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# Article

## A Review of IoT in Education: Benefits and Challenges

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**Article info**

**Article history:**

Accepted: April. 2021

**Keywords:**

Internet of things;
Modern Digital Tools;
Attendance Tracking
Student;
Student assessment

**Abstract**

Internet of Things (IoT) has emerged as a new technology with the aim of improving diverse sectors. Due to the ubiquity of IoT devices, academic institutions and schools are seeking to incorporate IoT into education activities. The goal of this paper is to review the current state-of-the-art in order to explore the revolution that has been occurred since the incorporation of IoT in education. Besides, the possible opportunities that could be gained for students, instructors, and admins from the adaption of IoT in the educational process are classified.

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## 1. Introduction

The development and growth of the internet is naturally exponential. In the past 25 years, internet has continuously expanded to connect people from all over the world through computers, laptops, smart phones and other devices. Nowadays, with the development of the global internet, various devices such as household appliances, automobiles, different electrical devices and various smart devices can also use internet services to communicate, which leads to the creation of the Internet of Things (IoT). IoT enables different real-world objects called "things" to communicate with each other on the global internet using services that support Internet Protocol (IP) through wired or wireless communication networks. These things can perceive the surrounding environment and act on it autonomously, meanwhile transforming the surrounding physical world into a very large information and knowledge base [1].

The term “Internet of Things” was firstly coined by Kevin Ashton in 1999. Various terms are derived from the literature of IoT technology, including Internet of Everything (IoE), Industrial IoT, Internet of Anything, Internet of People, Internet of Services, Web of Things, Machine-to-Machine communication or Internet of Signs, Internet of Data or Internet of Processes [2].

According to [3], IoT stands for "anything at all, depending on requirements". Cisco defines IoT as a network of connected physical objects. Cisco pointed out: "IoE integrates people, processes, things and data, together to make connections of network more valuable than ever and relevant before turning information into actions that can bring new capabilities, unprecedented economic opportunities, and richer experience, to individuals, companies, and countries [4].

IoT network connects different types of devices, such as personal computers, tablets, PDAs, laptops, smart phones and other handheld embedded devices. These devices collect useful information through various sensors and data collection technology, and then transfer it to other processing equipment for interpretation and decision-making [3].

The core function of the IoT lies on the ability of devices to exchange information without any necessary human intervention. This phenomenon is called as communication of Machine-to-Machine (M2M) [5, 6]. IoT-based systems communicate via wireless technologies [7], such as Radio Frequency Identification (RFID) [8, 9], ZigBee [10], Wireless Sensor Network (WSN) [11]. Figure 1 shows the connectivity between devices to exchange information.

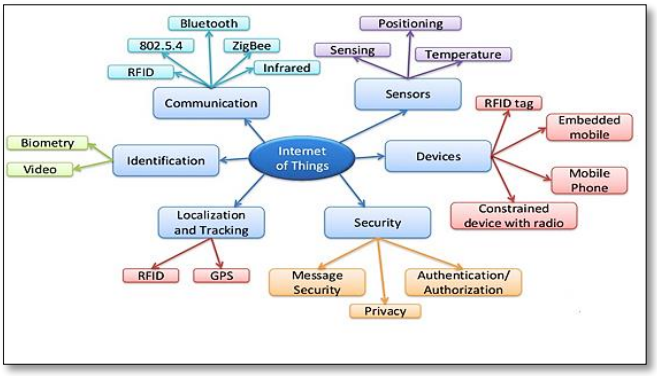


**Figure 1**. IoT connectivity [1]

IoT applications have been used in multiple fields such as smart retail, medical services, smart home, customer service, industrial Internet and environmental monitoring. Now, due to its ubiquitous nature, schools and academic institutions are seeking to incorporate the IoT into educational activities to benefit teachers, students, employees, and the entire education system. For this purpose, many researchers conducted to suggest applications of IoT to solve various models, objectives, specializations and concepts in the field of education [12]. The main purpose of this work is to discuss the usefulness

and applications of the IoT in the field of education. Moreover, we focus on opportunities of IoT in field of education especially with all interconnected actors (instructor, students and staff) in the education process. In addition, we discuss the challenges of IoT in field of education. The rest of the paper is organized as follows: Section 2 presents the literature review; Section 3 presents the IoT in learning process, Section 4 presents the benefits of IoT; Section 5 presents the challenges of IoT; Section 6 presents the conclusion of paper.

