

Sh. Turashova^{1*} , K. Seiduali¹ , U. Bazarbayeva¹ ,
Sh. Urazgaliyeva¹ , M. Yersin¹ 

¹ Abai Kazakh National Pedagogical University, Almaty, Kazakhstan

*e-mail: sh.turashova@abaiuniversity.edu.kz

DIGITAL EDUCATIONAL RESOURCES IN TEACHING FUTURE INFORMATICS TEACHERS TO CREATE IOT DEVICES

Abstract

The Internet of Things (IoT) today is not just a technological trend, but a reality that is rapidly changing our lives. Cisco predicts that by 2030, the number of connected devices in the world will increase and reach 500 billion. This means that IoT will become an integral part of the future and the demand for IoT specialists will grow steadily. In this regard, preparing the younger generation for life in the IoT world is becoming a critically important task. The inclusion of IoT issues in the school's Informatics curriculum is an important step towards developing the necessary knowledge and skills for students. However, for the successful implementation of this program, it is necessary to provide schools with competent informatics teachers with not only theoretical knowledge, but also practical skills in the field of IoT. This will ensure high-quality education for students, prepare them for life in the IoT world and contribute to the development of this promising area of technology. To improve the effectiveness of teacher training, it is advisable to use modern teaching methods and digital educational resources. However, an analysis of existing scientific and methodological research in the field of teaching Internet of Things technology allows us to note an objectively small number of works devoted to the training of future informatics teachers in the field of IoT, especially in modern conditions of digitalization of education. The purpose of this study is to develop and test a model for teaching future informatics teachers how to create IoT devices as part of interdisciplinary projects based on modern digital educational resources. Research results: as part of an interdisciplinary IoT-based project, an automatic watering system for indoor plants was developed, the most effective digital educational resources and a learning model for creating and developing this IoT device were identified and developed using them. The degree of student satisfaction with the learning process of creating IoT devices using digital educational resources was assessed.

Keywords: digital educational resources, modern learning tools, IoT devices, interactive technologies, multimedia technologies, training of future informatics teachers.

Ш. Тұрашова¹, Қ. Сейдуәлі¹, Ү. Базарбаева¹, Ш. Уразғалиева¹, М.Е. Ерсін¹

¹Абай атындағы Қазақ ұлттық педагогикалық университеті, Алматы қ., Қазақстан

ИОТ ҚҰРЫЛҒЫЛАРЫН ҚҰРУ БОЙЫНША БОЛАШАҚ ИНФОРМАТИКА МҰҒАЛІМДЕРІН ОҚЫТУДАҒЫ ЦИФРЛЫҚ БІЛІМ БЕРУ РЕСУРСТАРЫ

Аңдатпа

Заттар интернеті (IoT) бүгінде тек технологиялық тренд емес, біздің өмірімізді тез өзгертетін шындық. Cisco компаниясының болжамы бойынша, 2030 жылға қарай әлемде қосылған құрылғылардың саны артып, 500 миллиардқа жетеді. Бұл IoT болашақтың ажырамас бөлігі болады және IoT мамандарына сұраныс тұрақты түрде артады дегенді білдіреді. Осыған байланысты, өскелең ұрпақты IoT әлемінде өмір сүруге дайындау маңызды міндетке айналуда. Мектептегі информатика бағдарламасына IoT сұрақтарын қосу-оқушылардың қажетті білім мен дағдыларды қалыптастыру жолындағы маңызды қадам. Алайда, бұл бағдарламаны сәтті жүзеге асыру үшін мектептерді тек теориялық білімі ғана емес, сонымен қатар IoT саласында практикалық дағдылары бар құзыретті информатика мұғалімдерімен қамтамасыз ету қажет. Бұл оқушыларды сапалы оқытуды қамтамасыз етуге, оларды IoT әлемінде өмір сүруге дайындауға және технологиялардың осы перспективалық бағытын дамытуға ықпал етуге мүмкіндік береді. Мұғалімдерді даярлаудың тиімділігін арттыру үшін оқытудың заманауи әдістері мен цифрлық білім беру ресурстарын қолданған жөн. Алайда, заттар интернеті технологиясын оқыту саласындағы қолданыстағы ғылыми-әдістемелік зерттеулерді талдау

