

Sh.S. Tutkyshbaeva
A.B. Zakirova

L.N. Gumilyov Eurasian National University, Astana, Kazakhstan
(E-mail: shyryn.tutkyshbaeva@gmail.com, alma_zakirova@mail.ru)

Learning and teaching model using the IoT concept in education

Abstract. *The Internet of Things (IoT) is a massive network of things that includes people, smart objects and devices, information, and data that collect and share data about each other and the environment they belong to. The IoT is developing rapidly and improving people's lives in all spheres. Examples of the IoT are smart cities, smart healthcare, home automation, security, and education. Today, learning and education models have changed significantly with the introduction of the IoT in education. This article considers all practical methods of integrating the IoT function into education, namely improving student learning. Besides, this article focuses on how these aspects of the IoT will help create a smarter concept and model of education.*

Keywords: *IoT, education, concept, platform, RFID, learning modes.*

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Introduction

New developments and technologies are an integral part of education. Thus, the term "education" today is not limited to textbooks but, to a greater extent, refers to the digital environment of knowledge and information. Since innovative technologies are now being used in education, we can see an increase in the involvement of students in the learning process. We observe improvements in students' understanding of the learning materials and their final results. One of the most potent aspects of technology is the Internet of Things (known shortly as the "IoT"). More precisely, the IoT consists of any device with an "On" or "Off" switch connected to the Internet [1]. For instance, Juniper Research highlights that the total number of IoT devices and sensors will surpass 50 billion by 2022, compared to 21 billion in 2018 [2]. Since

we expect IoT technology to expand significantly in the coming years, this article explores how IoT technology can improve the educational sphere and develop online learning and teaching.

The second purpose of this article is to focus on studying IoT courses in educational institutions. With the accelerated development of IoT and the expected high demand for IoT professionals, universities and high schools have begun studying and implementing IoT courses in their curricula. Unfortunately, learning the IoT comprehensively requires many hands-on skills, such as software engineering, electronics, and even data science. Therefore, students who want to join this growing technology movement face an educational "overload" of knowledge from multiple fields. The challenges that the students face vary depending on the choice of software technology. Moreover, teaching staff experience the same difficulties when developing

IoT courses. They must consider the diversity of skills students need to acquire, the variety of other technologies, and finally, structure them by educational classes and laboratories [3][4].

This article also presents our analysis of existing teaching methods. Then this article describes existing platforms and the new platform that we are proposing. Our proposed platform is web-based and allows teachers to upload, expand and edit IoT-related materials such as books, slides, laboratory works, projects, and other data. Besides, students can access them free of charge without any restrictions. This platform aims to be a place where teaching staff can post the lessons they want while students can access them, making it a hub of desired knowledge about IoT.

The main part

2.1 The impact of the Internet of Things on education

The model of the influence of the IoT in education can be divided into two stages:

1. Applications or the platform for learning IoT courses [12];
2. Learning model or ways to conduct classes using the IoT (Table 1).

2.1.1 Existing learning platforms

There are many platforms where IoT courses can be studied, such as Coursera, Udemy, Code School, Class Central, GitHub, Bitbucket and other popular platforms. Having analysed all these learning platforms, we proposed our platform. Our solution is a platform that will solve all the needs presented above (IoT). The platform is designed for both students and teaching staff who want to learn or share IoT content. This platform is specially designed so that people can gain knowledge and practical skills about IoT and share their work.

The platform contains many features to facilitate the learning process. The information is structured by course; each course consists of books, slides and projects.

To create a new course, the user must log in as a teaching staff and follow the steps (Figure 1). Besides, teaching staff can track grades and student activity and monitor their progress. We have integrated the platform with IoT technology (FaceID) [6], allowing users to edit applications directly from the current platform. This way, we save students from taking additional steps to install a platform to develop projects. The IoT allows them to create projects and start working on them immediately.