## 2. Literature Review

Educational technology has played an important role in connecting and educating students. IoT technology has a significant impact on the education field. IoT does not only change the traditional learning and teaching methods, it also changes the infrastructure of educational institutions [13]. IoT technology may play an important role in improving education at all levels including universities, colleges and schools. From students to teachers, from classrooms to campuses, everything can benefit from this technology. There are many researchers discussed the IoT in education.

M. Kassab et al. [12] summarized and categorized the existing benefits and challenges of integration of the IoT with education field, and proposed a framework to appropriately position and promote new research activities. They conducted a systematic literature review to extract, evaluate, identify and synthesize some published researches about the symbiosis of IoT in education to answer some research questions and determine the state evidence with in-depth analysis.

IoT is the most challenging platform to specify the association of physical objects in the near future. M. Al-Emran et al. [14] highlighted the latest developments in the adoption of IoT applications in education and provided various opportunities and challenges for future experiments. The authors summarized the horizons of IoT technologies in education in general, medical education and vocational training in particular, in addition to discussing wearable technologies and their relationship to education and education with green IoT.

A. C. Martín et al. [15] analyzed the current situation of smart education. A study of the development of published papers on smart education, its technologies, keywords and methods of data collection and analysis, education level and localization. The developed systems in the selected papers were also reviewed, and their quality and feasibility evaluated. At the end of the research, they identified the opportunities and the most important areas for improvement. They concluded that, despite the vagueness of the term, there do exist developments today that can make educational technology more suitable for learners, thereby providing a foundation for smarter ways of learning.

A. M. Alalade et al. [7] provided a little insight on the basic knowledge of the IoT, its architecture, its core fundamentals, and furthermore contributed to understand the application of the IoT in the education field. This research was carried out in a more advanced and state-of-the-art IoT-centric teaching plan, which included smart laboratories, smart classrooms, and the entire smart campus.

D. D. Ramlowat and B. K. Pattanayak [1] addressed the importance of IoT technology in the field of education to improve efficiency of teaching and learning process. They focused on the innovations suggested by several authors about implementing IoT resources in the field of education, such as distance education, computer science education, consumer green education and

medical science education. The interrelationship between IoT and the cloud-computing paradigm discussed in education.

S. Pervez et al. [16] discussed several aspects of IoT with respect of productivity levels, which helps contemporary learners and educators to learn from the results of the processed data. They showed the different learning trends and the success rate of these application methods. They also discussed the various educational perspectives that must be incorporated when developing educational curricula to meet the requirements of society's smart literacy. The results assisted decision makers and recommended the use of more professional methods to improve the better teaching model platforms in specific communities.

Das et al. [17] studied and discussed some of IoT-based applications in depth, such as smart classroom, smart e-learning, smart library, etc. In addition, they discussed the technologies needed to enable urban and rural residents to use an education system based on the IoT. They tried to address this gap and find a new direction to help integrate the knowledge of rural and urban students and empower people through the power of IoT. Their work discussed the importance of applications and technologies required to build a smart education system, and helped researchers think about new applications and technologies based on the IoT.

## 3. IoT and Participates in Education Process

Now, due to IoT's ubiquitous nature, academic institutions and schools are seeking to incorporate IoT into educational activities to benefit students, lecturers, administrators, and the entire education system. Many researchers discussed IoT's opportunities in education and classified it. M. Kassab et al. [12] identified three dimensions to classify benefits of IoT in education field and discussed its benefits for each dimension such as perception, learning principles and education sitting (mode). Figure 2 shows the three-dimensional scheme for IoT in field of education. A perception is a way to look at something, to understand or interact with. More specifically, perception refers to the stakeholder role, which requires the IoT system to provide one of its services in an educational environment. Stakeholders have a goal with respect to the system, one that can be satisfied through its operations. They have identified three different main stakeholders from the extracted scenarios. Each of the main stakeholders has a perception when they interact with IoT technology when deployed in the education field: student, instructor and staff(Admin) [12]. However, the authors presented IoT applications and services in education in relation to the three stakeholders involved in the educational process according to their perception in general without classifying IoT services for each participant in the educational process in a detailed manner.

