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DEVELOPMENT OF DIGITAL COMPETENCIES OF PRIMARY SCHOOL STUDENTS

Abstract

The article examines the content, structure, and pedagogical conditions necessary for the development of digital competence among primary school students. The rapid growth of information technologies has a strong impact on education, making the acquisition of digital literacy and the ability to act effectively in a digital environment an urgent task. The purpose of the study is to clarify the structural components of digital competence and to determine pedagogical conditions that ensure its successful formation in the early stages of schooling. The research methodology includes comparative analysis of national and international studies as well as experimental work with control and experimental groups. The study identifies the key elements of digital competence: information, communication, technical, and ethical-legal literacy. Based on the experience of countries such as Finland, Estonia, Singapore, and South Korea, several international models for the development of digital competence are analyzed. The findings highlight essential pedagogical conditions such as systematic use of ICT tools, interdisciplinary integration, age-appropriate task design, and fostering digital ethics and online safety. Among the effective methods proposed are game-based learning, STEM/STEAM approaches, and the use of digital portfolios. The results demonstrate that the suggested approaches significantly enhance the level of digital competence among primary school students. The conclusions may serve as a basis for improving educational programs and provide teachers, methodologists, and researchers with scientifically grounded strategies for integrating digital competence into teaching practice.

Key words: digital competence, digital tools, primary class, ICT, digital literacy, digital security, educational technologies.

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БАСТАУЫШ СЫНЫП ОҚУШЫЛАРЫНЫҢ ЦИФРЛЫҚ ҚҰЗЫРЕТТІЛІКТЕРІН ДАМУЫ

Аңдатпа

Бұл мақалада бастауыш сынып оқушыларының цифрлық құзыреттілігін қалыптастыруға қажетті мазмұн, құрылым және педагогикалық шарттар ғылыми тұрғыда негізделген. Ақпараттық технологиялардың жедел дамуы білім беру жүйесіне айтарлықтай әсер етіп, оқушылардың цифрлық сауаттылығын дамыту мен оларды цифрлық ортада тиімді әрекет етуге үйрету өзекті міндетке айналды. Зерттеудің негізгі мақсаты – бастауыш мектеп деңгейінде цифрлық құзыреттіліктің құрылымдық компоненттерін нақтылау және оны қалыптастырудың педагогикалық шарттарын анықтау. Зерттеу барысында отандық және шетелдік ғылыми еңбектерге салыстырмалы талдау жүргізіліп, бақылау және тәжірибелік топтардың қатысуымен

эксперименттік жұмыс жүзеге асырылды. Автор цифрлық құзыреттіліктің негізгі құрамдас бөліктерін айқындайды: ақпараттық, коммуникативтік, техникалық және этикалық-құқықтық сауаттылық. Финляндия, Эстония, Сингапур және Оңтүстік Корея секілді елдердің тәжірибесіне сүйене отырып, цифрлық дағдыларды дамытуға бағытталған халықаралық үлгілер мен тәсілдер қарастырылған. Зерттеу нәтижелері бойынша цифрлық құзыреттілікті дамытуға ықпал ететін бірқатар педагогикалық шарттар айқындалды: ақпараттық-коммуникациялық технологияларды жүйелі пайдалану, пәнаралық ықпалдастық, жас ерекшелігіне сай тапсырмаларды бейімдеу, сондай-ақ цифрлық этика мен қауіпсіздік мәдениетін қалыптастыру. Тиімді құралдардың қатарында ойын технологиялары, STEM/STEAM элементтері және цифрлық портфолио әдістері ұсынылады. Алынған деректер аталған тәсілдердің тиімділігін дәлелдеп, нәтижелерді білім беру бағдарламаларын жетілдіруде және мұғалімдерді даярлау тәжірибесінде пайдалануға мүмкіндік береді.

Түйін сөздер: цифрлық құзыреттілік, цифрлық құралдар, бастауыш сынып, АКТ, цифрлық сауаттылық, цифрлық қауіпсіздік, білім беру технологиялары.