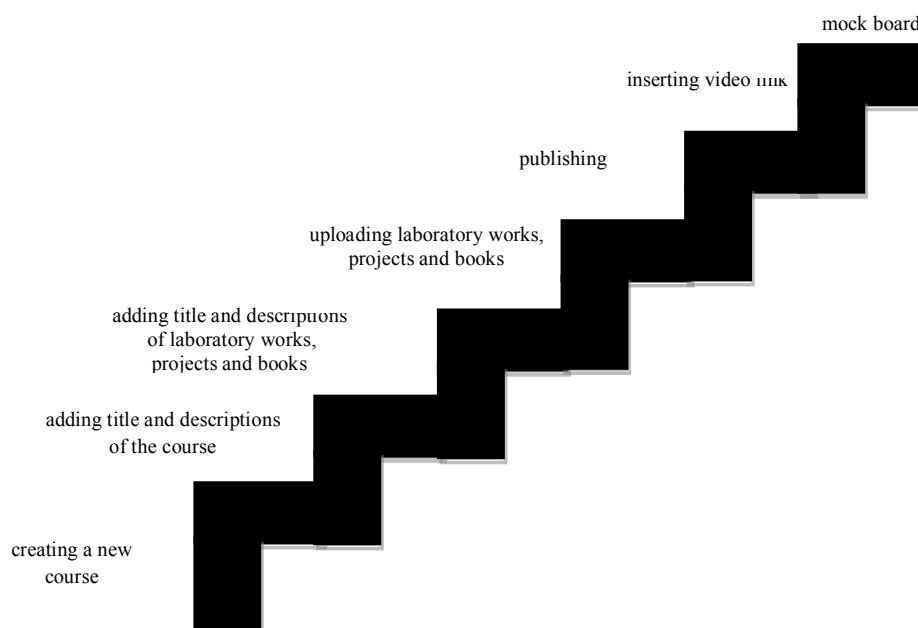


Figure 1. The process of uploading a course to the platform

When teaching staff and students click on a course, they can see a small overview, like a page showing a description and related objects. Users can edit and open the course or even share it via email or other social networks. In addition, the overview has a feature that allows you to expand a course to create a new course starting from the previous one. When developing the described platform, we considered the needs of students and teaching staff for taking or creating a new course. Our solution was to create a platform that is a combination of a classic learning platform like Coursera and code-sharing platforms like GitHub and Bitbucket, offering both the benefit of accessing structured information and creating an open environment. It encourages teaching staff and students to collaborate and provide feedback. We also have added a feature to provide feedback between teaching staff and students.

2.1.2 The concept of using the Internet of Things technology in education (blended learning)

It is a concept whereby students from various parts of the world can participate in the same classes with the help of ICT solutions. It facilitates the intellect and knowledge of many people and increases learning efficiency compared to

what one participant alone can achieve. It helps develop critical thinking and problem-solving skills by accelerating interaction between diverse students.

Virtual instructor

This learning mode focuses on making video lectures available after classes. At the University of Padua, Padua, Italy (Italian: Università degli Studi di Padova), a successful attempt was made to use and implement the IoT on campus. It suggests using Raspberry Pi and a webcam to broadcast online automatically, record a lecture when it starts, and upload it to the cloud when it ends [7]. Such a virtual classroom will help improve the learning and understanding of concepts, as full-subject lectures will be available to students and can be viewed multiple times.

Yonsei University, Seoul, South Korea, demonstrates another successful example of IoT implementation. Through the OCX (Open Campus Experience) concept, Yonsei University strives to manage and provide students with all the information created on campus. Students learn about all cultural, educational and academic events via an internal mobile application synchronised with their calendars. Professors can