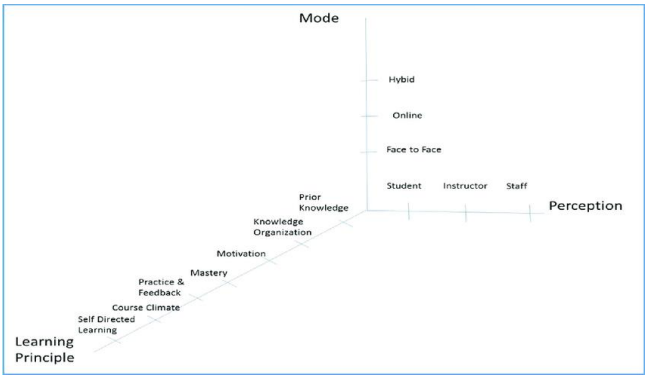


**Figure 2.** The three-dimensional scheme for Internet of things in education[2]

IoT has the potential to greatly change the educational process and the relationship between the participants in education process. In this paper, we focus on IoT in field of education specifically, IoT opportunities for each service

related to the stakeholder involved in the educational process separately. Figure 3 shows IoT opportunities for the services of the three stakeholders involved in the educational process.

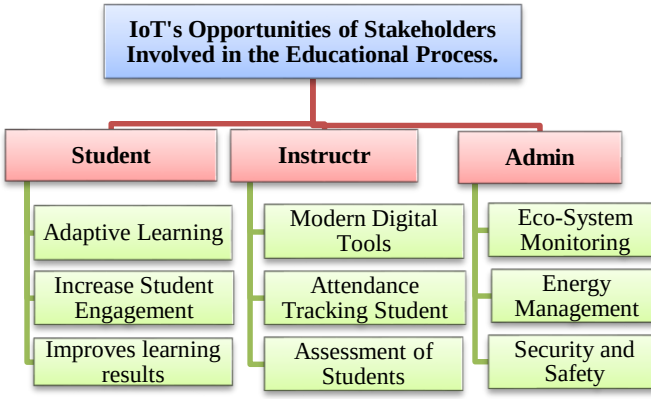


**Figure 3.** IoT's opportunities of stakeholders involved in the educational process.

## 4. IoT Benefits of Student

The definition of student includes scholar, learner, and pupil. A student is one of the key chain links in the education process. We can study the opportunities of the IoT in education specifically, for students. Moreover, IoT can provide students with disabilities with the help and support they need to achieve a good quality of life and allow them to participate in social and economic life. In this section, we will discuss the most important opportunities of IoT provided from a student's perspective with/without disabilities as follows:

### 4.1. IoT-based Adaptive Learning

There are many opportunities that have made learning adaptive according to student's needs. IoT not only provides learning, but also supports learning. IoT may create a customized learning environment according to students' individual learning style, personality, level of achievement, strengths, feelings, interests, or cultural background of the students. Moreover, IoT helps to make learning available when needed by the student and at the time when the student needs the information or knowledge. The most important and newest opportunities based on IoT which have made learning adaptive discussed and proposed by many researchers such as the use IoT to assist students with disabilities, personal learning and ubiquitous learning.

Sula et al. [18] implemented the performance of a new system based on IoT and P2P technology for supporting learning process and improving the life quality of children with Autism Spectrum Disorder (ASD). They used SmartBox device and JXTA-Overlay platform to monitor the children and create P2P communication between children, caregivers and therapists.

R. Mehta [19] talked about five ways of IoT to change education and the field of learning from special education. Anyone who is slightest interested in the education of special children will know the role of bibs of technology. Children with autistic respond very well to tablets, as do children with other diseases. Children with ADHD, dyslexia or other learning disabilities can greatly help them through any available technology. Along with this, smart schools also have a system for educating people like special students. The public will therefore have more understanding and openness to special individuals. It is easier for special children to work in a neutral environment and alone.

Sula et al. [20] proposed an intelligent auxiliary environment system that used heuristic diagnostic teaching process. The purpose was to identify each student's mathematics learning ability and their creative characteristics. The proposed system used computers, sensors, RFID tag readers and SmartBox devices to support the learning of students with autism spectrum disorders by providing a case-by-case basis-based personalized feedback and practices.

