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IMPLEMENTATION OF IOT TECHNOLOGIES IN PEDAGOGICAL UNIVERSITY EDUCATION

The purpose of this study is a comprehensive analysis of the current state and prospects of using Internet of Things technologies in higher pedagogical education, the development of a conceptual model for integrating IoT into the educational process of pedagogical universities, taking into account the peculiarities of training future teachers.

The research methodology consists of studying and analyzing the literature on the IoT transformation of teacher education, questioning teachers and students in order to identify their opinions on the need to introduce IoT into the educational process, and determining the most promising areas for integrating IoT technologies into the system of training future teachers.

The results of the study. Based on the analysis of the literature, the results of a survey of students and teachers of computer science, future specialists in the field of ICT for education, a conceptual model of IoT integration into the educational process of pedagogical universities has been developed, the main ways of its implementation have been identified and justified.

Conclusion. The introduction of IoT technologies into the educational process of pedagogical universities will optimize the management of the educational process, increase the efficiency and quality of education,

and provide more effective training of specialists in the field of IoT for education.

The developed conceptual model of IoT integration into the educational process of pedagogical universities is an important step towards the successful integration of IoT into pedagogical education, allows you to provide a holistic vision of the entire process and build a logical sequence of actions for its implementation.

Keywords: Internet of Things, education, pedagogical universities, conceptual model, digital technologies, IoT devices, cloud platforms, smart classrooms.

Introduction

Modern technologies, including the Internet of Things, are rapidly developing, penetrating more and more deeply into all spheres of human activity, transforming familiar processes and opening up new opportunities. The education system is no exception.

IoT technologies open up new prospects for its development, require rethinking traditional approaches to the organization of the educational process and teaching methods, identifying the most effective strategies for their integration into education and training for work in the digital environment. Pedagogical universities are influenced by these processes and cannot stay away from them. Future teachers should be prepared for the fact that their professional activities will be closely related to the use of IoT technologies.

Questions on IoT are included in the curriculum of the school computer science course for 11th grade students in the Natural and Mathematical direction (NMD), as a separate section. This necessitates the training of competent computer science teachers who are able not only to develop and implement IoT systems, but also to teach them to the younger generation. Despite the obvious importance of the topic, the question of how to effectively integrate IoT technologies into the pedagogical process and prepare future teachers to work in this environment and teach them to schoolchildren remains insufficiently studied. To solve this problem, it is necessary to find possible ways to integrate innovative IoT technologies into the teacher education system in order to organize the educational process and train specialists for professional activity, taking into account modern technological trends. This confirms the relevance of the topic under consideration.

The purpose of this study is a comprehensive analysis of the current state and prospects of using Internet of Things technologies in higher pedagogical education, the development of a conceptual model for integrating IoT into the educational process of pedagogical universities, taking into account the peculiarities of training future teachers.

Materials and methods

The study and analysis of literary sources on the research topic, practical experience of the introduction of IoT into the education system, a statistical survey to determine the opinions of users on the implementation of IoT in the system of teacher education. The survey respondents were teachers and students of pedagogical universities, teachers of educational institutions. Development of a model for integrating IoT into the educational process of pedagogical universities, reflecting the relationship between IoT elements and pedagogical processes in higher education institutions.

The digital revolution has already led to the introduction of IoT in educational institutions almost all over the world. The introduction of new technologies in education has played an important role in the modernization of the educational process. IoT has not only made changes to the infrastructure of educational institutions, but also changed traditional pedagogical teaching methods to more innovative ones [1].

In developed countries, the Internet of Things is actively used as an educational and research tool. Schools and universities in the USA and the UK use IoT to teach the basics of programming [2]. Online learning has also not been left aside: language schools are creating interactive IoT-based platforms equipped with voice and visual sensors to teach English. These platforms allow students to improve their pronunciation and accent in real time [3].

