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ВЕСТНИК

РОО «НАЦИОНАЛЬНОЙ
АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН»
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В 2016 году для развития и улучшения качества жизни казахстанцев был создан частный Благотворительный фонд «Халык». За годы своей деятельности на реализацию благотворительных проектов в областях образования и науки, социальной защиты, культуры, здравоохранения и спорта, Фонд выделил более 45 миллиардов тенге.

Особое внимание Благотворительный фонд «Халык» уделяет образовательным программам, считая это направление одним из ключевых в своей деятельности. Оказывая поддержку отечественному образованию, Фонд вносит свой посильный вклад в развитие качественного образования в Казахстане. Тем самым способствуя росту числа людей, способных менять жизнь в стране к лучшему – профессионалов в различных сферах, потенциальных лидеров и «великих умов». Одной из значимых инициатив фонда «Халык» в образовательной сфере стал проект Ozgeris powered by Halyk Fund – первый в стране бизнес-инкубатор для учащихся 9-11 классов, который помогает развивать необходимые в современном мире предпринимательские навыки. Так, на содействие малому бизнесу школьников было выделено более 200 грантов. Для поддержки талантливых и мотивированных детей Фонд неоднократно выделял гранты на обучение в Международной школе «Мирас» и в Astana IT University, а также помог казахстанским школьникам принять участие в престижном конкурсе «USTEM Robotics» в США. Авторские работы в рамках проекта «Тәлімгер», которому Фонд оказал поддержку, легли в основу учебной программы, учебников и учебно-методических книг по предмету «Основы предпринимательства и бизнеса», преподаваемого в 10-11 классах казахстанских школ и колледжей.

Помимо помощи школьникам, учащимся колледжей и студентам Фонд считает важным внести свой вклад в повышение квалификации педагогов, совершенствование их знаний и навыков, поскольку именно они являются проводниками знаний будущих поколений казахстанцев. При поддержке Фонда «Халык» в южной столице был организован ежегодный городской конкурс педагогов «Almaty Digital Ustaz.

Важной инициативой стал реализуемый проект по обучению основам финансовой грамотности преподавателей из восьми областей Казахстана, что должно оказать существенное влияние на воспитание финансовой

грамотности и предпринимательского мышления у нового поколения граждан страны.

Необходимую помощь Фонд «Халык» оказывает и тем, кто особенно остро в ней нуждается. В рамках социальной защиты населения активно проводится работа по поддержке детей, оставшихся без родителей, детей и взрослых из социально уязвимых слоев населения, людей с ограниченными возможностями, а также обеспечению нуждающихся социальным жильем, строительству социально важных объектов, таких как детские сады, детские площадки и физкультурно-оздоровительные комплексы.

В копилку добрых дел Фонда «Халык» можно добавить оказание помощи детскому спорту, куда относится поддержка в развитии детского футбола и карате в нашей стране. Жизненно важную помощь Благотворительный фонд «Халык» оказал нашим соотечественникам во время недавней пандемии COVID-19. Тогда, в разгар тяжелой борьбы с коронавирусной инфекцией Фонд выделил свыше 11 миллиардов тенге на приобретение необходимого медицинского оборудования и дорогостоящих медицинских препаратов, автомобилей скорой медицинской помощи и средств защиты, адресную материальную помощь социально уязвимым слоям населения и денежные выплаты медицинским работникам.

В 2023 году наряду с другими проектами, нацеленными на повышение благосостояния казахстанских граждан Фонд решил уделить особое внимание науке, поскольку она является частью общественной культуры, а уровень ее развития определяет уровень развития государства.

Поддержка Фондом выпуска журналов Национальной Академии наук Республики Казахстан, которые входят в международные фонды Scopus и Wos и в которых публикуются статьи отечественных ученых, докторантов и магистрантов, а также научных сотрудников высших учебных заведений и научно-исследовательских институтов нашей страны является не менее значимым вкладом Фонда в развитие казахстанского общества.

С уважением, Благотворительный Фонд «Халык»!