M. C. Domingo [56] proposed an appropriate learning environment for learners with special educational needs. IoT created a user friendly environment for people with disabilities and helped for their social integration. The smart devices and applications facilitated the management and execution of daily activities made them more.

With regard to personal learning, A. Uzelac et al. [21], a smart classroom was proposed, which can measure the level of interest of students by using cameras and microphones to monitor their behavior. The influence of different parameters in the physical environment (such as temperature, environmental noise and CO2 level) on students' attention is also analyzed. This helps to customize the way of personalized learning plans.

S. Meacham et al. [22] proposed an IoT system that enabled a large number of students in lecture class and laboratories to conduct personalized education. The proposed system based on a case study based on the work of a medium-sized university in the UK.

M. Kravčík et al. [23] mainly focused on IoT and related technologies to study how to improve this filed. They claimed that proper interpretation and analysis of big educational data, which can make personal learning and training experiences more accurate, personalized and adaptable, thereby making them more effective, attractive and efficient. The information collected through a rich palette of available allows for better personalization and adaptiveness of learning.

Recently, the concept of personal learning environment (PLE) has emerged, opening new doors for more effective learning and overcoming many limitations of the traditional TEL model. According to Chatty et al. [24], they provided details of the theory, design, implementation, and evaluation of mixed and match personality learning environment framework (PLEF). The main purpose of PLEF is to help learners to use various digital media and data to create custom learning mashups.

Finally, learning can be adapted to the student's needs by ubiquitous learning which means students will able to learn from anywhere at any time. A. Labus et al. [25] focused on integrating wearable technology into the e-learning structure so that ubiquitous learning can be achieved through devices interactions and collaborative work. They proposed an integrated model that enables this goal to be achieved. The proposed model consisted of physical wearable technology infrastructure, software to run devices, and cloud computing platform.

An attempt of transferring learning from traditional form to e-learning was proposed by

K. Papadokostaki et al. [26]. They explore the experience API specification and examine how it can be used for the implementation of adaptive learning applications to make ubiquitous learning real for different learning level

R. Xue et al. [27] proposed a framework based on IoT to construct ubiquitous learning environment. This framework was divided into three main layers including application layer, network layer, and perception layer. Besides, its architecture was clearly presented, and its applicability was articulated through an example.

K. Mershad and P. Wakim [28] proposed "Remote Lectures" to enhance LMS framework through the utilization of IoT infrastructure. Communication towers were used to transmit multimedia and data to distant locations. Some IoT devices were installed in the classroom to record and transmit the delivered lectures and its related material such as lecture notes, interactive exercises to the LMS of the enrolled students. Their proposed gave students more flexibility in managing their schedules. However, the proposed feature allows students to capture all important resources related to the lecture from anywhere and at any time.

### 4.2. IoT-based Increase Student Engagement

Utilizing IoT infrastructure in learning increase the growth of student's engagement in the learning process. Student engagement is a multifaceted theory that constitutes of three factors; behavioral, emotional and cognitive engagement. Many researchers discussed opportunities for IoT to make education more enjoyable and attractive, which leads to maximizing student engagement in education. The most important is making the learning process more interactive, just like playing the game or providing interactive environments between students themselves and between students and teachers.

If we consider student engagement in education as the degree of attention, curiosity, interest, inquisitiveness, motivated, optimism, awareness and passion that students/learners show, which extends to the enthusiasm level they must improve and study in their education. Two-sided interactive feature of IoT device makes it an effective tool that facilitate greater student participation in the process of learning. Through various communication technologies available in the IoT learning environment, students can answer questions and provide feedback quickly and repeatedly. Also, the instructors can define various strategies and techniques for education in order to capture the feedback of learners in real time [29]. The principle of improving students' "motivation" is addressed through bridging the communication between teachers and students using the IoT. In this context, based on cloud computing platform technology, combined with internet and web technologies, an innovative interactive platform for ideological education is proposed [30]. The platform includes five functional layers and three-layer architecture. The feasibility of this platform has been verified by studio visual as the development environment and the expression of ASPX documents [30].