A successful example of IoT implementation is Yonsei University, Seoul, South Korea. The Open Campus Experience concept allows him to centrally manage all information about university life and provide students with convenient access to it through a mobile application. This allows students to always be up to date and plan their time effectively. Teachers, in turn, have the opportunity to record and broadcast their lectures online, expanding the audience beyond the campus [4].

An interesting and promising area of IoT implementation in education, which attracts students and creates conditions for practical training in IoT technologies, is the development and implementation of an appropriate IoT discipline [2].

Realizing the importance of IoT as an academic discipline, the Open University of Great Britain has introduced a new training course “My Digital Life” based on IoT concepts for undergraduate and graduate students. Studying this course helps students use IoT as a tool for exploring and analyzing the physical and virtual world around them [5].

The creation of a security system in educational institutions is one of the most sought–after areas of IoT implementation in education. With IoT, universities and schools can restrict students and visitors’ access to classrooms and laboratories, which will reduce the risk of accidents [6-7].

One of the main changes under the influence of IoT is that the routine tasks of the student and teacher will be automated, which will make it possible to devote more time and attention to the learning process. IoT technologies will create more comfortable learning conditions, motivate and interest students in learning by linking real and virtual objects. The creation of smart laboratories and equipping them with IoT devices for conducting more complex and accurate experiments will help expand opportunities for scientific research. The effectiveness and impact of IoT on the education system are predictable and should not be ignored [6].

Results and discussion

To date, almost all pedagogical universities in the Republic of Kazakhstan are connected to the Internet. Each of them contains a huge variety of objects that can potentially be connected to the IoT network, such as windows, doors, projectors, printers, classrooms, laboratories, etc. Using sensors, RFID, NFC, QR tags and other IoT technologies, these objects can be transformed into intelligent objects [8]. Moreover, each educational building can include applications for online learning using IoT, IoT-based smart classrooms, IoT-based laboratories, smart libraries, etc. The integration of the IoT into pedagogical universities is not only the introduction of new technologies into educational institutions to automate energy management and ensure safety and comfortable conditions in educational premises. The main goals of the IoT transformation of pedagogical universities are to increase the efficiency and quality of education; optimize the management of the educational process; create a smart educational environment, improve interaction between teachers and students, as well as the development of IoT competencies of future teachers.

The existing fragmentation in the use of IoT technologies in teacher education, the lack of a unified, systematic concept for their implementation in the teacher training system does not allow them to fully unlock their potential and makes it difficult to use them effectively in practice. The development of a unified conceptual model will make it possible to systematize the IoT implementation process, define clear goals and objectives, and create a unified ecosystem of IoT devices and services in education, which will increase the efficiency of their use.

The process of introducing IoT into the teacher education system is complex and multifaceted, requiring a deep understanding of the specifics of training future teachers. Therefore, the model being created for the introduction of IoT technologies into teacher education should be not only technologically advanced, but also pedagogically sound, taking into account the specifics of teacher training and include both technical (installation of smart devices, application development), organizational and pedagogical aspects (Figure 1).