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THE USE OF INFORMATION AND COMMUNICATION TECHNOLOGIES IN THE PROCESS OF STEM EDUCATION

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Abstract. The study and use of information and communication technologies (hereinafter - ICT) in the process of STEM education is extremely relevant in Kazakhstan for several reasons: in the modern era of digital transformation the use of ICT becomes an integral part of various spheres of activity; the study of ICT in STEM education allows students to develop not only technical skills, but also digital literacy, necessary for successful functioning in the modern information society. In addition, ICTs provide opportunities for remote learning, e-learning, and online resources, which help increase accessibility to education in regions with disabilities. This is especially important for Kazakhstan, where many settlements are located in remote and hard-to-reach areas. Thus, the purpose of this study is to analyze and study the use of information and communication technologies in the process of STEM education in Kazakhstan. The object of the study: the use of information and communication technologies in the process of STEM education in Kazakhstan. Subjects of the study: the impact of ICT on the effectiveness of the educational process and the development of students' skills. Research methodology - literature analysis, study of scientific publications, research studies, reports related to the use of ICT in STEM education, as well as experimental work and statistical analysis.

Key words: STEM technology, education, ICT, learning process, application, effectiveness, skills development.

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STEM-БІЛІМ БЕРУ ПРОЦЕСІНДЕ АҚПАРАТТЫҚ-КОММУНИКАЦИЯЛЫҚ ТЕХНОЛОГИЯЛАРДЫ ПАЙДАЛАНУ

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Аннотация. STEM-білім беру процесінде ақпараттық — коммуникациялық технологияларды (бұдан әрі-акт) зерделеу және пайдалану Қазақстанда бірнеше себептер бойынша өте өзекті: цифрлық трансформацияның қазіргі дәуірінде АКТ-ны пайдалану қызметтің әртүрлі салаларының ажырамас бөлігіне айналады; STEM-білім беруде АКТ-ны зерделеу студенттерге техникалық дағдыларды ғана емес, сонымен қатар қажетті цифрлық сауаттылықты дамытуға мүмкіндік береді. қазіргі ақпараттық қоғамда табысты жұмыс істеу. Сонымен қатар, АКТ мүмкіндігі шектеулі аймақтарда білім алудың қолжетімділігін арттыруға көмектесетін қашықтықтан оқыту, электрондық оқыту және онлайн ресурстар мүмкіндіктерін ұсынады. Бұл әсіресе көптеген елді мекендер шалғай және жету қиын аудандарда орналасқан Қазақстан үшін өте маңызды. Осылайша, бұл зерттеудің мақсаты Қазақстандағы STEM-білім беру процесінде ақпараттық-коммуникациялық технологияларды пайдалануды талдау және зерделеу болып табылады. Зерттеу нысаны: Қазақстандағы STEM-білім беру процесінде ақпараттық-коммуникациялық технологияларды пайдалану. Зерттеу пәндері: АКТ-ның оқу процесінің тиімділігіне және оқушылардың дағдыларын дамытуға әсері. Зерттеу әдістемесі-әдебиеттерді талдау, ғылыми басылымдарды зерттеу, ғылыми-зерттеу жұмыстары, STEM білім берудегі АКТ-ны қолдануға қатысты есептер, эксперименттік жұмыс және статистикалық талдау.

Түйін сөздер: STEM-технология, білім беру, АКТ, оқу процесі, қолдану, тиімділік, дағдыларды дамыту

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ИСПОЛЬЗОВАНИЕ ИНФОРМАЦИОННО-КОММУНИКАЦИОННЫХ ТЕХНОЛОГИЙ В ПРОЦЕССЕ STEM-ОБРАЗОВАНИЯ

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Аннотация. Изучение и использование информационно-коммуникационных технологий (далее - ИКТ) в процессе STEM-образования чрезвычайно актуально в Казахстане по нескольким причинам: в современную эпоху цифровой трансформации использование ИКТ становится неотъемлемой частью различных сфер деятельности; изучение ИКТ в STEM-образовании позволяет студентам развивать не только технические навыки, но и цифровую грамотность, необходимую для успешного функционирования в современном информационном обществе. Кроме того, ИКТ предоставляют возможности для дистанционного обучения, электронного обучения и онлайн-ресурсов, которые помогают повысить доступность образования в регионах с ограниченными возможностями. Это особенно важно для Казахстана, где многие населенные пункты расположены в отдаленных и труднодоступных районах. Таким образом, целью данного исследования является анализ и изучение использования информационно-коммуникационных технологий в процессе STEM-образования в Казахстане. Объект исследования: использование информационно-коммуникационных технологий в процессе STEM-образования в Казахстане. Предметы исследования: влияние ИКТ на эффективность образовательного процесса и развитие навыков учащихся. Методология исследования - анализ литературы: изучение научных публикаций,

научно-исследовательских работ, отчетов, связанных с использованием ИКТ в STEM-образовании, а также экспериментальная работа и статистический анализ.