S. Satu et al. [31] proposed an educational platform called the intelligence of learning things (IoLT). It is a blended learning method based on the IoT, which can enhance traditional education systems through innovative and interactive learning strategies and technologies. In this platform, different applications and devices can be used to collaborate and share their ideas with stakeholders (for example, teachers and students) through the system using IoT. Therefore, the proposed model able to ensure smarter and more effective method than traditional methods.

J. Henry et al. [32] introduced a computer algorithm used to quantify student engagement based on individual feedback, attendance, and punctuality. The data algorithm uses game points to depict the results to meet the needs of gamification, serious games and edutainment. By including the IoT, they obtained behavioral engagement data related to real-world events. In addition, they introduced the IoT as a tool to measure the impact of the real-world environment on student engagement.

R. Garris et al. [33] proposed an input-process output game model, which focused on the instructional games and it engagement to learners to accomplish better learning outcomes. The proposed model detailed a repeated game cycle that include user behavior, user judgement and feedback of system and encourages interacting with a game.

Z. AjazMoharkan et al. [34] discussed some applications of IoT in education in general, and in e-learning in particular. In addition, they proposed smart learning model based on the IoT and e-learning gamification technology. The proposed educational model was smart and participatory due to the application of gamification concepts, which made learning more attractive.

### 4.3. IoT Improves learning results of students

IoT can assist institutions to improve the quality of learning and teaching by providing a richer learning experience and real-time actionable insights into student performance.

Bob Nilsson et al. [35] argued that today's education field has used IoT devices such as tablets, e-books, fitness bands, sensors, augmented reality and virtual reality headsets to track and monitor students' various Aspects, such as understanding students' learning patterns.

A. Uzelac et al. [21], a smart classroom was proposed, which can measure the level of students' interest by using cameras and microphones to monitor their behaviour. The influence of different parameters in the physical environment (such as temperature, environmental noise and CO2 level) on students' attention is also analyzed. This helps to customize the way of personalized learning plans.

## 5. IoT Benefits of Instructor

University professors or school teachers-they are all called instructors. They also get a lot of benefits from IoT in education. When we come to IoT's opportunities and their innovative technics of instructors, it is clear that technological developments have brought some noticeable improvements in the teaching process. [41]. IoT helps instructors to focus on student learning instead of wasting time to maintain large procedure when dealing with students in the classroom. Networked devices can save time and allow instructors to focus on cultivating some extra qualities of students [39]. In this section, we will discuss four of the most important IoT opportunities that can improve teaching process. The Strong Sides of IoT from an instructor perspective as follows.

### 5.1. IoT-based Modern Digital Tools

IoT offers modern digital tools to better explain new subjects and classroom management. A. M. Alalade et al. [36] discussed different physical applications of IoT in different areas of academia, including IoT in the classroom. Recently, a very powerful teaching platform called smart boards have been used in the classroom. With online presentations and videos, it can help teachers explain lectures more easily. In addition, interactive tools such as educational games and exercises can be used through the smart board, which is very helpful for educating students effectively. Furthermore, they discussed other ways to incorporate IoT in education involves the use of Web-based tools, programs, smart marker, and smart cameras.

J. Vihervaara and T. Alapaholuoma [37] emphasized that IoT is capable to improve vocational education and training in many ways. IoT can be an effective educational tool for building coaching skills of students trying to find answers to undiscovered problems using electronic devices.

The term "classroom management" represents the way a teacher achieves ordered in the classroom. With the help of smart devices such as cameras, microphones and many other sensors, which can measure how students are satisfied with the things they learn about the term, classroom management becomes very simple and easier to understand. Moreover, teacher can know when to talk louder, when the concentration of students is falling down and when to take a break [38]. IoT can help to improve the learning environment in the classroom for higher education. It provides a good level of control and a large amount of sensor data, allowing instructors to adjust classroom conditions according to the subject and time of day continuously. The intensity of natural light and artificial light can be controlled. It can improve air quality and noise levels. By monitoring the ambient sound level at the back of

the room, you can alert instructors when their voice is difficult to understand [35].

### 5.2. IoT-based Attendance Tracking Student

IoT automates students' attendance tracking instead of manual process done by the instructor, which in turns save some times for instructors. Therefore, IoT-based attendance management system will reduce the overhead of calculating attendance hours [39].