IoT саласында, әсіресе білім беруді цифрландырудың қазіргі жағдайында болашақ информатика мұғалімдерін даярлау мәселелеріне арналған жұмыстардың объективті аз санын атап өтуге мүмкіндік береді. Бұл зерттеудің мақсаты болашақ информатика мұғалімдерін заманауи цифрлық білім беру ресурстарына негізделген пәнаралық жобалар шеңберінде IoT құрылғыларын құруға оқыту моделін әзірлеу және сынақтан өткізу болып табылады. Зерттеу нәтижелері: пәнаралық жоба аясында IoT негізінде бөлме өсімдіктерді автоматты суару жүйесі әзірленді, ең тиімді цифрлық білім беру ресурстары және осы IoT құрылғысын жасау процесін оқыту моделі анықталды және әзірленді, оларды пайдалана отырып, цифрлық білім беру ресурстары көмегімен IoT құрылғыларын құруды оқыту процесіне студенттердің қанағаттану дәрежесі бағаланды.

Түйін сөздер: цифрлық білім беру ресурстары, заманауи оқыту құралдары, IoT-құрылғылар, интерактивті технологиялар, мультимедиялық технологиялар, болашақ информатика мұғалімдерін оқыту.

Ш. Турашова¹, К. Сейдуали¹, У. Базарбаева¹, Ш. Уразғалиева¹, М.Е. Ерсин¹

¹ Казахский национальный педагогический университет имени Абая, Алматы, Казахстан

ЦИФРОВЫЕ ОБРАЗОВАТЕЛЬНЫЕ РЕСУРСЫ В ОБУЧЕНИИ БУДУЩИХ УЧИТЕЛЕЙ ИНФОРМАТИКИ СОЗДАНИЮ IoT-УСТРОЙСТВ

Аннотация

Интернет вещей (IoT) сегодня – это не просто технологический тренд, а реальность, которая стремительно меняет нашу жизнь. По прогнозам компании Cisco, к 2030 году количество подключенных устройств в мире увеличится и достигнет 500 миллиардов. Это означает, что IoT станет неотъемлемой частью будущего и спрос на специалистов в области IoT будет неуклонно расти. В этой связи, подготовка подрастающего поколения к жизни в мире IoT становится критически важной задачей. Включение вопросов по IoT в школьную программу информатики – это важный шаг на пути к формированию у учащихся необходимых знаний и навыков. Однако, для успешной реализации этой программы, необходимо обеспечить школы компетентными учителями информатики, обладающими не только теоретическими знаниями, но и практическими навыками в области IoT. Это позволит обеспечить качественное обучение учащихся, подготовить их к жизни в мире IoT и способствовать развитию данного перспективного направления технологий. Для повышения эффективности подготовки педагогов целесообразно использовать современные методы обучения и цифровые образовательные ресурсы. Однако анализ существующих научно-методических исследований в области обучения технологии интернета вещей позволяет отметить объективно малое количество работ, посвященных вопросам подготовки будущих учителей информатики в области IoT, особенно в современных условиях цифровизации образования. Целью данного исследования является разработка и апробация модели обучения будущих учителей информатики созданию IoT-устройств в рамках междисциплинарных проектов на основе современных цифровых образовательных ресурсов. Результаты исследования: в рамках междисциплинарного проекта на базе IoT разработана система автоматического полива комнатных растений, определены и разработаны наиболее эффективные цифровые образовательные ресурсы и модель обучения процессу создания разработки данного IoT-устройства с их использованием оценена степень удовлетворенности студентов процессом обучения созданию IoT-устройств с использованием цифровых образовательных ресурсов.

Ключевые слова: цифровые образовательные ресурсы, современные средства обучения, IoT-устройства, интерактивные технологии, мультимедийные технологии, обучение будущих учителей информатики.

Main provisions

The idea of the research is to develop and test a model for teaching future informatics teachers to create IoT devices using digital educational resources (DER) as part of an interdisciplinary project. As a practical task, an automatic plant watering system based on the Arduino and TinkerCad platforms was implemented. The research used methods of pedagogical design, questionnaires and analysis of digital tools. The results showed that the use of SDG increases the motivation and involvement of students, promotes the formation of practical skills and improves the quality of training of future teachers in the context of digitalization of education.