Ключевые слова: STEM-технология, образование, ИКТ, учебный процесс, применение, эффективность, развитие навыков

Introduction

STEM technology is widely used, and it is believed that STEM is a curriculum based on the idea of teaching students in four specific disciplines — science, technology, engineering and mathematics - within an interdisciplinary and applied approach (Abdieva, 2018:110–117). STEM is used in Kazakhstan mainly for the general designation of scientific disciplines along with the designation "exact sciences", which are described as sciences that "use mathematical methods, calculations, mathematical logic in describing their phenomena." Currently, there are many efforts to document the importance and value of STEM technology, as well as its use in education, but only a few of them are aimed at transforming STEM education using ICTs. It is worth noting that in the learning process, the tasks of STEM education are:

- formation of skills for solving complex practical problems;
- critical thinking, creativity and cognitive flexibility, organizational and communication skills;
- the ability to assess problems and make decisions, readiness for an informed choice and development of a future profession;
- general cultural, technological, communicative and social competencies, mathematical and natural science literacy;
- comprehensive development of the personality by identifying its inclinations and abilities;
- mastering the means of cognitive and practical activity (Baymakanov, 2021: 40–48).

Thus, strengthening the role of STEM education is one of the priorities for the modernization of education, an integral part of state policy to increase the level of competitiveness of the national economy and human development capital, one of the main factors of innovation in education that meets the requirements of the economy and the needs of society. Thus, the use of information and communication technologies in the process of STEM education in Kazakhstan is important and is becoming more widespread. Here are a few aspects that demonstrate the active use of ICT in STEM education in Kazakhstan:

- Integration of ICT into curricula. Kazakhstan is actively working on the integration of ICT into STEM curricula. This includes the use of computer programs, interactive educational platforms, web resources and online courses, specialized software and hardware such as 3D printers and robotics.
- virtual and distance learning. In light of recent events such as the COVID-19 pandemic, the use of ICTs has become even more relevant to ensure access to

education. Kazakhstan is actively working on the development of virtual and distance learning using online platforms, video conferencing systems and specialized educational resources.

- project work and collaboration. With online tools for project collaboration, communication, and exchange of ideas, students can develop teamwork, critical thinking, and problem-solving skills.

- preparation for a future career. Technologies such as artificial intelligence, the Internet of Things, big data, and automation are becoming more prevalent in various industries. The use of ICT in STEM education allows students to understand and apply these technologies, as well as develop skills to adapt to a rapidly changing technological environment.

- Fostering innovation and technological entrepreneurship. ICTs play a key role in the development of innovation and technological entrepreneurship in Kazakhstan. The use of ICT in STEM education contributes to the development of creative thinking, problem solving and the ability to innovate in students. This helps to create a favorable environment for the development of startups and innovative projects, and also prepares young professionals who are ready to introduce new technologies and create their own technology companies (Chao, 2018: 1487–1506).

Research materials and methods

Recent research focuses on the difficulties faced by students in the study of STEM education, as well as teachers in the use of information and communication technologies. This applies to teaching styles, learning approaches, STEM learning strategies, as well as ICT use methods. Research methodology — analysis of literature, study of scientific publications, scientific studies, reports related to the use of ICT in STEM education, as well as experimental work and statistical analysis of the data obtained.