One of the simple techniques that is focused on taking student attendance is proposed by F. Akhter et al. [39]. This system utilizes IoT to collect student attendance and to store them securely in database. The system architecture is constituted of some modules including FRID, NodeMCUV3, and fingerprint sensor which is used as an authentication tool. Whereas, RFID module is responsible for scanning RFID tags and sends data to the central server. The system then able to generate attendance reports based on the collected data.

When students attend the classroom, they can use smart devices (such as Nymi) to automatically record their attendance. The device is a wearable "smartband" that uses the wearer's ECG pattern to verify a student's identity [40]. On the other hand, a face tracking approach was adapted in the work proposed by S. R. Babu et al. [41] to automate students' attendance process. They used techniques such as face recognition, object detection, and convolutional neural networks. The proposed system has reduced training time and computational complexity compared to the current system.

Z. Jiang [42] proposed IoT-based student attendance management system, which employs some key technologies such as embedded development, ZigBee, RFID, and others. Using the RFID technology and WSN technology to capture the student's trajectory, it can provide record and analyze students' activities trajectory, analysis data for the student attendance management system, and grasp real-time dynamics of students.

The system can effectively strengthen the supervision of student activities, reduce the burden of attendance management of teachers and students, and improve the level of intelligent management, which has important practical significance for the construction of an intelligent campus.

P. Tan at al. [43] designed and implemented an IoT-based teaching management system to help teacher to perform automatic attendance record and strengthen student learning motivation. It used an open source hardware platform such as RFID-RC522 and Node MCU to implement a Wi-Fi-supported RFID reader. The proposed WiRF system used to record students' attendance and record their behavior automatically to assist the teacher. The system has a positive impact on student learning in higher education and improves student attendance rate.

H. Rjeib et al. [44] proposed a system of attendance management (AMS) students based on RFID, and an information service system for an academic field that used RFID technology in addition to programmable logic circuits (such as Arduino) and Web-based applications. The proposed system not only save time, but also reduce documentation work without any power consumption.

On another hand, a web-based attendance system is proposed in [45] which use NFC technology that is available in smart phones. The attendance rate will be automatically saved on the server when the student clicks the matrix card on the NFC smart phone. Both students and teachers can check their presences via their smart phone [45].

B.I Ahmad [46] proposed NFC-based smart attendance system to simplify the process of attendance, by simply the lecturer's NFC-based

mobile device in the class or touching an attendance poster. The system presented substantially improved the current attendance registration system and eliminate many paper works involved in it. Other benefits include save the attendance data, facilitate the creation of various attendance reports, and make the attendance decision-making process is simple. Moreover, one of the main distinguishing characteristics of their proposed system is that the hardware required is minimal.

K. Ashwin et al. [47] proposed a method to monitor student attendance by using the RFID tags in the student ID cards. When a student enters the classroom, the system records the student's ID and uses Geo-fencing technique to track their current location on the campus.

### 5.3. IoT-based Assessment of Students

IoT presents some new methods to assess the students. The benefit of incorporating IoT technology in students' assessment is to automate some of tedious instructors' tasks and save time. As a result, the automation of grading assignments tasks will certainly reduce instructors' efforts and allowing them to focus more on enhancing their teaching skills.

K. Mershad et al. [48] introduced the "Students Assessment" application integrated within the proposed LearnSmart LMS [28]. The application uses IoT tools and services to automatically assess and grade students after completing laboratory experiments. The proposed application exploited the power and ability of IoT to enable lab instructors to monitor students' activity while they are conducting experiments, and then automatically evaluate and grade them. The proposed application is one of the first applications that uses IoT and machine learning tools to assessment student in laboratory experiments.

M. Rhoads and B. Stachowiak [49] in their book on the added value of technology in teaching, conclude that educational institutes and instructors must always invest in better understanding the importance of regularly analyzing assessments in a qualitative method instead of only depend on quantitative results and how it can really assist improve learners' performance, and in constantly pursuing advanced and efficient assessments tools.

M. Farhan et al. [50] developed an IoT-based interoperable model to analysis of different students' response to e-Learning by using data collection workflow and an algorithm for attention scoring. This was applied to students attending video lectures comprising an electronic learning component of their studies.