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РАЗВИТИЕ ЦИФРОВЫХ КОМПЕТЕНЦИЙ УЧАЩИХСЯ НАЧАЛЬНЫХ КЛАССОВ

Аннотация

Статья посвящена обоснованию содержания, структуры и педагогических условий формирования цифровых компетенций у младших школьников. Ускоренное развитие информационных технологий оказывает значительное влияние на систему образования, что актуализирует задачу развития цифровой грамотности и способности учащихся эффективно действовать в цифровой среде. Цель исследования заключалась в уточнении структуры цифровой компетентности и определении педагогических условий её формирования на начальной ступени обучения. В работе использованы методы сравнительного анализа отечественных и зарубежных научных источников, а также экспериментальное исследование с участием контрольной и экспериментальной групп. Автор выделяет ключевые компоненты цифровой компетентности: информационную, коммуникативную, техническую и этико-правовую грамотность. На основе международного опыта (Финляндия, Эстония, Сингапур, Южная Корея) описаны модели и подходы к развитию цифровых навыков. В результате определены эффективные педагогические условия: системное использование ИКТ, межпредметная интеграция, адаптация заданий к возрастным особенностям, формирование цифровой этики и культуры безопасности. В качестве действенных инструментов предложены игровые технологии, STEM/STEAM-практики и цифровое портфолио. Полученные данные подтвердили эффективность применения данных условий и подходов, что позволяет рекомендовать результаты исследования для совершенствования образовательных программ и практики подготовки педагогов.

Ключевые слова: цифровая компетентность, цифровые инструменты, начальная школа, ИКТ, цифровая грамотность, цифровая безопасность, образовательные технологии.

Introduction. The digital age is marked by rapid development of innovative technologies and new means of communication. It has brought an explosion of data and improved our ability to process it. New technologies are changing not only how people communicate and interact socially, but also

impacting individual personalities. Digitalization has triggered significant changes in the labor market. These include online work, distance learning, trading through digital applications, quick access to documents via online services, electronic libraries, and digital transformation of education [1].

Kazakhstan's strategy to join the world's 30 most developed countries emphasizes the creation of research centers. These centers will focus on robotics, mobile technologies, cloud and Grid computing, artificial intelligence, high-performance computing systems, information protection, security, and multimedia technologies [2].

The role of digital technologies in education continues to grow daily. Since the 21st century is the era of the information society and digital transformation, developing students' digital competence has become a key educational goal. Early education is especially important, as it lays the foundation for a child's personal development and information culture. Developing digital competence at this stage helps children function effectively in modern society [3].

Digital competence is more than just the ability to use computer tools. It encompasses a broad set of skills, including searching for information, processing and critically evaluating it, using the internet safely, adhering to ethical norms in digital environments, and effectively working with various devices [4]. UNESCO highlights digital competence as a vital 21st-century skill and stresses the importance of cultivating it from a young age [5].

In Kazakhstan, integrating digital educational resources and ICT tools into classrooms is a key part of updating secondary education content. This is a specific requirement for primary school teachers [6]. Therefore, it is important to define effective approaches for developing students' digital competence. Pedagogical support and the influence of family and social environments must also be considered.

This article explores the content, significance, and pedagogical conditions for forming digital competence in primary school students. It also analyzes methods and modern educational technologies that support this development.

Materials and methods. Digital competence refers to an individual's ability to use digital technologies effectively, safely, and responsibly. It includes not only basic ICT knowledge and skills but also the capacity for independent thinking, critical evaluation of information, creative decision-making, and social responsibility (see Table 1) [8].

