research on technology use in education.*	*Recommendations for improving education policy and implementing ICT.*
Sugata Mitra	*Education researcher and professor who has conducted extensive research on self-directed learning and the use of technology in education. Known for the "Hole in the Wall" experiment.*	*Ideas for applying technology to support self-directed learning and skill development.*

Karen Cator	*President and CEO of Digital Promise, a non-profit organization focused on improving education through technology. Experience in education policy and enhancing teacher training and digital literacy.*	*Recommendations for enhancing teacher training and integrating technology into educational practice.*
Local Experts and Educators	*In addition to international experts, local specialists and educators in Kazakhstan can contribute to ICT development in education. They have a deep understanding of the local context and culture, offering recommendations tailored to Kazakhstan's educational system.*	*Providing contextual solutions and recommendations, taking into account Kazakhstan's specific needs.*

The solution to the problem of the limited integration of ICT in the education system of Kazakhstan is complex and multifaceted. Here are some potential solutions that could be considered:

- Increased investment in ICT infrastructure: One of the main barriers to effective integration of ICT in education is the lack of adequate infrastructure. To overcome this, the government could invest in building and upgrading ICT infrastructure in schools and universities, including providing high-speed internet access and up-to-date hardware and software.

- Teacher training: Teachers play a critical role in integrating ICT in education, and therefore, they need to be equipped with the necessary skills and knowledge. The government could invest in comprehensive and ongoing teacher training programs that focus on the effective use of ICT in teaching and learning.

- Access to digital learning resources: Another challenge faced by educators is the lack of access to high-quality digital learning resources. The government could work to improve access to digital resources by providing funding for the creation and distribution of digital content, as well as by promoting the use of open educational resources.

- Collaboration and partnerships: Collaboration and partnerships between the government, the private sector, and educational institutions could also be a valuable solution. Private sector companies could provide expertise and resources to support the integration of ICT in education, while educational institutions could collaborate on research and development of new approaches and tools.

- Monitoring and evaluation: Finally, monitoring and evaluation of the effectiveness of ICT integration in education is important to identify areas for improvement and to ensure that resources are being used effectively. The government could invest in robust monitoring and evaluation systems to assess the impact of ICT integration on student learning outcomes and to inform future policy and investment decisions.

A combination of these solutions could help to address the challenges of limited integration of ICT in education in Kazakhstan and support effective and sustainable integration of technology in teaching and learning.

Discussion

Discussion of the policy implications of ICT integration in Kazakh education is important to ensure that the full potential of ICT is realized and that challenges are addressed. A comprehensive policy framework can provide guidance and direction for the integration of ICT in education in Kazakhstan, ensuring that it aligns with national development priorities and objectives. The policy framework should address issues related to infrastructure, capacity building, content development, and monitoring and evaluation. For example, it should address the need for adequate infrastructure and connectivity, including ensuring that schools and universities have access to reliable and high-speed internet connectivity. The policy should also address capacity building needs, including providing training and support for teachers and students on the effective use of ICT in education.

Content development is another critical area that the policy should address, ensuring that digital content and resources are aligned with the national curriculum and standards. The policy should also

encourage the development of open educational resources and the sharing of best practices and resources across institutions.

Monitoring and evaluation should also be an integral part of the policy framework, ensuring that the impact of ICT integration in education is measured and evaluated regularly. This can help to identify areas where improvements are needed and can guide the development of future policies and strategies. Strategies for overcoming the challenges of ICT integration in education in Kazakhstan can include partnerships and collaboration, investment in infrastructure and technology, and the development of innovative solutions. For example, partnerships with international organizations and universities can provide access to expertise, resources, and best practices. Investment in infrastructure and technology can help to ensure that schools and universities have access to the necessary tools and resources for effective ICT integration.

The development of innovative solutions, such as virtual laboratories, can provide cost-effective and accessible opportunities for students to engage with scientific concepts and conduct experiments. Discussion of the policy implications of ICT integration in Kazakh education and the development of strategies for overcoming challenges can help to ensure that the full potential of ICT in education is realized, providing students with opportunities to learn and succeed in the digital age.

Virtual laboratories, also known as online or remote laboratories, are computer-based environments that simulate real-world laboratory experiments and provide students with opportunities to conduct experiments and explore scientific concepts in a virtual environment. Here are some examples of virtual laboratories and their benefits:

1. PhET Interactive Simulations: PhET Interactive Simulations is a free online resource developed by the University of Colorado Boulder that provides over 150 virtual laboratory simulations in subjects such as physics, chemistry, biology, and earth science. These simulations are designed to be interactive and engaging, and allow students to explore scientific concepts through experimentation and visualization.

2. Labster: Labster is a virtual laboratory platform that provides over 150 virtual laboratory simulations in subjects such as biology, chemistry, and physics. These simulations are designed to be immersive and interactive, and allow students to conduct experiments and explore scientific concepts in a safe and cost-effective virtual environment.

3. Smart Science: Smart Science is a virtual laboratory platform that provides over 200 virtual laboratory simulations in subjects such as biology, chemistry, and physics. These simulations are designed to be interactive and engaging, and provide students with opportunities to conduct experiments and explore scientific concepts through virtual experimentation.