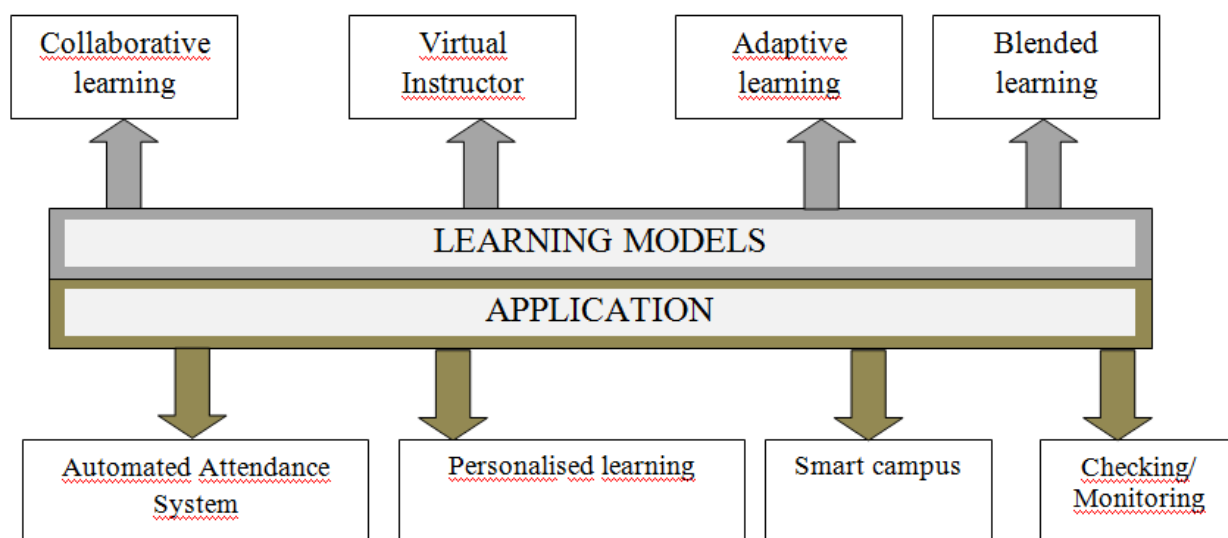


Figure 2. Model of the Internet of Things in education

Below, we will discuss closely the learning modes we indicated in Figure 2.

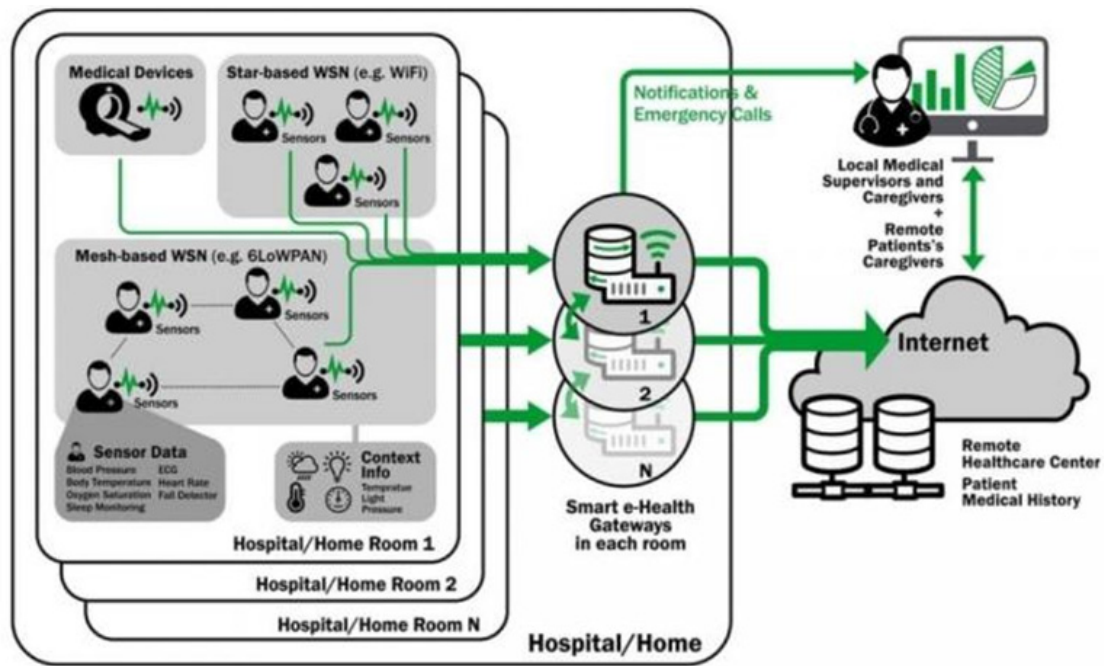


Figure 3. IoT system for detecting stress, depression and anxiety [14]

also record lectures or broadcast them online, and external auditors can review them by connecting through the web platform [13].