Results and discussion

Information and communication technologies have radically transformed the educational space, qualitatively changed the environment, opened up new opportunities and became a basic backbone factor in the development of education. And this is not only the use of electronic classes through applications (such as Classroom, Online-mektep, Universe, ZOOM), but also many creative opportunities. It's no secret that the use of QR codes, augmented and virtual reality is now becoming popular. At availability of available technologies, it is not difficult to master and use them (Gordeeva, 2022). Augmented reality technology promises to be no less common in education. Mobile applications are pleasing with their diversity. Augmented reality (AR) technologies are able to project digital information (images, video, text, graphics) outside the screens of devices and combine virtual objects with the real environment. Virtual reality (VR) with the help of a 360° image takes the student to an artificial world where the environment is completely changed. Teachers can use virtual and augmented reality to interact with students with various objects in three-dimensional space. Thanks to the knowledge and skills gained during self-education and advanced training courses, teachers introduce students to new trends

in education: QR code, cloud services, electronic testing, learn to create electronic textbooks and deepen their knowledge in the field of STEM.

Thus, the model for the implementation of STEM education with the use of ICT has become its own "formula for success", which helps to stimulate students to independent and creative activities, ensures the involvement of "atypical" forms of work. State-of-the-art tools:

- online tests;
- online Olympiads;
- Google apps;
- Microsoft Education features;
- educational platforms help to motivate, increase the interest of students, consolidate time in the classroom and are excellent helpers for teachers in preparing for the lesson.

The use of information and communication technologies (ICTs) in education has changed traditional methods of teaching and learning, opening up new opportunities and perspectives for both educators and students. ICTs encompass a wide range of digital tools, devices and applications that facilitate the creation, storage, retrieval and dissemination of information. Some of the main uses of ICT in education are listed below:

- Access to information: The Internet has revolutionized access to information, making it easily accessible to both students and teachers. With just a few clicks, students can access a wealth of knowledge from online resources, e-books, digital libraries, and educational sites. This access to information helps students gain a deeper understanding of subjects, conduct research, and stay up to date with current information.

- Active learning: ICTs provide active learning that engages learners in active participation. Multimedia assets such as video, animation, simulations, and virtual reality enhance comprehension by presenting complex concepts in a visual and interactive way. These resources respond to a variety of learning styles, allowing students to comprehend concepts at their own pace and in ways that suit their individual preferences.

- Collaboration and communication: ICTs facilitate communication and collaboration between students and teachers across geographical boundaries. Online platforms, discussion forums, and virtual classrooms allow for real-time interaction, exchange ideas, and collaborative learning. Students can engage in group projects, participate in online debates, and receive timely feedback from their peers and teachers. This collaborative environment fosters teamwork, critical thinking, and problem-solving skills.

- Personalized learning: ICTs allow you to personalize the learning experience to meet the individual needs of students. Adaptive learning systems and intelligent tutoring systems use analytics and algorithms to assess student performance, identify their strengths, weaknesses, and provide targeted learning. This personalized approach ensures that students receive the support and resources they need to maximize their learning potential.

- Assessment and feedback: ICTs offer innovative assessment methods that go beyond traditional exams and tests. Online assessment tools, learning management systems, and automated grading systems simplify the assessment process by providing immediate feedback to students. This feedback helps students track their progress, identify areas for improvement, and make adjustments to their learning strategies.

- Professional development: ICTs have become essential tools for professional development in education. Educators can access online courses, webinars, and educational resources to improve their teaching skills, learn about new pedagogical approaches, and stay up-to-date with the latest research and developments in their field. Online communities and social media also provide platforms for educators to communicate, collaborate, and share best practices.

While ICTs have revolutionized education, it is important to ensure equal access to technology and address the digital divide. Efforts must be made to provide the necessary infrastructure, internet connectivity and learning so that all students and teachers can benefit from ICT in education. Thus, the main conditions for the development of STEM education in educational institutions with ICT integration are:

- development of values to achieve a common goal;
- team and leaders;
- STEM education model;
- plan for the development of STEM education;
- learning and gaining new experience;
- expanding the circle of like-minded people and presenting the results.

Thus, the model for the introduction of ICT in STEM education in secondary and higher education institutions is presented in Figure 1.