Introduction

Currently, a new system of higher pedagogical education is being formed, focused on training specialists capable of integrating modern technologies into the educational process. One of the key areas of such training is the training of future informatics teachers to create IoT devices, which requires the use of effective digital educational resources.

Digital Educational Resources (DER) are modern learning tools implemented in digital format [1]. Their use is aimed at improving the effectiveness of the educational process, developing practical skills among students and solving key teaching tasks.

Modern educational standards are focused on the active introduction of digital technologies into the educational process.

In high school, learning the basics of the Internet of Things is included in the Informatics program, which examines the basic principles of smart devices and their role in the digital ecosystem. School textbooks on Informatics for 11th grade present topics related to the concept of IoT, intelligent control systems, as well as the development of projects using hardware and software platforms [2].

Special attention is paid to the practical development of technologies, including software modeling and design tools. One of the effective training resources in this area is Cisco Packet Tracer, a powerful computer network simulator that allows you to simulate the operation of IoT devices, analyze their interaction, and test various operating scenarios. Using such tools allows students to learn the basics of working with IoT without the need for physical equipment, which makes learning more accessible and interactive.

In modern educational practice, more and more attention is being paid to interdisciplinary projects that allow students to apply knowledge from various fields to solve practical problems. IoT technologies can become an effective tool for such projects, combining Informatics, physics and mathematics. For the successful implementation of such initiatives in the educational process, a teacher must know how to integrate digital tools, as well as develop educational resources that allow students to master working with IoT devices in practice.

The use of modern digital educational resources is becoming an integral part of the training of future informatics teachers, providing access to educational materials, simulation environments, and software platforms for designing and programming IoT devices [3]. They contribute not only to the optimization of the educational process, but also to its individualization, allowing students to master the material at a pace convenient for them, apply the acquired knowledge in practice and develop their own IoT projects.

In modern conditions, the key task of training future informatics teachers is not only to transfer fundamental knowledge to them, but also to form their competencies in the field of digital technologies and the Internet of Things. Students who actively use digital educational resources acquire independent learning skills, the ability to work with large amounts of information, analyze and apply modern technologies in practice.

A special role in this process belongs to the teacher, who must not only be familiar with the methods of using data centers, but also be able to organize an educational environment that includes digital platforms, virtual laboratories, tools for programming and testing IoT devices. This requires new approaches to the training of teaching staff, ensuring the formation of the necessary competencies to work in a digital educational environment [4].

The introduction of digital educational resources into the process of teaching future informatics teachers how to create IoT devices opens up wide opportunities for improving the quality of specialist training. The use of interactive e-courses, cloud services, training simulators and specialized software environments allows students to master the design, programming and testing of IoT systems in practice.

Digital educational resources provide flexibility and adaptability of learning, the ability to integrate modern development tools into the learning process, support teamwork and remote interaction [5].

Thus, digital educational resources are becoming not just an auxiliary tool, but an essential element of the educational process that allows future informatics teachers to effectively master and apply Internet of Things technologies [6]. Their competent use helps to increase the level of training of specialists who are able to implement modern educational programs focused on the digital transformation of the educational process.

Research methodology

Digital educational resources play a key role in mastering academic disciplines, consolidating theoretical knowledge and developing practical skills. They also facilitate the organization of intermediate and final control, assessment of independent and household work, as well as provide opportunities for self-monitoring and knowledge correction.

A teacher introducing digital educational resources into the educational process is faced with the task of choosing the optimal type of resource in accordance with the objectives of the lesson, studying the methodology of its application and evaluating the effectiveness of its use [7]. In addition, it is possible to develop your own digital educational resources adapted to the specifics of the training course.

One of the most accessible and illustrative examples of IoT devices that can be implemented in the educational process is the Arduino-based automatic irrigation system for indoor plants.

This project allows students to explore key aspects of how IoT works, including sensor applications, data processing, and device management.

The design of an automatic irrigation system provides an opportunity to study the principles of interaction of electronic components and programming of microcontrollers, as well as to create a functioning device capable of monitoring soil moisture levels and controlling water supply [8].