Besides, with the help of IoT technology, we can determine whether students suffer from stress, depression, and anxiety. Such technology will significantly affect learning since identifying these issues will be much easier (Figure 3). Thus, we can take steps to reduce and prevent stress, depression, and anxiety in the future. Also, based on the collected data, teaching staff or the administration of an educational institution can adopt methods that will make the lessons more exciting and captivating.

Adaptive learning

It is a data-driven approach that promotes personalised learning for every person. It links the classroom with the real environment, such as the number of students present, room temperature, student activity, etc. It adjusts the way and pace of teaching and learning based on data collected from the students [8].

Blended learning

This learning mode merges face-to-face teaching with e-learning (online) to a certain

extent. There are advantages of a hybrid learning mode. First, all student learning modalities within the specified course are connected, providing an integrated learning environment. Second, the students can fully control the place, ways, time, and pace of learning [9].

Applications

As for applications, we will consider an automated attendance system since we used this system in the abovementioned platform.

To eliminate the problems of managing and monitoring attendance, employing IoT technology, higher education institutions can adopt an automated attendance system. As an automated attendance system, we suggest applying the two different models.

- A fully automated attendance system can be created using Radio Frequency Identification (RFID) technology and Raspberry Pi and PIR sensors. It will use the RFID tag on students' ID cards to mark their attendance. When a student enters the classroom, PIR 1 is activated, and the RFID reader reads the UID on the student's ID card. The system marks the student as "attending" only when the student enters the classroom, and the PIR 2 sensor is activated.

- Using face detection and recognition technology that broadcasts live the students present in the classroom through a camera connected to Raspberry Pi, we connected FaceID to the learning platform [10]. These images are then compared with stored student images to recognise those students who are present and mark their attendance.

Automated attendance monitoring helps eliminate the need to record attendance manually and avoids errors or marking attendance unethically.

Further, we will describe how the IoT affects the teaching staff and students.

Teaching staff

While teaching in traditional classes, the teaching staff is responsible for teaching, taking notes on the board, keeping track of attendance, supervising assignments, and recording results to maintain the overall classroom environment. The IoT in classes will help any teaching staff manage these responsibilities easily.

For example, in an automated attendance system, students will be marked as attending relying on their RFID tags [11] or using FaceID. Then, notes will be automatically available in the cloud before each class, students will submit all assignments online, and the system will automatically manage all student notes. Also, diverse multimedia content, such as educational videos, infographics, complex formulas, and other content, can be easily presented and displayed interactively using smart whiteboards instead of traditional chalkboards.

Students

As for students' learning, the IoT will change their education model in the following ways.

- With the hybrid learning mode, all subject notes, lectures, assignments, and tests will be available on a common platform, and students can watch the video lectures anytime and anywhere.
- IoT classes will help accommodate physical and mental disabilities as students can now learn at their own pace and in their place

without the excessive stress of keeping up with the pace of other students.

- Students may not carry books and notes to classes. So, students can access all resources online through their laptops, tablets, or smartphones.

- Through collaborative learning, students from all over the world can study in the same class together. It helps students expand their knowledge horizons.

Conclusion

Summarising the result of the performed work, we concluded that using IoT technology in education would significantly improve the education system. We assumed the following based on the steps we identified at the beginning of the article.

In the first stage, we determined the need for an IoT learning platform. We have analysed existing platforms to identify their advantages and disadvantages, and finally, we have developed a solution suitable for teaching staff and students to share and contribute to IoT learning materials. SMEDUFACE is a platform where students can find useful information about IoT. Designed for educational environments containing IoT courses, this platform simplifies the course creation process for teaching staff and students by organising everything (like books, platforms, laboratory work and other data) needed for the course in one place.