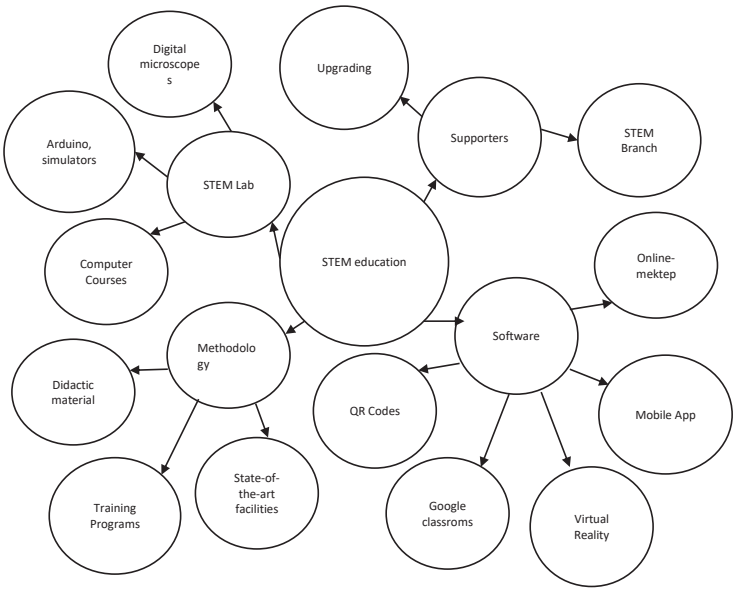

Figure 1. A model for implementing ICT in STEM education

For the systematic implementation of ICT in STEM education in institutions, it is necessary:

- to study the approaches and features of modern STEM education;
- implement a policy of transformation of the institution with the help of STEM and ICT integration;
- develop an implementation strategy and plan;
- determine resource provision and indicators.

One of the most important components of the model for the use of ICT in the process of STEM education is the formation of a circle of like-minded people among the administration, teachers, students and their parents, including through advanced training of teachers (participation in webinars, trainings, competitions, Olympiads) (Ivanov, 2019: 24–30). Thus, information and communication technologies act in STEM education both as a subject of study and as a means of teaching. Therefore, the creation of a unified information and educational environment that ensures the management of the educational process, the exchange of ideas and thoughts, and joint work on projects is a prerequisite for the implementation of STEM in an educational institution. Such an environment for the use of ICT in STEM education includes:

1. STEM laboratories with appropriate equipment (computers, tablets, electron microscopes, 3D printers, robotic constructors and platforms, etc.).
2. Software (distance learning systems, mobile applications, augmented and virtual reality applications, electronic educational resources, cloud environments, etc.).
3. Methodological support (methods, forms, teaching aids: textbooks, manuals, didactic materials, etc.).

In addition, changes should occur in all areas of the educational institution:

- creation of infrastructure;
- content and assessment of students' achievements;
- teacher training;
- ensuring continuous monitoring.

Teachers should prepare students not just for tests, not for assignments, but for a successful future. The challenge for many was distance learning, which forced them to quickly adapt to work in the digital world. Teachers also faced the question of remote work on an individual trajectory, the search for tools that allow them to become remote assistants for students, support the educational process and increase motivation to work. It is believed that the teacher plays a crucial role in the educational process. Therefore, the improvement of the education system should begin with the training of future teachers. Teachers should be trained according to the methods that they will use in their future work (Maimataeva et al., 2022: 1647–1654). It is possible to imagine the following stages of conducting a lesson using ICT in STEM education.

Table 1. Exemplary use of ICT at different stages of the lesson

№	Stages of the lesson	ICT Use Cases
1	Assimilation of new knowledge, development of skills	Audio and video fragments, sound recordings, electronic presentation

2	Generalization or systematization of knowledge	Interactive game, educational games
3	Application of knowledge and skills	Software Training Tasks
4	Assignment control	The use of software that provides interactive exercises and activities, such as: - game "Selection" - tasks based on multiple choice (4 types of tasks). - filling in the gaps. -juxtaposition. -crossword. - restoration of the logical sequence. - restoration of classification. - open-ended questions.
5	Knowledge control	Testing software, online didactic materials

A specialized STEM education course should be based on the use of ICT during lectures, seminars and practical exercises of active learning methods:

- non-imitation (problem lectures and seminars, discussions);
- simulation (analysis of specific situations and solving pedagogical problems, using software, preparing tasks, tests, crosswords).