Necessary components

The following hardware components are used to implement the automatic irrigation system:

- The Arduino Nano board is a control microcontroller that provides irrigation control algorithms.
- Soil moisture sensor – measures the soil moisture level and transmits the data to the controller.
- Water pump (pump) – responsible for supplying water to the plant.
- Relay module – controls the operation of the pump, ensuring a secure connection.
- Connecting wires – used to connect all components.
- Water supply tubes – direct the liquid from the pump to the plant.

Software and operating algorithm

The controller is programmed via the Arduino IDE, and TinkerCad can be used to test the model.

The algorithm of the system includes the following steps:

1. Data reading – the humidity sensor measures the moisture level in the soil and transmits the information to the Arduino.
2. Reading analysis – the microcontroller compares the received data with a preset threshold value.
3. Making a decision – if the soil moisture is below the set level, the Arduino activates the relay module.
4. Irrigation activation – a water pump is turned on, which supplies water through a drip irrigation system.
5. Turning off the pump – when the required humidity level is reached, the water supply stops.

The variety of digital educational resources allows teachers to choose the most appropriate tools, depending on the educational goals and the level of training of students. The classification of digital educational resources according to various criteria are shown in Table 1.

Table 1. Classification of digital educational resources.

| <i>Basis of classification</i> | <i>Types of digital educational resources</i> |
|--|---|
| <i>By the type of information provided</i> | <i>Text resources, audio resources, audiovisual resources, visual resources, interactive models, combined resources</i> |
| <i>For the intended purpose</i> | <i>Educational resources, educational resources</i> |
| <i>By the availability of a printed equivalent</i> | <i>Digital analogues of printed publications, resources originally created in digital format</i> |
| <i>On teaching methods</i> | <i>Conventional, learning tools, programmed, problematic, combined</i> |

Using digital educational resources

Various digital educational resources are proposed to improve learning efficiency, including educational platforms, massive open online courses (MOOCs), and data visualization tools.

Educational platforms

Educational platforms provide access to structured courses, interactive laboratories, simulators of IoT environments, as well as tools for project activities [9]. For example:

- Flexibly adapt the learning process to the level of students' training.
- Develop the digital competencies of future teachers.
- Integrate IoT learning into a single educational ecosystem.

Massive Open Online Courses (MOOCs)

MOOCs are a sought-after distance learning format that is actively used to train future informatics teachers in the field of IoT [10].

They provide the following advantages:

- Access to relevant knowledge in the field of IoT regardless of the place of residence.
- Practice-oriented learning through simulators and virtual labs.
- A personalized learning trajectory tailored to the individual needs of students.
- Formation of digital competencies necessary for working in modern educational environments.

The use of digital educational resources in the training of future informatics teachers opens up wide opportunities for mastering the principles of designing IoT devices. The development of educational projects, such as a smart irrigation system, allows students not only to consolidate their theoretical knowledge, but also to gain practical experience working with microcontrollers, sensors and actuators [11].

The integration of digital technologies, including educational platforms, online courses and visualization tools, improves the quality of the educational process, promotes individualization of learning and the formation of key digital competencies.

Results of the study

To successfully master IoT technologies, students must not only learn how individual components work, but also be able to integrate them into a single device. Digital educational resources play a significant role in this process, which help at every stage of creating an IoT device, making learning more visual, interactive and effective [12].

At the stage of selecting and describing the necessary equipment. The most suitable ones are:

- Augmented reality infographics – helps students quickly learn the characteristics of the equipment [13]. For example, an infographic showing the operation scheme of soil moisture sensors and the interaction of the main components (electromagnetic valves, controllers) allows you to visually present the device of a smart automatic irrigation system. The use of AR technologies makes it possible to view 3D models of sensors, pumps, and valves, evaluating their performance in real space. The model shows in the figure 1.

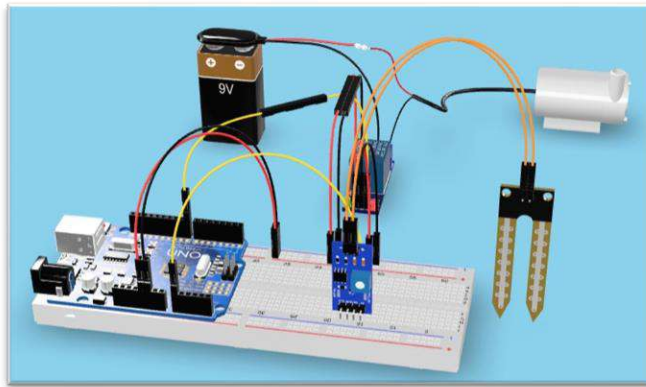


Figure 1. Development of automatic irrigation system

At the stage of building an IoT device creation scheme:

- Video scribing is a method of animated narration that helps explain the principles of operation of a smart irrigation system [14].
- Screencast recordings of the screen with a step-by-step demonstration of work in TinkerCad and Cisco Packet Tracer, showing the process of connecting sensors and configuring the system. The model shows in the figure 2.

