



# The Impact and Role of Internet of Things in Education Sector

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## To Cite this Article

Revathi B and Arulanandam K. The Impact and Role of Internet of Things in Education Sector. International Journal for Modern Trends in Science and Technology 2022, 8(S08), pp. 57-62. <https://doi.org/10.46501/IJMTST08S0811>

## Article Info

Received: 26 May 2022; Accepted: 24 June 2022; Published: 28 June 2022.

## ABSTRACT

*A key priority in education nowadays is improving the methodology of the learning environment and creating multimedia teaching tools. In light of this, the development of an IoT-based wisdom of education platform is really intriguing. The Internet of Things (IoT) is a network of various "Connected Things" that is quickly expanding. Schools, colleges, and universities may increase the security of their campuses, monitor important resources, and improve information access in the learning environment thanks to the growth of mobile technology and the IoT. Instead of the static lesson plans of the past, teachers can even use modern technology to develop innovative lesson plans. The note-taking, schedule checking, and research chores that students currently perform can be automated when they use these mobile IoT devices in the classroom. The use of IoT in academia is comparable to a new wave of change that has opened up new chances and possibilities for the enhancement of both the infrastructure of educational institutions and the process of teaching and learning. The relevance and uses of IoT in the sphere of education are discussed in this paper.*

**KEYWORDS:** IoT; Smart Classroom; Internet; Connected Things; Education

## 1. INTRODUCTION

Anything and everywhere may now be connected to the Internet and become "Smart" thanks to the idea of connected gadgets or objects. Connected devices can exchange information and communicate with one another to help one another make decisions. The phrase "Internet of Things" refers to the entire idea. The most meaningful innovations are those that vanish, claims Mark Weiser. They become so ingrained in daily life that it is impossible to tell them apart [1]. The phrase "Internet of Things" was first coined in 1999 by Kevin Ashton. Numerous scholars have attempted to define the Internet of Things (IoT) in a variety of ways since its inception, including the Internet of Everything, the Internet of Anything, the Internet of People and Services, the Internet of Data, and the Internet of Processes [2]. IoT can

be "anything at all, depending on requirements," claims [3].



Fig. 1 Internet of (Every) Things

The Internet of Things (IoT) network links various gadgets, including PDAs, tablets, smart phones, laptops, and personal computers. Other examples include gadgets that assess heart rate and blood pressure, robotics, self-driving cars, household appliances, biochip wristbands for farm animals or pets, and so on. These devices use a range of sensors and data gathering technology to capture meaningful information, which they subsequently transfer to other processing equipment for analysis and decision-making [2]. Numerous projections have been made regarding the exponential growth of connected devices. By 2020, 20.8 billion new things will be connected, predicts Gartner. The expansion of IoT connectivity is fantastic, says Machina Research: to 27 billion from 6 billion in 2015. IoT will also generate over two zettabytes of data, generally from consumer electronic devices.

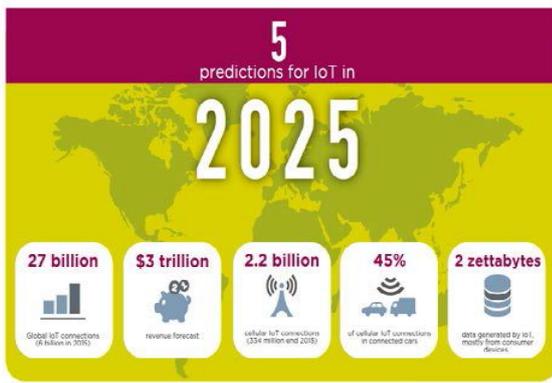


Fig. 2 Five Predictions for IoT in 2025 [4]

Wireless technologies like RFID (Radio-Frequency Identification), ZigBee, NFC (Near Field Communication), WSN (Wireless Sensor Network), WLAN (Wireless Local Area Network), DSL (Digital Subscriber Line), UMTS (Universal Mobile Telecommunications System), WiMax (Worldwide Interoperability for Microwave Access), GPRS (General Packet Radio Service), or LTE (Long-Term Evolution) are used by IoT-based systems to communicate [5].