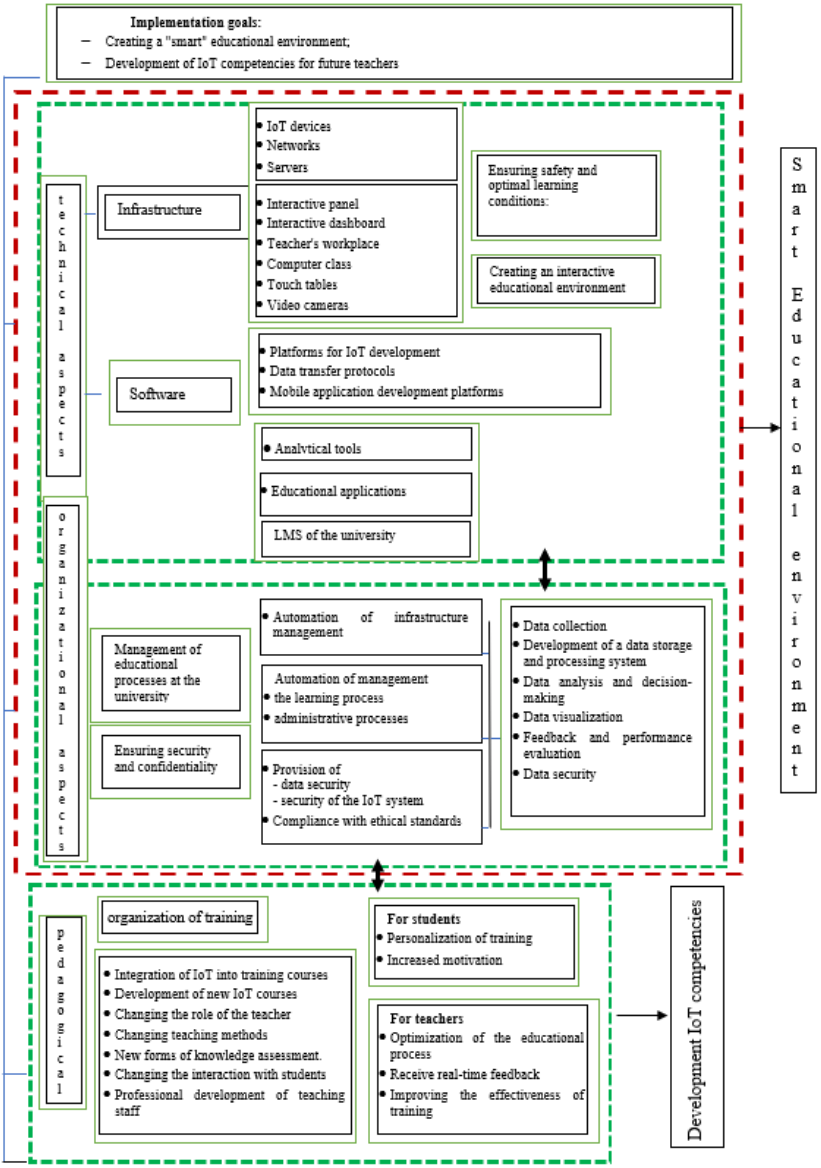

Figure 1 – Conceptual model of IoT implementation in the educational process of a pedagogical university

Technical aspects cover a set of technical equipment and software, network infrastructures and protocols, on which the entire system of the "smart" educational environment will be built. It is on this technical basis that all the functionality of the environment will be implemented, providing personalized learning, adaptive user interaction, safety and optimal learning conditions, as well as automation of educational process management at the university.

Their choice is determined based on the goals and objectives of implementing IoT in the teacher training system. First of all, these are IoT devices such as lighting sensors, temperature, humidity, motion, CCTV cameras, smart sockets, etc. depending on the tasks (creation of a smart lock, smart lighting, smart blinds, smart ventilation, smart video camera, etc.), also an interactive panel, an interactive dashboard, a workplace teachers, computer lab, touch tables, etc.

The devices must be compatible with each other and with the selected platform. It is important to choose low-power devices, especially for stand-alone devices.

To manage IoT devices and collect data, you need to choose the appropriate platform. It should provide tools for data collection, visualization and analysis, device management, and should be able to scale as the number of devices and users grows. Popular options include:

Cloud platforms: AWS, Azure, Google Cloud

Mobile application development platforms: Flutter, React Native

Data analysis platforms: TensorFlow, PyTorch

Data transfer protocols: MQTT, CoAP

IoT Development Platforms: Arduino, Raspberry Pi, Node-RED

LMS of the university

It is necessary to provide a stable and high-speed network connection for all IoT devices. This includes Wi-Fi, Ethernet and possibly cellular networks.

In addition, a powerful server is required to collect, store and process data coming from IoT devices.

The identification of technical, organizational and managerial aspects in the conceptual model of IoT implementation in the educational process of pedagogical universities is extremely important. They allow you not only to see which specific IoT devices (sensors, actuators, controllers) and interactive equipment, software and networks will be used in the classroom and how they are managed to optimize the educational process, but also are key factors in creating an intelligent educational environment based on IoT, which provides conditions for flexible, personalized and an effective learning process, contributes to improving the quality and effectiveness of learning.