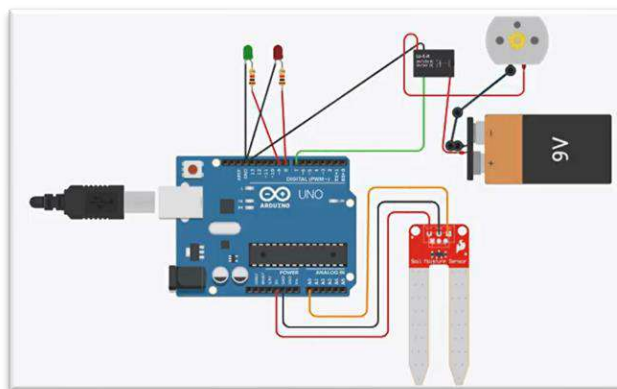


Figure 2. Automatic irrigation system via the Arduino IDE and TinkerCad

At the prototype assembly stage:

- Interactive video – allows students to make decisions during device assembly, test the system and fix errors.
- A chatbot is a virtual assistant that advises on assembly, configuration, and troubleshooting issues [15].

All listed educational resources can be posted on a special website or in a multimedia textbook.

- Website is a single resource with video tutorials, diagrams, instructions and tests.
- Multimedia book – an electronic manual with integrated interactive elements.

Evaluating the effectiveness of digital educational resources

To assess the impact of the use of data analysis on learning, a survey was conducted among 3rd-year students majoring in Informatics. 216 students participated in the study.

The survey includes questions about the usefulness, convenience, and effectiveness of the digital resources presented in table 2:

Table 2. Survey of 3rd year students of the Informatics specialty on the effectiveness of the digital resources presented.

| № | Questions | No (%) | I find it difficult to answer (%) | Yes (%) |
|----|---|--------|-----------------------------------|---------|
| 1 | Was the digital educational resource useful to you when studying the Smart Plant Watering project? | 14% | 3% | 83% |
| 2 | Have infographics and video scribing helped to better understand the stages of creating an IoT device? | 2% | 10% | 88% |
| 3 | Was the process of working with the online TinkerCad platform convenient when designing the device circuit? | 4,5% | 5,5% | 90% |
| 4 | Were you able to assemble a prototype of the device without difficulty using the digital materials provided? | 1% | 7% | 92% |
| 5 | Was the mobile application developed clear and easy to control the device? | 0% | 25% | 75% |
| 6 | Did the interactive videos and virtual labs help in understanding how IoT devices work? | 10% | 20% | 70% |
| 7 | Were the learning materials of the multimedia book or website sufficient for self-study? | 8% | 60% | 32% |
| 8 | Would you like to use similar digital learning resources in future learning projects? | 12% | 8% | 80% |
| 9 | Was it convenient to interact with the instructor and students through online platforms (GitHub, Google Colab)? | 10% | 8% | 82% |
| 10 | Do you feel that the use of DER has increased your IoT knowledge and skills? | 2% | 24% | 74% |

The results of the study show that 83% of the students indicated that digital educational resources (DERs) were useful, and 88% confirmed that infographics and video scribing helped them to better understand the steps involved in building an IoT device. During the design phase, 90% of students found the TinkerCad platform user-friendly and 92% had no difficulty assembling the prototype using the digital materials provided. However, 25% of students found it difficult to rate the usability of the mobile app, which may indicate a need for improvement. 80% of students expressed a desire to use such DERs in the future, which confirms their practical value and relevance in the educational process. These results highlight key aspects that ensure the successful integration of digital learning resources into teaching.