Security & privacy, availability, mobility, dependability, performance, interoperability, scalability, trust, and management are the major IoT challenges [6]. Applications for IoT exist in a variety of fields, including are Smart Cities, Smart Energy and Smart Grid, Smart Transportation and Mobility, Smart Homes, Smart Buildings and Infrastructure, Smart Factory and Manufacturing, Smart Health, Food and Water Tracking and Security are just a few examples of useful IoT

applications based on the needs of potential users [7]. In this paper, the IoT's place in education is especially discussed. The remainder of the paper is structured as follows: IoT in Education is discussed in Section 2's backdrop and overview, in Section 3's discussion of IoT-based smart environments and their components, in Section 4's discussion of some of the difficulties in integrating IoT into a setup, and in Sections 5 and 6's Future Scope and Conclusion.

## 2. IOT IN EDUCATION

Connecting and educating the pupils has been greatly aided by technology in education. IoT technology has a significant impact on the sector of education. The Internet of Things (IoT) has altered not only conventional teaching methods but also the architecture of educational institutions [8]. Due to its use as a technology tool to improve academic infrastructure and as a subject or course to teach basic ideas of computer science, the term "Internet of Things in Education" is seen as having two distinct meanings [9]. IoT technology is probably improving instruction at all levels, including in schools, colleges, and universities. Everything can benefit from this technology, from students to teachers to classrooms to campuses. IoT is being used in education as a teaching and research tool. The interaction of people (students and professors) and (physical and virtual) things in the academic environment can be facilitated by integrating IoT as a new actor in educational environments, claims [10]. IoT may be taught as a subject and is a great way to introduce students to computer science fundamentals while also keeping their interest [11]. The Open University in the UK developed a new course called My Digital Life for undergraduate computer science students based on IoT concepts after realizing the significance of IoT as a topic of active study. Students can utilize IoT as a tool to comprehend and critically analyze the environment around them and to understand their place in it with the help of My Digital Life [4]. English language instruction uses an interactive IoT model. This technique makes use of voice and visual sensors to correct the pronunciation and mouth structure of English language learners [12]. To gather information and assess students' learning strategies using learning analytics techniques, another system employs objects with tags and a learning management system [13].

### 3. IOT-BASED SMART ENVIRONMENT

According to Mark Weiser, everyone will be able to complete common tasks using smart settings and technologies that are available everywhere [1]. Smart surroundings can include smart workplaces, smart abodes, smart learning spaces, and more [14]. IoT-based smart environments' main goal is to make ordinary daily tasks easier. For instance, when we are driving, we may want to know the best route, the status of the roads, whether there are any traffic snarls, or we may want to switch radio stations. One merely needs to use their voice to obtain all of this information via sensors, actuators, and smart devices [15]. Learning, thinking, and forecasting are three of the Smart environment's main goals. To put it another way, creative environments must learn about or comprehend how the environment able to react according to the action or situation. A smart environment can be expressed "as one that can acquire and apply knowledge about the environment and its inhabitants to improve their experience in that environment" [16].

#### A. IoT-based Smart Campus

Almost every university campus has Internet access, and each campus has a variety of physical features like windows, doors, projectors, printers, classrooms, labs, parking, buildings, etc. These objects can be transformed into Smart objects using sensors, RFID, NFC, QR tags, and other IoT technologies [17]. A Smart Campus can be a system that combines several smart objects. The following could be found on a wise campus:

- Smart E-learning Application with IoT
- Smart IoT-based Classroom
- Smart IoT-based Laboratory
- IoT Sensors for Notes Sharing
- IoT Sensors for Mobiles Devices
- IoT-enabled Hotspot for Campus [8]

In addition to the elements listed above, a smart campus may also have smart lighting, smart parking, smart inventory, and smart tracking of students, commodities, and equipment utilizing RFID technology [17]. The smart education institute features datacenters for processing all forms of data, smart classrooms, smart hallways with info boards, and more [18]