The pedagogical aspect is no less important for the successful implementation of IoT in the educational process of pedagogical universities. It includes:

– Integration of IoT into training courses, organization of classes using IoT devices;

Development of new IoT courses;

– Changing teaching methods;

– Changing the form of knowledge assessment in a smart learning environment;

– Changing the interaction with students;

– Professional development of teaching staff.

The pedagogical aspect complements the technical and organizational one, ensuring the effective implementation of IoT in the educational process. Without a well-thought-out pedagogical approach, even the most modern technical infrastructure will not be able to provide effective training.

A comprehensive combination of the above-mentioned technical, organizational and pedagogical aspects of the introduction of IoT into the educational process will create not just a smart educational environment, but also prepare a new generation of teachers in this environment who are able to work effectively in the conditions of IoT transformation of educational institutions and use IoT technologies in their professional and pedagogical activities.

Moreover, it is very important to prepare future computer science teachers who are also capable and ready to transfer their knowledge in the field of IoT to their students. In the Republic of Kazakhstan, the Internet of Things as a separate section is included in the content of the computer science course of the 11th grade of the natural and mathematical direction.

The development of IoT competencies of future teachers, along with the creation of a smart educational environment, is an equally important goal of introducing IoT into the educational process of pedagogical universities. These two goals are closely related and complement each other. The introduction of IoT in the pedagogical university not only creates a modern educational environment, but also prepares future teachers to work in the digital world. Therefore, in the conceptual model of IoT implementation in the educational process of pedagogical universities, it is important to highlight the pedagogical aspect.

The effectiveness and impact of IoT on the education system are predictable and should not be ignored.

The successful IoT transformation of pedagogical universities is a multifaceted, multi-stage process that requires careful planning and an integrated approach, and is carried out in stages, starting with

1 analysis of the needs and capabilities of the educational organization, which includes:

– study of the existing technical base and infrastructure of the university;

– assessment of the level of IoT competencies of teachers and students;

– identification of specific educational programs in which it is advisable to introduce IoT courses.

and further;

2 creation of an innovative educational environment based on IoT, which is one of the key stages of the IoT transformation of the university and includes:

– creation of smart classrooms equipped with IoT devices that allow you to monitor the level of illumination, temperature, CO2 levels, the presence of students in the classroom, automatic assessment of assignments, etc. This will create comfortable learning conditions and improve the efficiency of the educational process;

– combining interactive panels with computers of the teacher and students into a single system for a more efficient organization of the educational process;

– creation of virtual laboratories where students will be able to simulate various IoT systems and conduct experiments without using physical equipment, with an AI assistant;

– creation of IoT laboratories equipped with sets of microcontrollers, sensors, actuators, software, 3D printers for the development and debugging of prototypes of IoT devices;

– providing reliable and high-speed wireless Internet access for all participants in the educational process and developing cloud platforms for collecting, processing and analyzing data from IoT devices.

3 Training of future IoT specialists for education and training of the younger generation of schoolchildren:

– inclusion in the curricula of disciplines on the basics of IoT, programming of IoT devices, design of IoT systems;

– creating practical modules that involve students working with real IoT devices and platforms;

– development of projects aimed at creating educational IoT solutions for schools and other educational institutions.

4 Training of teaching staff:

– conducting regular trainings and advanced training courses for teachers on the subject of IoT and methods of using IoT in education;

– development of methodological materials and teaching aids;

– formation of a community of teachers who actively use IoT in their work to share experiences and develop joint projects.

5 Organization of student project work:

– organizing contests and hackathons for students to develop IoT projects, stimulating their creative activity and innovative ideas;

– integration with the real sector: Cooperation with enterprises and organizations working in the field of IoT to create real projects of practical importance.

Effective implementation of IoT in education is impossible without taking into account the needs and expectations of its potential users: university teachers, practitioners and future teachers, university administration. Taking into account their opinions will serve as a good basis for the formation of a smart educational environment based on IoT and will allow the introduction of new functionality in accordance with real demand.