Discussions

One of the most significant factors of effectiveness is the availability and completeness of educational materials that cover both theoretical and practical aspects of the discipline. This allows students not only to familiarise themselves with the basics of how IoT systems components work, but also to apply the knowledge gained during project activities.

Integration of DER with modelling and programming platforms such as TinkerCad and Arduino IDE is integral to effective learning [13]. These tools allow students to design and test circuits of IoT devices in a virtual environment, which significantly lowers the threshold of entry into the study of Internet of Things technologies.

In addition, the use of interactive elements (video tutorials, simulations, test tasks) contributes to a deeper understanding of the material. Interactive methods activate students' learning activities, increase their level of involvement and allow to demonstrate the operation of hardware and software components of IoT systems. To improve the objectivity of knowledge control, it is advisable to

introduce automated testing tools (testing and simulation tasks), which provides not only timely feedback, but also the possibility of individual learning pace.

Another important factor is the adaptation of the interface of digital educational resources, which makes it possible to ensure the convenience of work on various devices (PCs, tablets, smartphones). This approach increases the accessibility of learning materials and promotes continuous learning outside of the classroom. Personalisation of the educational process, based on taking into account the level of students' preparation, also plays a significant role. The inclusion of adaptive learning features allows each student to master the material at a comfortable pace, receiving the necessary additional clarification or, conversely, moving on to more complex tasks [14]. Practice-oriented learning is an important component of IoT training, so the introduction of lab activities and step-by-step tutorials is necessary to build applied design and programming skills in students. Finally, the effectiveness of digital educational resources increases significantly when they are integrated with the university's learning platforms (Google Classroom, Microsoft Teams). This allows creating a unified educational environment that provides interaction between students and teachers, access to learning materials and automated checking of assignments. Thus, the use of digital educational resources helps not only to increase students' motivation, but also to develop their practical skills in the field of IoT, which is of key importance for the training of qualified specialists in this field.

Conclusion

The use of digital educational resources in teaching future informatics teachers to create IoT devices is a promising direction in modern pedagogy. Interactive and multimedia technologies promote deeper learning of complex topics, increase the level of student engagement and ensure the formation of key professional competences. The development and implementation of effective teaching methods with the use of DER significantly improve the training of specialists in the field of IoT and digital technologies. In the future, it is possible to expand the functionality of digital educational resources by introducing artificial intelligence technologies, adaptive learning systems and virtual reality. This will make it possible to integrate IoT even deeper into the educational process and create a more flexible and personalised learning model.

Acknowledgements

This research is funded by the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan within the project «IoT Transformation of an Educational Institution: Design, Implementation of Smart Classrooms and Training of Specialists in the Field of IoT for Education» (IRN AP23490844).

Список использованных источников

[1] Графова, О.П. (2020). Электронный образовательный ресурс и цифровой образовательный ресурс: сходства и различия понятий / О.П. Графова, Л.В. Витвицкая // Современное образование: научные подходы, опыт, проблемы, перспективы. – С. 163-166. <http://elib.pnzgu.ru/library/1604434366> (дата обращения: 05.03.2025).

[2] Ongarbayeva, A.D., Kaldybaev, S.K., Kasymaliev, M.U., Kozhasheva, G.O., Yermekova, N.S. (2021). Methodology of preparing future computer science teachers to create electronic educational resources. *World Journal on Educational Technology: Current Issues*. 13(3), 386-396 <https://doi.org/10.18844/wjet.v13i3.5933> (дата обращения: 05.03.2025).

[3] Burd, Barry & Barker, Lecia & Divitini, Monica & Fermin Perez, Felix Armando & Russell, Ingrid & Siever, Bill & Tudor, Nicoleta. (2017). Courses, Content, and Tools for Internet of Things in Computer Science Education. 125-139. 10.1145/3174781.3174788. (Дата цитирования 8.03.2025) <https://doi.org/10.1145/3174781.3174788> (дата обращения: 05.03.2025).

[4] Victor Callaghan. (2012). Buzz-Boarding; practical support for teaching computing based on the internet-of-things. In 1st Annual Conference on the Aiming for Excellence in STEM Learning and Teaching, Imperial College, London & The Royal Geographical Society. 12–13.