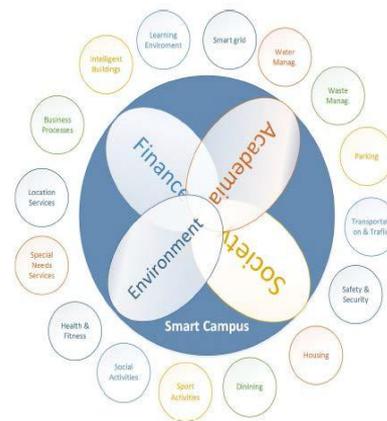


Fig. 3 Smart Campus and its applications [22]

#### A1. IoT-based Smart Classroom

The term "smart classroom" refers to a learning environment that is furnished with cutting-edge teaching tools based on modern technology. These "smart" objects may include cameras, microphones, and other sensors that can be used to gauge how satisfied students are with their education or a variety of other relevant factors. The intelligent object makes managing classes simple and comfortable. The use of IoT in the classroom could contribute to a more favorable environment for learning and teaching.

**Smart Classroom Management:** The phrase "Classroom Management" refers to a teacher's methods or strategies for organizing and running his or her classroom. With the help of smart gadgets, teachers can now choose when to speak out loud in response to students losing interest or becoming less focused [19].

A popular trend among educational institutions throughout the world is the use of IoT devices for teaching and learning, which offers a fresh and inventive approach to instruction and classroom management. These tools are already in use. The following are a few examples of IoT gadgets utilized in classrooms:

- Interactive Whiteboards
- Tablets and Mobile devices
- 3-D Printers
- EBooks
- Student ID Cards
- Temperature Sensors
- Security Cameras and Video
- Room Temperature Sensors
- Electric Lighting and Maintenance
- Smart HVAC (Heating, Ventilation, and Air

Conditioning) systems

- Attendance Tracking Systems
- Wireless door locks

Both teachers and students benefit from smart classrooms because they enable them to understand what and how kids prefer to study. Additionally, smart classrooms aid students in understanding the true value of technology use, which facilitates learning [20], [21]. The development of educational technology has made it easier for teachers to create collaborative, useful, and productive classroom environments that can be controlled by IoT. The majority of recent studies suggest several models for smart classrooms. Numerous cutting-edge and ground-breaking ideas are being presented or implemented in the field of education, such as the use of IoT and crowdsourcing in e-education to enhance the processes of teaching and learning.

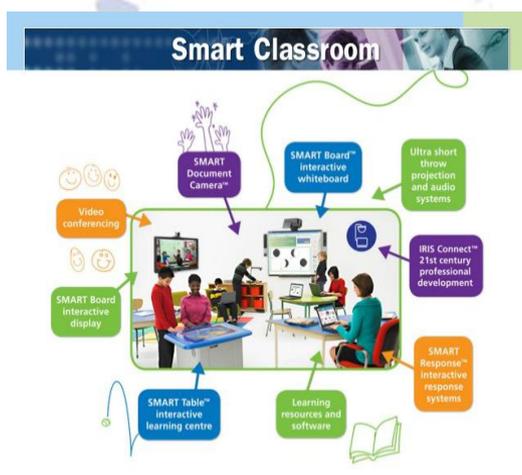


Fig. 4 Smart Classroom

Smart Classroom Attendance System: Taking a class's attendance takes time. Utilizing IoT can help you save time and effort. An effective smart classroom roll caller system (SCRCS) leveraging IoT architecture was suggested in a study to accurately and promptly collect or record student attendance at the end of each period. The ID cards of the students are equipped with RFID tags. Every classroom can have the SCRCS installed, which can read every student's identity card simultaneously. At the start of every session, an LED display displays not just the overall attendance but also all of the students' identity cards in various SCRCS slots. The academic office also maintains a record of each student's attendance [21]. Another study suggested using NFC technology in Android smart phones to create a

web-based attendance system. The attendance is instantly saved on the server when the student taps their matric card against an NFC Android Smartphone. Both teachers and students can use their smart phones to check attendance [22]. Real-time feedback on lecture quality: The quality of the lecture has a direct impact on how well the students grasp it. The quality of lectures can be greatly improved with the help of student feedback. A study proposes a creative environment that can monitor and observe students' reactions to a lecture using sensing and monitoring technology. The real-time feedback on lecture quality provided by this IoT-based smart classroom would aid in improving the lecture quality [23].