To determine the priority functions of the smart educational environment for potential users, as well as areas of application of IoT in the educational process of pedagogical universities, they were asked 10 questions (Table 1) covering key aspects of the functionality of the smart educational environment, using the Likert scale to assess the degree of their agreement or disagreement with various statements.

This will optimize the functionality of the environment being developed and make it more convenient and efficient. The survey was attended by 216 respondents (students of the specialty «computer science», «computer science and robotics» and «information systems in education», as well as teaching staff of pedagogical universities in Almaty).

Table 1 – Questionnaire «IoT in teacher education»

1	Do you think that using IoT can improve the effectiveness of the educational process?
2	Can smart devices help create a more comfortable and safe educational environment?
3	Would it be useful if IoT could be used to automatically monitor class attendance?
4	Would you like to have a smart educational environment implemented in your educational institution?
5	Do you think that the integration of the smart audience system with the university's educational platform will optimize the learning process?
6	Can IoT devices be used for educational research?
7	Do you think that IoT can help better track student progress in real time?

8	Would you like to receive analytical data on the student learning process to improve the quality of teaching?
9	Do you think that IoT can help in personalizing learning?
10	Do you think that students of pedagogical universities should master the basics of creating IoT devices?

In this questionnaire, the Likert scale 3 was used (1-"no", 2-"I don't know", 3 – «yes»). Teachers, students and administrative staff evaluated it according to their real ideas.

The results of the survey (in percentages) are shown in Figure 2:

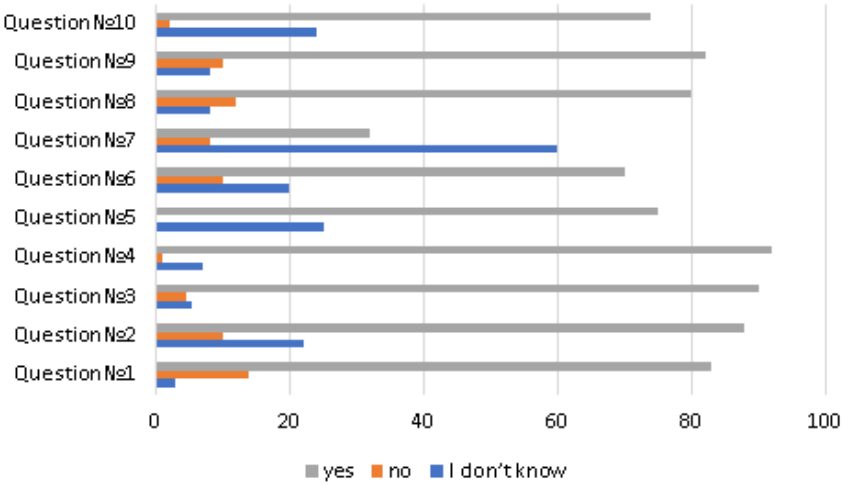

Figure 2 – The results of the survey

The obtained results have been statistically processed to assess their validity and reliability. The results showed that Cronbach's alpha (α) is 0.9047 and the square root of α, which is usually used to determine validity, is 0.951. This indicates that the reliability and validity values are good and indicate a high internal consistency of the data [9–10].

As a result of the survey, it was revealed that 92 % of respondents have an idea about IoT and would like to have a smart educational environment implemented in their educational institution. The remaining 7 % held a neutral position and 1% expressed doubt about awareness of the essence and functions of the IoT.

Most users are interested in improving the learning environment, increasing its effectiveness and automating routine tasks.

In general, the survey results provided a more complete understanding of the needs and expectations of various user groups and highlighted the main areas of IoT application in the educational process of pedagogical universities.

Conclusion

The introduction of IoT in pedagogical universities is not just a technical modernization, but an integrated approach aimed at creating new opportunities for more personalized and effective learning, and training teachers who are able to work in conditions of digital transformation.