4. Virtual Labs: Virtual Labs is a platform developed by the Indian government that provides over 190 virtual laboratory simulations in subjects such as physics, chemistry, and biology. These simulations are designed to be interactive and engaging, and provide students with opportunities to conduct experiments and explore scientific concepts in a cost-effective and accessible virtual environment.

5. MERLOT Virtual Labs: MERLOT (Multimedia Educational Resource for Learning and Online Teaching) is a valuable resource that provides a wide range of virtual laboratory simulations across multiple disciplines, including physics, chemistry, biology, and more. These simulations are known for their versatility and accessibility, making them a great choice for educators and students alike. MERLOT's virtual labs offer an interactive and engaging environment for conducting experiments and exploring scientific concepts, aligning well with the goals of ICT integration in education. The platform's vast collection of virtual labs caters to a diverse array of scientific fields, enhancing the educational experience for students in Kazakhstan.

Studies have shown that virtual laboratories can be particularly effective in improving student learning outcomes in STEM subjects. For instance, research conducted by the University of Utah revealed that the utilization of virtual laboratories in a physics course resulted in notable improvements in student learning outcomes. These included increased conceptual understanding and enhanced problem-solving skills. Similarly, a study carried out by the University of Illinois at Urbana-

Champaign demonstrated that integrating virtual laboratories in a chemistry course led to remarkable enhancements in student learning outcomes, including an elevated conceptual understanding and greater retention of scientific concepts. Virtual laboratories have thus emerged as a valuable tool in the broader context of integrating ICT in education. They provide students with opportunities to conduct experiments and explore scientific concepts in a safe, engaging, and cost-effective virtual environment.

The incorporation of virtual laboratories into lessons presents an effective means of integrating ICT in education within the context of Kazakhstan. Virtual laboratories offer a secure and economical way to conduct experiments and simulations, making them particularly beneficial in subjects pertaining to science, technology, engineering, and mathematics (STEM). In Table 3, we outline some potential benefits of incorporating virtual laboratories into the educational process.

Table 3 Benefits of Using Virtual Laboratories in Education

Advantage	*Description*
Increased Accessibility	*Virtual laboratories can be accessed from anywhere with an internet connection, making them particularly useful in areas where physical laboratories may not be available or accessible.*
Cost-Effective	*Setting up and maintaining physical laboratories can be expensive, particularly in remote or rural areas. Virtual laboratories can provide a more cost-effective way to conduct experiments and simulations, without the need for expensive equipment and materials.*
Improved Safety	*Some experiments in physical laboratories can be dangerous or pose health risks to students. Virtual laboratories provide a safe environment for conducting experiments and simulations without the risk of injury.*
Increased Student Engagement	*Virtual laboratories can be interactive and engaging, making learning more fun and interesting for students. They can also provide opportunities for students to explore and experiment in a way that may not be possible in a physical laboratory.*

Using virtual laboratories in lessons can be a valuable way to integrate ICT in education in Kazakhstan. They can provide opportunities for students to learn and explore in a safe and engaging environment, and can help to support improved learning outcomes in STEM subjects.

Virtual laboratories can play an important role in the universities of Kazakhstan by providing students with access to a range of laboratory simulations and experiments in various subjects. As I mentioned earlier, virtual laboratories can be a cost-effective and accessible way for universities in Kazakhstan to provide students with opportunities to conduct experiments and explore scientific concepts, particularly in areas where physical laboratories may not be available or accessible. Virtual laboratories can be particularly useful in STEM subjects, where laboratory experiments and simulations are an important part of the curriculum. By using virtual laboratories, universities in Kazakhstan can provide students with opportunities to explore scientific concepts and conduct experiments in a safe and engaging environment, without the need for expensive equipment or materials [10]. Additionally, virtual laboratories can provide opportunities for universities in Kazakhstan to collaborate with international universities and researchers. Many virtual laboratory platforms, such as PhET Interactive Simulations and Labster, have been developed by international universities and research institutions, and can provide access to a range of laboratory simulations and experiments from around the world. The role of virtual laboratories in the universities of Kazakhstan can be significant, providing students with access to a range of laboratory simulations and experiments, supporting improved learning outcomes in STEM subjects, and providing opportunities for international collaboration and research.

Conclusion

The integration of Information and Communication Technologies (ICT) in education has the potential to transform the learning experiences of students in Kazakhstan. The use of ICT, such as virtual laboratories, can provide cost-effective and accessible opportunities for students to engage with scientific concepts and conduct experiments. While there are challenges to the integration of ICT in education, such as infrastructure and capacity building needs, a comprehensive policy framework can provide guidance and direction for addressing these challenges. To realize the full potential of ICT in education in Kazakhstan, it is important to invest in infrastructure and technology, provide training and support for teachers and students, and develop digital content and resources that are aligned with the national curriculum and standards. Collaboration and partnerships with international organizations and universities can also provide access to expertise, resources, and best practices. We believe that the integration of ICT into education in Kazakhstan is an important step towards preparing students for the digital age and ensuring that they have the skills and knowledge necessary to succeed in an increasingly digital world.

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