## A2. IoT-based Smart Lab

"The college building (or campus) is the lab," it is said. This kind of thinking is associated with the Living Labs movement, which got its start in the EU. Research was done to integrate the Internet of Things, the living lab concept, the i-campus, smart box design, and pervasive interactive programming (PiP). The study's main goal was to instruct novice programmers in the necessary programming abilities by combining IoT with PiP. The evaluation of PiP involved a total of 18 participants, including staff and students. The assessment's findings demonstrated that PiP assisted and supported participants from all backgrounds and age groups in understanding and effectively using programming skills [15]. Using a set of sensors with ZigBee and Raspberry Pi/Arduino boards that provide wireless communication in the lab, a study introduced a lab development kit. For the course labware, a module design approach was used. Students provided excellent feedback in a survey that was used to evaluate the Raspberry Pi-based Lab kit [24]. The authors of the study claim that online virtual laboratories can also help give any educational institution a quality and competitive edge. They provide a case study in which they read and display temperature sensor data using the IoT and Arduino platforms in conjunction with the Xively web service..



Fig. 5 IoT Lab

#### 4. CHALLENGES WITH INTEGRATION OF IOT IN EDUCATION

An educational provider may have to deal with a number of challenges for the successful integration of IoT devices in a learning environment, such as network bandwidth, dependable Wi-Fi connections, web analytics, security, privacy, availability of devices for students, teacher training, and equipment costs, among others. Below is a discussion of a few of the difficulties.

##### A. Privacy and security

As gadgets begin to monitor and gather data from kids, they endanger the security and privacy of those pupils because in an IoT-based environment, data is kept at an Internet-based network of connected devices. Any security lapse could result in the disclosure of a student's sensitive information, including their medical history, financial background, and other private details.

##### B. Dependable wireless connection

New educational technologies are constantly needed, such as high-speed wireless networks that have the bandwidth to deliver instruction in audio and video.

##### C. Organizational Responsibilities

The organization's ability to create an IoT configuration that is both dependable and accessible to all users may be hampered by the incompatibility of some devices and applications. An educational institution must ensure that its IT infrastructure and instructional strategies enable the usage of IoT in the classroom for IoT implementation to be successful. Educational organizations may benefit from investigating and experimenting with IoT options, despite the risks and potential limitations connected with technology.

##### D. Cost

An IoT-based educational institution can be expensive to set up in its entirety. Consequently, the price of tools and equipment presents additional difficulty.

#### 5. IMPACT OF IOT IN FUTURE EDUCATION

IoT will enhance the teaching and learning process in the future. Both kids and teachers will benefit from IoT's convenience. Teachers will be able to carry out their jobs more effectively, and students will learn more. It is anticipated that IoT tools will offer a more enticing, adaptable, engaging, and quantifiable educational system that meets the various demands of a large number of pupils.

Each student spends roughly 1025 hours per year in a classroom. Sadly, more than 308 of the 1025 hours are spent dealing with anticipated disruptions, such as the provision of course materials, transitions, or time spent at the start and end of a session.. According to this statistics, students spend one out of every five minutes in class performing tasks that may be easily eliminated with the help of an IoT network. Less time would need to be spent on routine tasks by teachers, and they might spend more time collaborating with students to assess their development. Additionally, they could automatically record attendance, employ neuro sensors to monitor learners' cognitive brain activity, send haptic sensations to a student's wearable to discreetly remind them to get back on target, and help students understand complex ideas in a short period of time. Even though the majority of schools have not yet implemented IoT programmes, such a setting for learning is not that far off [25].

#### 6. CONCLUSION

The use of technology and particularly the Internet of Things (IoT), in the field of education has created opportunities for fresh, creative solutions to make life easier and better for both students and instructors.

Designing IoT-based learning environments, such as smart classrooms, labs, and entire campuses, is now being researched. There is still a tone of research to be done on IoT in education, including studies into the efficacy of IoT-based smart learning apps. IoT has many benefits for education, but there may be a cost in terms of security and privacy. It's possible that in the future, fresh methods will be developed to address all of these problems.

## Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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