The topics of the lectures should be developed with the aim of providing theoretical knowledge and developing practical skills related to the use of ICT in the classroom. It goes without saying that teachers use a variety of digital resources to help students explore and learn, support classroom collaboration, and conduct formative assessment. They also use the internet and webinars to help students deepen their knowledge on specific topics. This means that technology has changed the way we teach and learn. The use of technology in science can be divided into four broad areas (Table 2).

Table 2. Classification of ICT use in STEM

Data processing	Information	Communication	Practical study
-data logging. -Spreadsheets. - charting tools.	-Internet.	- online means of communication (Zoom, Skype, Classroom, Teams). -collaboration	-simulation. -simulation.

The classification determines that technologies such as computers, data collection and analysis software, digital microscopes, multimedia, student response systems, and interactive whiteboards can help students actively participate in the acquisition of scientific knowledge and the development of the nature of science. Classic STEM ways of teaching and learning certainly attract learners as members of the digital generation, for whom learning takes place through the intuitive application of technology in everyday life. It is possible that the use of such technologies makes learning students more interesting, effective and of high quality. Since science is necessary for understanding how the world works, the use of technology in the development of STEM can be considered as the formation of scientific literacy in the following five stages (Figure 2).

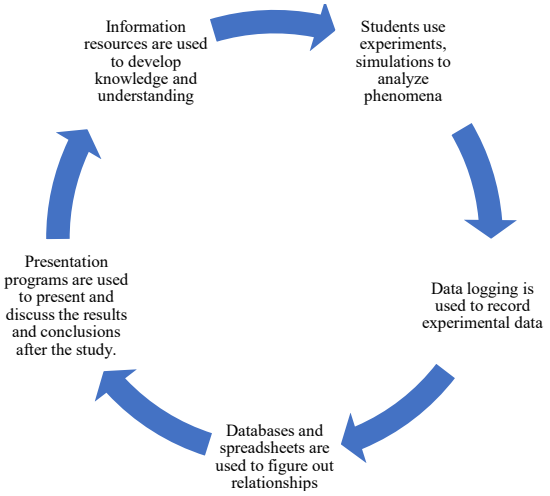

Figure 2. The Five Phases of Using ICT for STEM Learning

Within the framework of the above data, experimental work was carried out. Thus, in the experimental work, an assessment of the use of ICT in the process of STEM education in the experimental classroom was carried out. The control and experimental classes are shown below:

1. Control class - 9 "A".
2. Experimental class - 9 "B".

The initial test takes 40 minutes for each class. Thus, having received the first results after testing, we analyzed them and considered them according to a given criterion. We calculated the average values of the correct answers of students for each item and obtained the following data.

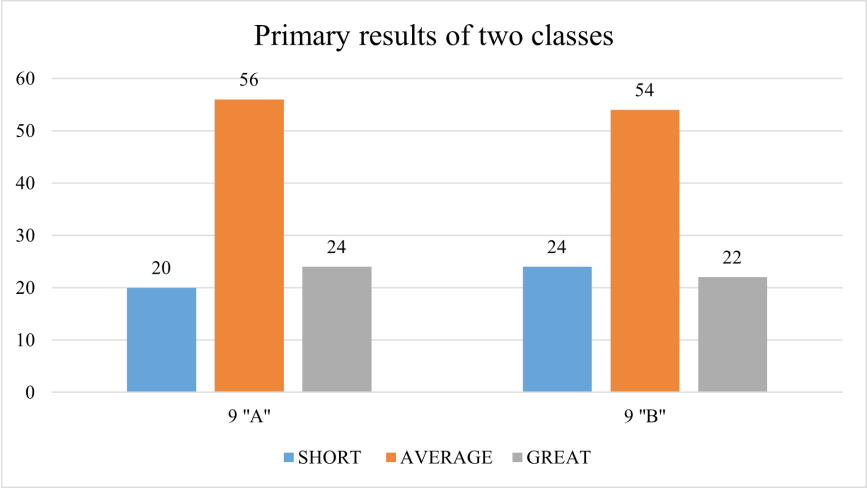

Figure 3. Primary test results

The result of this stage showed that the majority of students (control and experimental classes) had a lower level of knowledge before they were able to work on the application of ICT in STEM education:

- 24 % (control) and 22 % (experimental).
- 56 % (control) and 54 % (experimental).
- 20 % (control) and 24 % (experimental).