S. Shapsough et al. [51] proposed a mobile/tablet-based assessment system that uses smartphones and tablets to carry out evaluations and allowed real-time reporting. They used the architecture of MQTT publish-subscribe to provide almost assessment services in real-time to various types stakeholders of educational process including educational planners, teachers, principals, and parents. The proposed system collected and delivered assessment data involve sensor information from mobile devices used by students and teachers. The results of the system analyze generated by the analytical engines by the system were directed in real time to the appropriate stakeholders. A preliminary analysis of the proposed system showed promising results in terms of low power consumption in mobile devices and good scalability.

P. Verma et al. [52] presented a system for students to communicate with each other and objects related to the course. They proposed smart computing-based framework is divided into five-layers to facilitate the automation process of student performance assessment in engineering institutions. The daily activity dataset of students

created based on the sensing ability of IoT nodes. They used GPS and RFID sensors to obtain the location of students and objects, and analyzed the activities of students. The collected data is used to evaluate students' performance in the course.

## 6. IoT Benefits of Administration

Here we will focus on the potential benefits that would be obtained from IoT-based systems for dean, manager or the provost. IoT has the potential to produce significant gains in higher education institutions, especially in the automation of buildings, maintenance systems, energy management, environmental control, access systems to buildings and spaces, large systems of research environments, academic learning systems and safety systems for students, teachers, staff and the public. Many researchers discussed and proposed different IoT-based systems which offer opportunities for admin such as smart monitoring, increase security and safety, institutional energy management and LMS content can be modified.

### 6.1. IoT-based Eco-System Monitoring

IoT assists in smart monitoring of buildings including HVAC system, lighting, locks and monitoring students. M. Cata [53] proposed a model for a smart university that uses five main categories of sensor devices. According to many applications inside smart universities, they benefited from IoT services, such as: (1) smart parking that monitor vacant parking, thereby avoiding congestion or accidents; (2) smart lighting that can be based on external natural light data collected from sensors in order to automatically reduce classroom lighting, thereby reducing power consumption; (3) smart tracking, by using RFID technology to evaluate any emergency, so as to monitor the goods and equipment inside the university; (4) smart inventory, which can read QR by using a barcode reader labels to identify any equipment associated with barcodes. Since the health state of students is a key factor in determining the overall academic performance of students, it is essential to obtain high-quality medical services in any educational institution.

With respect to student monitoring, M. Kassab et al. [12] discussed some researches that attempted to monitor students in online laboratory and education settings. Due to the fact that student health state is extremely affect student’s overall academic performance, thus granting access to the health care services is important for establishing effective education. A study [54] showed how to use RFID to build eHealth system to monitor students at risk of hypertension as a wearable device. The system focuses on some health information of various students, such as medical history, electrocardiography (ECG) results, prescriptions, blood pressure, and other vital signs by IoT technology.

### 6.2. IoT-based Energy Management

IoT has been used in energy management to improve energy efficiency for a more sustainable future. This has led to the introduction of Smart Grid, which is a special form of energy management application in the IoT by many governments [55].

In order to provide a healthy atmosphere for learning and teaching, IoT allows the creation of a green campus environment for universities by reducing monitoring and controlling energy, CO2 emissions and water use [56]. With respect to energy saving, a work published in [57] proposed a green campus architecture to manage computers and air conditioning systems.

As a real example, COMFORTSENSE is an energy management system, which implemented in Campus Luigi Einaudi, University of Turin. The project utilizes the benefits of IoT technologies to advance building energy

efficiency and comfort [58]. The focus of this system is to consider campus areas and university buildings as a “living lab”, and thus collect data through smart phones and wearable devices instead of using traditional data collection ways.

### 6.3. IoT-based Security and Safety

IOT can improve security and safety. Smart technology can make schools safer. Several academic institutions for instance San Francisco University have combined technologies of IoT to enhance security and safety of campus[2]. For example, wearable wristbands can register entering of students to academic institution premises and classrooms. No more strolling between lessons or during lunch time. This measure also helps prevent unauthorized persons and other intruders from entering the school. In addition, more reliable surveillance cameras are used to monitor corridors and surrounding buildings to ensure the safety of students [3].