The developed conceptual model is an important step towards the successful integration of IoT into teacher education, allows you to provide a holistic vision of the entire process and build a logical sequence of actions for its implementation.

Its implementation will allow not only to create a smart educational environment based on IoT, but also to develop IoT competencies necessary for future teachers to effectively organize the educational process and teach schoolchildren.

The proposed model has high practical significance and can be used to form strategies for the digital transformation of educational institutions based on Internet of Things technologies and to develop roadmaps for the implementation of IoT in educational institutions.

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ПЕДАГОГИКАЛЫҚ ЖОҒАРЫ ОҚУ ОРЫНДАРЫНЫҢ БІЛІМ БЕРУ ҮДЕРІСІНЕ IOT ТЕХНОЛОГИЯЛАРЫН ЕНГІЗУ

Бұл зерттеудің мақсаты-болашақ информатика мұғалімдері мен АКТ мамандарын оқытуға арналған ақылды сыныпты жобалау тұжырымдамасын әзірлеу, оны әрі қарай жүзеге асыру ресурстарды басқаруды оңтайландырып қана қоймай, сонымен қатар тиімді, ыңғайлы және заманауи жағдай жасауға мүмкіндік береді.оқыту үшін.

Зерттеу әдістемесі оқу процесінде интеллектуалды аудиторияны құру және енгізу туралы әдебиеттерді талдаудан, оның функционалдығына қойылатын талаптарды анықтау мақсатында оның әлеуетті пайдаланушыларын зерттеуден тұрады.

Нәтижелер. Әдебиеттерді талдау негізінде информатика студенттері мен оқытушыларының, білім беру саласындағы акт саласындағы болашақ мамандардың сауалнамасының нәтижелері, «ақылды аудитория» үшін функционалды, оның негізгі құрылымдық компоненттері құрылды.оны жүзеге асыру анықталды және негізделді.

Қорытынды. Әзірленген тұжырымдама заманауи талаптарға жауап беретін функционалды ақылды аудиторияны құрудың технологиялық негізін анықтайды

Кілтті сөздер: заттар интернеті, білім беру, педагогикалық жоғары оқу орындары, тұжырымдамалық модель, цифрлық технологиялар, IoT-құрылғылар, бұлтты платформалар, ақылды оқу аудиториялары.

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О ВНЕДРЕНИИ IOT-ТЕХНОЛОГИЙ В ОБРАЗОВАТЕЛЬНЫЙ ПРОЦЕСС ПЕДАГОГИЧЕСКИХ ВУЗОВ

Целью данного исследования является комплексный анализ современного состояния и перспектив использования технологий Интернета вещей в высшем педагогическом образовании, разработка концептуальной модели интеграции IoT в образовательный процесс педагогических вузов, учитывая особенности подготовки будущих педагогов.

Методологию исследования составляют изучение и анализ литературы, посвященной IoT-трансформации педагогического образования, анкетирование преподавателей и студентов с целью выявления их мнения о необходимости внедрения IoT в образовательный процесс, и определения наиболее перспективных направлений интеграции технологий IoT в систему подготовки будущих учителей.

Результаты исследования. На основании анализа литературы, результатов опроса студентов и преподавателей информатики, будущих специалистов в области ИКТ для образования разработана концептуальная модель интеграции IoT в образовательный процесс педагогических вузов, определены и обоснованы основные пути ее реализации.

Заключение. Внедрение технологий IoT в образовательный процесс педагогических вузов позволит оптимизировать управление образовательным процессом, повысить эффективность и качество обучения, обеспечит более эффективную подготовку специалистов в области IoT для образования.

Разработанная концептуальная модель интеграции IoT в образовательный процесс педагогических вузов является важным шагом на пути к успешной интеграции IoT в педагогическое образование, позволяет обеспечить целостное видение всего процесса и выстроить логическую последовательность действий для его реализации.

Ключевые слова: Интернет вещей, образование, педагогические вузы, концептуальная модель, цифровые технологии, IoT-устройства, облачные платформы, умные учебные аудитории.

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