In the second stage, the IoT has become critical in education, facilitating technical and managerial activities. This article shows the tremendous impact of the IoT on education by defining where it can be applied. Besides, this article found the gaps in teaching methodology and suggested practical methods of using IoT features in education. Overall, the IoT is developing new opportunities for schools and universities by simplifying the work of teaching staff with the help of connected devices to bring IoT technologies to the classroom and move from traditional classroom systems to more intelligent education models that benefit students' learning.

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Ш.С. Туткышбаева, А.Б. Закирова

Л.Н. Гумилев атындағы Еуразия ұлттық университеті, Астана, Қазақстан

Білім берудегі IoT концепциясын пайдалану және оқыту моделі

Аңдатпа. Интернет заты – бұл бір-бірімен, сонымен қатар қоршаған ортаның бір бөлігі болып табылатын, деректерді жинайтын және бір-бірімен алмасатын, интеллектуалды нысандар мен құрылғылардан тұратын үлкен желі. Қазіргі уақытта Интернет заты өте қарқынды дамып, адамдардың өмірін жан-жақты жақсартуда. Мысалы: ақылды қалашықтар, денсаулық сақтау, үйді автоматтандыру, қауіпсіздік және білім беру. Қазіргі уақытта білім беру саласында интернет затының пайда болуымен оқыту мен білім беру моделі көп өзгергенін көріп отырмыз. Мақалада біз білім беруде IoT-тың тәжірибе арқылы оқытатын функциясын қарастырамыз, атап айтқанда студенттердің оқуын жақсартуын. Сондай-ақ біз

Интернет затының аспектілері білім берудің ақылды тұжырымдасы мен моделін жасауға қалай көмектесетініне назар аудардық.

Кілт сөздер: Интернет заты (IoT), білім беру, тұжырымдама, платформа, RFID, оқыту моделі.

Ш.С. Туткышбаева, А.Б. Закирова

Евразийский национальный университет им. Л.Н. Гумилева, Астана, Казахстан

Модель обучения и преподавания с применением концепции IoT в образовании

Аннотация. Интернет вещей (Internet of things) – это огромная сеть разных вещей, в том числе людей, интеллектуальных объектов и устройств, информации и данных, которые собирают и обмениваются данными друг о друге и об окружающей среде, частью которой они являются. Интернет вещей на данный момент очень быстро развивается и улучшает жизнь людей во всех направлениях. Например: умные города, умное здравоохранение, домашняя автоматизация, безопасность и образование. На данный момент мы видим, что с появлением в сфере образования Интернет вещей, модель обучение и модель образование сильно изменилась. В статье мы рассматриваем все практические методы интеграции функции IoT в образование, а именно улучшение обучения студентов. А также мы сосредоточились на том, как эти аспекты Интернет вещей помогут создать более умную концепцию и модель образования.

Ключевые слова: Интернет вещей (IoT), образование, концепция, платформа, RFID, модель обучение.

Information about authors:

Tutkyshbaeva Sh.S. – **Corresponding author**, Ph.D. student in Pedagogical Sciences, Department of Informatics, Faculty of Information Technologies, L.N. Gumilyov Eurasian National University, Astana, Kazakhstan.

Zakirova A.B. – Candidate of Pedagogical Sciences, Associate Professor of the Department of Informatics of the Faculty of Information Technologies, L.N. Gumilyov Eurasian National University, Astana, Kazakhstan.

Туткышбаева Ш.С. – **корреспонденция үшін автор**, Л.Н. Гумилев атындағы Еуразия ұлттық университетінің Ақпараттық технологиялар факультетінің информатика кафедрасының педагогика ғылымдарының докторанты, Астана, Қазақстан.

Закирова А.Б. – педагогика ғылымдарының кандидаты, Л.Н. Гумилев атындағы Еуразия ұлттық университетінің Ақпараттық технологиялар факультетінің информатика кафедрасының доценті, Астана, Қазақстан.