In the course of experimental work, students actively work on the platform, compete with each other, arrange competitions between classes, in addition to grades, they have the opportunity to receive awards. It's nice that parents and teachers are also interested in the resource. For example, mathematics teachers have begun to actively use platforms such as Geogebra (for students in grades 7–11) and Matific (a digital math platform developed by education professionals) to help implement the practical application of knowledge in an interesting and informative way. GeoGebra is not just a free dynamic geometric environment (Petrova, 2017: 142–147). The use of this tool makes complex drawings interesting and understandable, "dry" mathematical processes - turns into almost scientific work. Students especially like working with three-dimensional scenes, the ability to "explore" objects in full. A rather complex topic becomes more accessible, it saves time for understanding and helps in the application, acquisition of skills. In addition, the training platform "Online-mektep" provides three ways to use:

- assigning tasks and tracking successes;
- individual themes;
- use of planned tasks.

The system allows you to work not only with interesting, interactive tasks, but also to move your own learning trajectory. There is a good motivation system, so students not only work in the classroom, do homework (15–20 minutes), but also conquer bonus missions, find time for additional work, which brings success. "Matific" uses game-based principles to encourage students to learn through discovery, and has tools for teachers, including worksheets, lesson plans, and real-time reports. The program is available not only online, but also offline.

After the application of ICT in the teaching of the experimental class, based on the implementation model, testing was carried out to study the differences in the level of knowledge of students in grades 9 "A" and 9 "B". Testing to identify and develop the level of knowledge formation was carried out according to the same tasks as at the preliminary stage. The result is analyzed below.

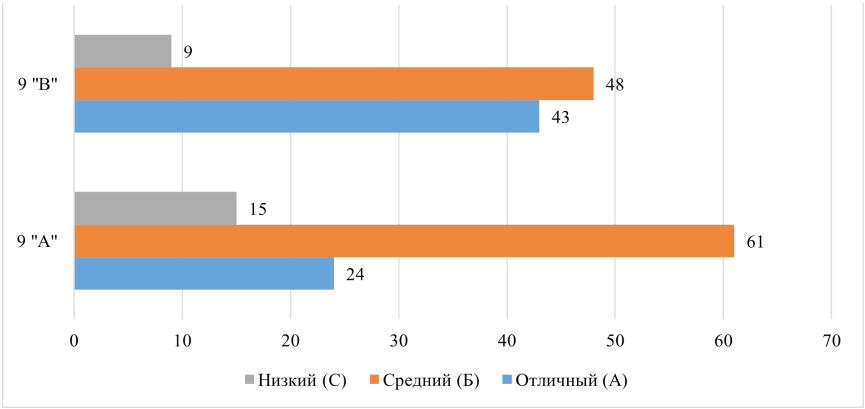

Figure 4. Results of final testing of control and experimental classes

Thus, we see a qualitative increase in knowledge in the experimental class 9 "A". Comparing the criteria, we found growth according to the given criteria:

- the experimental class (9 "B") in the assessment of "A - excellent) leads by 19 %.
- in the assessment "C – low" leads due to reductions in the percentage of students lagging behind by 6 %.

Educational technology is now an integral part of STEM education, and the creativity of teachers will continue to expand the use of ICT to achieve many of the learning and education goals facing their profession. Further harnessing the potential of ICT requires an adequate mix of resources, technical support and classroom management strategies (Sumatokhin, 2011: 17–271). The development of existing and promising ICT tools also requires teachers to change their views on the use of ICT in education, and continuous professional development in the use of ICT in education is facilitated by various ICT tools (Turganbayeva, 2019: 232–239). Based on the experiment, we propose five goals for using ICT in STEM education:

1. STEM education – technology can have a profound impact on STEM education, in particular, it can contribute to the rethinking of STEM pedagogy.

2. STEM skills such as collaboration, argumentation, experimentation, data collection, presentation of results, etc., can be facilitated by ICT tools.

3. The growing variety of application programs available requires students to be proactive, creative, and think originally, understand, and apply — all of which are the main goals of STEM education.