- [5] Как построить цифровую образовательную среду [Электронный ресурс]. – <http://www.edutainme.ru/post/manifesto-upd/> Режим (Дата доступа: цитирования 10.03.2025)
- [6] Akhmetova O. , Issayev C. and Kaiyrgaliyeva A. (2020). FORMATION FUTURE COMPUTER SCIENCE TEACHERS' COMMUNICATIVE ABILITIES IN STUDYING INTERNET OF THINGS (IoT). Bulletin of Abai KazNPU. Series of Physical and mathematical sciences. 72, 4 (Dec. 2020), 188–195. <https://doi.org/10.51889/2020-4.1728-7901.29>.
- [7] Современная образовательно-информационная среда / А.М. Кондаков, М.Л. Кондакова [Электронный ресурс]. – Режим доступа: [file:///C:/Users/1/Downloads/Kondakov_A.M.,_Kondakova_M.L.Sovremennaya_obrazovatelno_informatsionnaya_sreda\(BookFi\).pdf](file:///C:/Users/1/Downloads/Kondakov_A.M.,_Kondakova_M.L.Sovremennaya_obrazovatelno_informatsionnaya_sreda(BookFi).pdf) (дата обращения: 10.03.2025).
- [8] Dr.Faouzi Bouslama and Dr. Faisal Kalota. (2016). Creating Smart Classrooms to Benefit from Innovative Technologies and Learning Space Design\ International Journal of Instructional Media, vol.10, pp.423-634. DOI:10.1109/CTIT.2013.6749486
- [9] Массовый открытый онлайн-курс. Википедия [Электронный ресурс]. – Режим доступа: https://ru.wikipedia.org/wiki/Массовый_открытый_онлайн-курс. (дата обращения: 12.03.2025).
- [10] МООК и открытое образование: Значение для высшего образования [Электронный ресурс]. – Режим доступа: <https://openeducation.net/services/mook-i-otkrytoe-obrazovanie-znachenie-dlyavysshego-obrazovaniya/>. (дата обращения: 12.03.2025).
- [11] М. Б. Лебедева, М. А. Горюнова. (2019). Применение цифровых образовательных ресурсов на современном уроке : метод. пособие / – СПб.: ЛОИРО, – 127 с.
- [12] Song Shuqiang, Zhong Xiaoliu, Li Haixia, Du. (2014). Smart Classroom: from Conceptualization to Construction\, Jing Information Technology Center Tsinghua University Beijing, China, vol.45, pp.343-765.
- [13] Лозенко Г.Ф., Кривоплясова Е.В. (2015). Использование электронных образовательных ресурсов для подготовки будущих учителей информатики // Личность, семья и общество: вопросы педагогики и психологии. №2 (49). URL: <https://cyberleninka.ru/article/n/ispolzovanie-elektronnyh-obrazovatelnyh-resursov-dlya-podgotovki-buduschih-uchiteley-informatiki> (дата обращения: 21.03.2025)
- [14] Федорова Г.А. (2014). Разработка и применение электронных образовательных ресурсов в структуре методической подготовки бакалавров в педагогическом вузе // Вестник КГПУ им. В.П. Астафьева. №3 (29). URL: <https://cyberleninka.ru/article/n/razrabotka-i-primenenie-elektronnyh-obrazovatelnyh-resursov-v-strukture-metodicheskoy-podgotovki-bakalavrov-v-pedagogicheskom-vuze> (дата обращения: 22.03.2025)