Table 1. *Content analysis of the concept of «digital competence»*

№	Full name of the scientist	Reference
1	Khakimova T.	Digital competencies - the culture and skills of using information technologies along with the use of computer technology [1].
2	Akhmetova G.	Digital competence is the ability to own information and communication technologies and apply them in educational, creative and social relations [3].
3	Mukhanbetzhanova S.	Digital competencies - technological knowledge of primary school students aimed at developing information literacy [11].
4	Muratova M.	Digital competence is the ability to own information technologies and effectively act in a digital environment [10].
5	Sokolova L.	Digital competence is the ability to search, process, store and safely use digital information with social and communication skills [21].
6	Ivanova A.	Digital competence is the ability of an individual to effectively and safely use information and communication technologies [22].
7	Elland N.	Digital competence is a child's ability to learn and interact through play in a digital environment, an important factor in the educational process [15].
8	Eshet-Alkalai E.	Digital competence is a set of skills in search, assessment, application of information and effective use of digital technologies [7].
9	Ferrari A.	Digital competence - discovery, evaluation, creation and communication capabilities of information using digital technologies [8].
10	Ermer P. and Ottenbreit-Leftwich A.	Digital competencies - the abilities of teachers and students based on knowledge, reliability and confidence in the application of technology7

In the development of digital competencies, the leading countries - Finland, Estonia, Singapore, South Korea and Australia - are introducing a systematic digital educational strategy, starting from the level of primary education, and accordingly training teaching staff. In the practice of these countries, special attention is paid to such competencies as digital literacy, programming fundamentals, logical thinking and personal information security in accordance with the age characteristics of students.

In Finland, digital technologies are integrated into general education content. Digital competence is not included in the school curriculum as a separate subject, but an integrated approach applied in the disciplines. Teachers are offered special modules and are trained to effectively integrate technology into the learning process [18]. - Within the framework of the program "Program Tiger") learn the basics of coding, algorithmic thinking, robotics. The program has been implemented since 2012 and covers from preschool organizations to high school. In elementary school, students learn their first digital skills using tools such as Bee-Bot, LEGO WeDo, Scratch Jr., Code.org. This program is fully provided not only for students, but also with courses, webinars and digital materials for teachers [14].

In Singapore, the Cyber Wellness and ICT Master Plan programs will be implemented to develop digital competence. These programs cover not only the development of technologies by children, but also such areas as digital ethics, psychological safety, and the culture of online communication. In primary schools in Singapore, interactive classes for students, distance learning manuals, and virtual laboratories are widely used [11]. In general, international experience shows that the development of digital competencies in developed countries is considered not only as a subject education, but also as a tool for educating a student as a full-fledged member of the information society.

In recent years, the Republic of Kazakhstan has paid special attention to the digital transformation of education. Within the framework of the state program "Digital Kazakhstan," implemented in the period from 2018 to 2022, concrete steps were taken to provide educational organizations with broadband Internet, equip them with multimedia devices, and introduce digital educational resources [17]. The task of forming digital competencies within the framework of updating the content of education was reflected in the updated curricula. In grades 1-4, the subject "Informatics" is taught from grade 3. In addition, all disciplines provide a methodology for the effective use of ICT tools and the integration of digital literacy elements [19].

Domestic platforms such as BilimLand, Twig-Bilim, Kundelik.kz, Daryn.online, iTest, EduMarket offer interactive classes for teachers and primary school students, video explanations, test tasks, animations, virtual laboratories. These platforms serve as an effective tool for homework, distance learning, additional education and building an individual learning trajectory.

For example:

- BilimLand - presents more than 5,000 videos in Kazakh and Russian for grades 1-4 [23].
- Kundelik.kz is a single educational platform that provides digital communication between the teacher and parents, the student and the school administration [25].
- Daryn.online - offers digital courses to prepare for Olympiads and competitions [26].
- Twig-Bilim - provides scientific videos and a database of assignments in accordance with international standards [24].

In addition, Kazakhstan is working to increase the digital competence of teachers through professional development courses such as Digital Teacher.

The digital competence structure consists of several components:

- Information competencies - ability to search, sort and process information;
- Communication competencies - the ability to effectively interact with digital media;
- Technical competencies - skills in working with digital devices and programs;
- Ethical and legal literacy - compliance with safety rules and copyright rules on the Internet [7].

The primary school stage is the best time to lay the basis of competency data. Because children of this age have a high cognitive interest, they quickly assimilate new information and tend to learn through practical actions [11].