4. ICT tools exert complex critical pressures on the teacher's role as educators and their qualifications.

5. Students should take advantage of their native status in the ICT world for a deeper study of STEM subjects and methods. Due to the recent growth of mobile devices, students are forced to use technology for learning activities.

Thus, collaborative and online learning technologies open up great opportunities for students and teachers to learn throughout life. In addition, when using ICT tools in STEM education, it is recommended to:

- provide STEM teachers with pedagogical training, including the use of ICT in pedagogy;

- ensure students have sufficient access to appropriate technology tools to support STEM learning;

- think about what the technical component should look like when creating new STEM laboratories;

- Give teachers and students autonomy to choose the most appropriate ICT-based tools for STEM according to their own teaching and learning styles.

In addition to the technologies listed in the work, we can note a few more examples of real technologies that are widely used in STEM education:

1. Arduino. Arduino is an open-source electronic platform that allows students to create and program interactive projects by combining hardware and software to learn electronics, programming, and robotics.

2. Vernier sensors. Vernier sensors are data acquisition devices that measure and record data on various scientific parameters such as temperature, light intensity, pH, and motion. They are used in experiments and data analysis on STEM subjects.

3. Geographic Information Systems (GIS). GIS technology allows students to analyze and interpret spatial data, create maps, and explore geographic patterns and relationships, which contributes to the study of geography, ecology, and urban planning.

4. Virtual Reality (VR) and Augmented Reality (AR): VR and AR technologies provide an immersive learning experience that increases the effectiveness of learning STEM subjects. Students can explore virtual environments, conduct virtual experiments, and visualize complex concepts in a more interactive and engaging way.

5. Computer-aided design (CAD) software: CAD software allows students to create and design digital models of objects, buildings, or mechanical systems, providing a foundation for teaching engineering, architecture, and design.

6. Data logging systems: Data logging systems allow students to collect and analyze real-time data from sensors, experiments, and fieldwork. They facilitate the study of scientific phenomena and the application of data analysis methods.

7. Online Learning Platforms: Online learning platforms such as Khan Academy, Coursera, and edX offer a wide range of STEM courses and resources, providing opportunities for self-paced learning, skill development, and learning about STEM topics.

8. Mobile Apps: Numerous mobile apps are designed for STEM education, offering interactive learning experiences, science experiments, coding and simulation challenges that can be accessed on smartphones and tablets.

These are just a few examples of real-world technologies used in STEM education. The field of STEM education is constantly evolving, and new technologies are constantly emerging to offer innovative ways to engage students and enhance their learning in science, technology, engineering, and mathematics.

Conclusion

In conclusion, we note that STEM teaching using ICT places the demands of the XXI century on teachers, and knowledge, experience and motivation can be considered as one of the key factors that plays a significant role in the integration of

technology into the classroom. In fact, technology is just a tool, and its meaningful use depends on the teacher. The use of ICT in STEM education in Kazakhstan contributes to the creation of an innovative educational environment, where students can actively participate in project work, collaboration and practical tasks. They get the opportunity to apply the acquired knowledge and skills in practice, work with modern technologies, model and experiment, as well as develop programming and data analysis skills. By harnessing the power of technology, educators can create dynamic learning environments that help students become active learners, critical thinkers, and global citizens. Based on our research in the Kazakh education system, we can identify some recommendations and directions for action on the component of the use of ICT by STEM teachers and their students:

- First, there is a need to expand the use of digital resources and tools in STEM education activities, as a way to stimulate in-depth learning and the acquisition of twenty-first century skills, such as problem solving, analysis, evaluation and critical thinking, collaboration, creativity.

- secondly, should increase access and interaction with certain scientists (researchers, inventors, theorists) and become familiar with the tools they use. This can be a direct way, through visits to institutes and research centers of innovative development, as well as indirectly with the help of technologies - video conferencing, webinars, filling common databases with local information, etc.

- third, the need for a systematic and well-organized approach to empowering teachers in STEM education, integrating the use of technology, confronting and reinforcing teachers' attitudes and beliefs with the reality of students, schools, higher education institutions and the community. This can be transferred to a STEM teacher training and professional development strategy based on transformational learning, impacting authentic STEM learning and careers.

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