References

- [1] Grafova, O.P. (2020). Jelektronnyj obrazovatel'nyj resurs i cifrovoj obrazovatel'nyj resurs: shodstva i razlichija ponjatij / O.P. Grafova, L.V. Vitvickaja // Sovremennoe obrazovanie: nauchnye podhody, opyt, problemy, perspektivy. – S. 163-166. <http://elib.pnzgu.ru/library/1604434366> (date of application: 05.03.2025)
- [2] Ongarbayeva, A.D., Kaldybaev, S.K., Kasymaliev, M.U., Kozhasheva, G.O., Yermekova, N.S. (2021). Methodology of preparing future computer science teachers to create electronic educational resources. World Journal on Educational Technology: Current Issues. 13(3), 386-396 <https://doi.org/10.18844/wjet.v13i3.5933>. (date of application: 05.03.2025)
- [3] Burd, Barry & Barker, Lecia & Divitini, Monica & Fermin Perez, Felix Armando & Russell, Ingrid & Siever, Bill & Tudor, Nicoleta. (2017). Courses, Content, and Tools for Internet of Things in Computer Science Education. 125-139. 10.1145/3174781.3174788. <https://doi.org/10.1145/3174781.3174788> (date of application: 05.03.2025)
- [4] Victor Callaghan. (2012). Buzz-Boarding; practical support for teaching computing based on the internet-of-things. In 1st Annual Conference on the Aiming for Excellence in STEM Learning and Teaching, Imperial College, London & The Royal Geographical Society. 12–13.
- [5] Kak postroit' cifrovuju obrazovatel'nuju sredu [Jelektronnyj resurs]. – <http://www.edutainme.ru/post/manifesto-upd/> Rezhim (date of application: 10.03.2025)
- [6] Akhmetova O, Issayev C. and Kaiyrgaliyeva A. (2020). FORMATION FUTURE COMPUTER SCIENCE TEACHERS' COMMUNICATIVE ABILITIES IN STUDYING INTERNET OF THINGS (IoT). Bulletin of Abai KazNPU. Series of Physical and mathematical sciences. 72, 4 (Dec. 2020), 188–195. <https://doi.org/10.51889/2020-4.1728-7901.29>.

[7] *Sovremennaja obrazovatel'no-informacionnaja sreda* / A.M. Kondakov, M.L. Kondakova [Jelektronnyj resurs]. – Rezhim dostupa: [file:///C:/Users/1/Downloads/Kondakov_A.M.,_Kondakova_M.L.Sovremennaya_obraz\(BookFi\).pdf](file:///C:/Users/1/Downloads/Kondakov_A.M.,_Kondakova_M.L.Sovremennaya_obraz(BookFi).pdf) (date of application: 10.03.2025)

[8] Dr.Faouzi Bouslama and Dr. Faisal Kalota. (2016). *Creating Smart Classrooms to Benefit from Innovative Technologies and Learning Space Design* \ International Journal of Instructional Media, vol.10, pp.423-634. DOI:10.1109/CTIT.2013.6749486

[9] *Massovyj otkrytyj onlajn-kurs. Vikipedija* [Jelektronnyj resurs]. – Rezhim dostupa: https://ru.wikipedia.org/wiki/Massovyj_otkrytyj_onlajn-kurs. (date of application: 12.03.2025)

[10] *MOOK i otkrytoe obrazovanie: Znachenie dlja vysshego obrazovanija* [Jelektronnyj resurs]. – Rezhim dostupa: <https://openeducation.net/services/mook-i-otkrytoe-obrazovanie-znachenie-dlyavysshego-obrazovaniya/>. (date of application: 12.03.2025).

[11] M. B. Lebedeva, M. A. Gorjunova. (2019). *Primenenie cifrovyyh obrazovatel'nyh resursov na sovremennom uroke : metod. posobie* / – SPb.: LOIRO, – 127 s.

[12] Song Shuqiang, Zhong Xiaoliu, Li Haixia, Du. (2014). *Smart Classroom: from Conceptualization to Construction*, Jing Information Technology Center Tsinghua University Beijing, China, vol.45, pp.343-765.

[13] Lozenko G.F., Krivopljasova E.V. (2015). *Ispol'zovanie jelektronnyh obrazovatel'nyh resursov dlja podgotovki budushhih uchiteley informatiki // Lichnost', sem'ja i obshhestvo: voprosy pedagogiki i psihologii. №2 (49). URL: <https://cyberleninka.ru/article/n/ispolzovanie-elektronnyh-obrazovatelnyh-resursov-dlya-podgotovki-buduschih-uchiteley-informatiki> (date of application: 21.03.2025)*

[14] Fedorova G.A. (2014). *Razrabotka i primeneniye jelektronnyh obrazovatel'nyh resursov v strukture metodicheskoy podgotovki bakalavrov v pedagogicheskom vuze // Vestnik KGPU im. V.P. Astaf'eva. №3 (29). URL: <https://cyberleninka.ru/article/n/razrabotka-i-primeneniye-elektronnyh-obrazovatelnyh-resursov-v-strukture-metodicheskoy-podgotovki-bakalavrov-v-pedagogicheskom-vuze> (date of application: 22.03.2025)*