The following pedagogical conditions are important for the effective formation of digital competencies among primary school students:

a) systematic application of ICTs

Targeted and systematic use of digital resources and interactive tools (for example, interactive whiteboard, digital tasks, multimedia presentations) not only increases the motivation of students to study, but also contributes to the formation of their digital skills [12].

b) Integrated learning approach

It is necessary to develop digital competencies, integrating them not only in computer science, but also in language, natural sciences, and mathematics. For example, the use of electronic dictionaries in Kazakh language lessons, digital math exercises, online research in cognition lessons are examples of an integrated approach.

b) Student age assignments

Digital tasks for elementary students should be simple, based on game elements, rich in visual materials. This arouses their cognitive interest and increases their interest in working in the digital environment [10].

c) Digital security and ethics training

Warning students from threats on the Internet (for example, phishing, cyberbullying) and teaching norms of behavior on the network are an important component of the formation of digital competence. In elementary school, this knowledge should be transmitted in a simple form, understandable for the child, through play or video recording [9].

The primary school teacher is the main figure guiding the student to the first acquaintance with the digital world. The teacher himself must be a competent specialist who knows digital technologies, modern teaching methods. In addition, partnership with parents allows the child to properly use digital means even in an extracurricular environment [13].

Digital competence as a pedagogical category in education has been widely studied over the past decade. Its content is related not only to technical literacy, but also to the formation of the student's personal, cognitive and social skills. This competence includes the following aspects:

- Digital creativity - the student's ability to express his thoughts in a digital environment in visual, text, sound form;
- Critical thinking and media literacy - analysis of information obtained from the Internet, recognition of false information;
- Cyberculture and ethics - compliance with the norms of behavior on the network, submission to ethical rules;
- Digital self-education - the ability to self-develop using online resources [20].

These competencies are beginning to take shape in primary school students and affect their lifelong educational trajectory.

Methodical approaches to the development of digital competence in elementary school

a) Development through gaming technology

Primary school play is a leading activity. Therefore, in the formation of digital competencies, elements of gamification are effectively used (digital quizzes, interactive games, video tasks). For example, platforms such as Kahoot, Wordwall, LearningApps increase student interest and make them active digital users.

b) STEM and STEAM integration

The organization of entry-level design and research work in the areas of STEM (Science, Technology, Engineering, Mathematics) and STEAM (A - Arts) forms the technological thinking of students. For example, simple robotics for students in grades 3-4, the Scratch programming environment - develops their skills in interacting with the digital world [15].

b) Digital portfolio and reflection

The digital portfolio system, which allows you to summarize and analyze the achievements of each student in digital format, creates the conditions for a responsible attitude of the student to his training.

Platforms such as Google Sites, Padlet or Seesaw allow you to develop digital thinking, student creativity.

In the Kazakhstani context, several barriers limit the development of digital competence:

- unequal access to high-speed Internet between urban and rural areas;
- insufficient provision of schools with modern devices;
- varying levels of teacher digital literacy [9].

Another important aspect is digital safety and ethics, which, according to experts, should be taught from primary school age in an adapted form (through games, cartoons, role-playing tasks). However, in Kazakhstan these issues are often presented formally, without practical application.

In addition, new challenges such as AI literacy and data protection have become relevant after the COVID-19 pandemic, when distance learning accelerated the use of online services. Currently, Kazakhstani curricula rarely include these aspects, which creates risks of unpreparedness of children for the digital environment of the future [10].

Results and discussions. Student responses were classified as high, medium, or low level according to predefined rubrics. Statistical processing included descriptive analysis and to check the significance of differences between groups. Digital competence in this research is understood not only as technical literacy, but also as a set of skills that include:

- information search and critical evaluation,
- safe and ethical use of the Internet,
- communication and collaboration with digital tools,
- creativity and problem solving with the help of technology.

The study was conducted in one of the secondary schools of Almaty in 2025. Two 4th-grade classes were selected: experimental group (n = 23) and control group (n = 25). Selection was based on the principle of convenience sampling, which is a limitation of the study. Randomization was not carried out, which reduces the representativeness of the results, but allows identifying initial trends.

A diagnostic survey was developed, consisting of 10 closed-ended and situational questions, validated by three experts in pedagogy and ICT education. The questions covered three main criteria:

1. Ability to use the Internet (e.g., “How do you search for information for homework?”);
2. Awareness of digital tools (e.g., “Which digital platforms do you know and use?”);
3. Practical application of digital technologies (e.g., “Can you create a presentation or document without the help of adults?”).

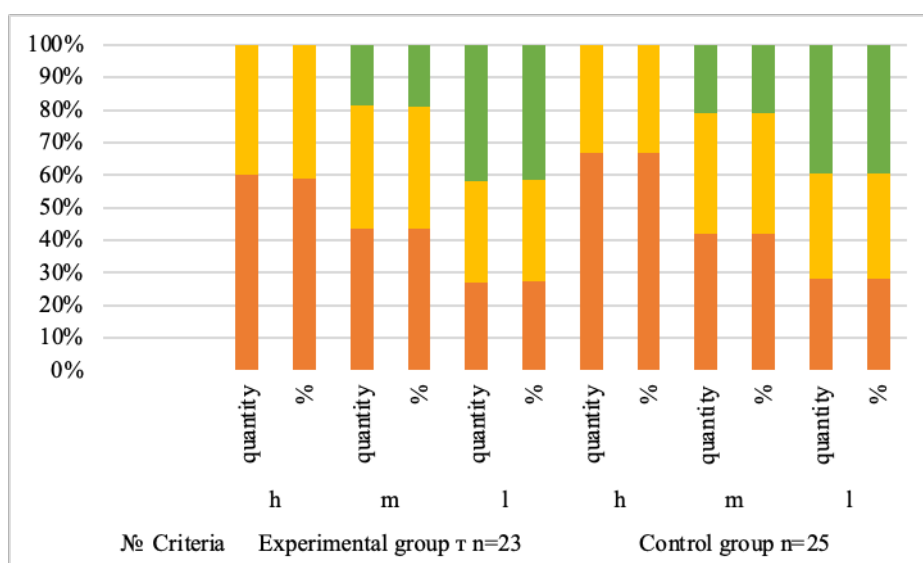


Figure 1: Survey result indicators

According to the first criterion, out of 23 students in the experimental group, 13% showed a high level, 30% - medium, 57% - low. According to the second criterion, 9% of the total number of students showed a high level, 26% - average, 65% - low. According to the third criterion, the high level indicator for all classes is 0%, and the average - 13%, low - 87%. According to the first criterion, out of 25 students in the control group, 8% showed a high, 32% - an average, 60% - a low level. According to the second criterion, 4% of the total number of students showed a high level, 28% - average, 68% - low. According to the third criterion, the high level indicator for all classes is 0%, and the average - 16%, low - 84%.

In the analysis of the survey results, 65% of the students in the experimental group showed that they knew about digital tools, while in the control group this figure was 68%. However, the proportion of students who know how to use digital means turned out to be quite low. In the experimental group, this indicator is only 13%, in the control group - 16%. The proportion of students who cannot use digital media at all was high in both study groups and showed 87% and 84%, respectively. These data show that while students' digital competencies are generally satisfactory, the ability to put them into practice is extremely low. The results of the survey showed that for the effective implementation of digital technologies in the process of primary education, it is necessary to develop not only digital knowledge, but also the practical skills of students.

Conclusion. The development of digital competencies of primary school students is one of the main directions of the educational process of the XXI century. The concept of digital competence is broad and comprehensive, in addition to mastering information and communication technologies, includes critical thinking, ethical compliance, creativity and the ability to educate oneself.

It is important to systematically apply digital technologies in the pedagogical process, ensure integration between disciplines and implement methodological approaches in accordance with the age characteristics of students. In addition, digital security and Internet ethics training is a necessary component for regulating student behavior in the digital space.

The results of the study show that while primary school students have a basic understanding of the application of digital tools, the ability to effectively use these technologies in practice is still at a low level. This indicates the need for systematic and targeted pedagogical work in the formation of digital competencies.

The international experience and educational policy of Kazakhstan clearly demonstrate the need to form digital competencies in the initial link. This area will ensure the digitalization and adaptation of the education system in accordance with the requirements of the information society. The development of pedagogical support, teaching aids and the establishment of effective cooperation with parents are the most important conditions for improving the digital literacy of students.

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