A. B. Manduri et al.[4] used the core technologies of edge computing, IOT and cloud computing design the framework of an intelligent emergency alert system. IOT is committed to developing the world smarter and can make a significant contribution to the design of the Framework of Smart Security (SSF) for educational institutions. They tested the proposed system on Cisco Packet Tracer 7. The results showed that the approach used in this system proposed plays an effective role in alerting security not only in institutions of educational but also in other institutions as well.

With the combined technology of IoT and RFID, schools can generate real-time pre-recorded announcements for various emergencies. Educational institutions can immediately close the door in case of panic or emergency. In addition, parents can also track their children's real-time movement, especially the duration of school entry and exit at the same time. At the same time, the staff can ensure that the students are in the classroom they should go to [5].

D. Palma et al. [6] developed an NFC-based classroom access control method to create a real-time classroom control tool. The system of classroom registration is based on a network of a set of connected sensors that collect information about classroom access and display the classroom status on a web-based application and TV panels of university.

## 7. Challenges with Integration of IoT in Education

IoT technology plays an important role in improving the educational processes. IoT influences on student, instructor and admin, in addition it transforms and improves education methods. Many studies have discussed the benefits of IoT in the educational process, both for the student and for any participant in the education process. On the contrary, there are many challenges associated with applications of IoT in education filed. Some issues are very specific and affect only a small number of people, such as disability, while others are more common [15]. For instance, adaptation to new technologies. According to the analyzed paper, the challenges to education in general that need further research are:

### 7.1. Security and Privacy

Security requirements have always been an important aspect of education filed. Concerns about security have increased due to the increase in communications and complexity of IoT technology. The "security / privacy" quality concerns are the most discussed because most studies have discussed them [12]. One of the most important security issues facing the education is the exposure of educational institutions to electronic attacks (cyberattacks), which will prevent schools / universities from operating as intended. Due to the

interconnectedness of the large number of devices, Cascade failures may appear, making it difficult to protect simultaneously with all related problems via antenna transmission. Data breaches considered a security challenge. Regarding privacy, whether that monitoring is known or unknown, many devices used in specialized pre-configured IoT will collect different data. But why collect this data, who owns it and where is it going? The legal professions, government agencies that oversee education, and a series of education standards should answer these questions [62].

### 7.2. Humanization

The ethical role that IoT may play in a person's life is questionable, especially with regard to personal control. IoT applications involve more than just devices that interact with each other. The success of IoT mainly depends on the way of connection technology, rather than the humanization of connection technology. IoT may make people move toward specific habits, thereby reducing people's autonomy, thereby transferring power to companies that focus on gains financial. This means for the system of education that the influential factor is the organizations that controls the tools and techniques used by academic professionals, not the academic professionals themselves. The valid concern is dehumanization in interacting of humans with machines. Numerous studies indicate that the interaction between students face to face will benefit social skills of children, and it will contribute positively to build of character. Hence, going to school is the problem that may arise from the increase in IoT technologies in education as a result of the partial loss of the social aspect [12].

### 7.3. Scalability

Scalability creates concerns regarding the big data and the cost of implementing IoT in education. The integration of the IoT in education filed is no exception. Incorporating the IoT into education will generate great volume of data. Therefore, the data needs to be managed, analyzed and processed to obtain information and trends. Moreover, there have been several papers focusing on data visualization technology and dashboards. There is still a long way to go to deal with the large amount of data generated in the intelligent education environment, display them correctly and make it easier for students and teachers to understand the data. [26]. With scalability, concerns related to discussion about the cost of IoT technology in education have also become important [30]. Financially, there are immature experiences everywhere [11]. For example, admin, student and teacher training [25], the reduction of public service investment, the current situation of the world economy [1], and the limited resources of universities have prevented the smart campus from becoming a reality [19] The question that arises is how will schools and universities purchase and maintain this equipment? The financial obligations resulting from the shift to an IoT ecosystem focused on education cannot be underestimated. The economic benefits of IoT in education are discussed in the following four selected articles [54].

### 7.4. Adoption ICT in education

In many developed countries the use of ICTs in education extensively studied, yet in developing countries it is still neglected. In order to help decision-makers take effective measures for its dissemination, researchers and scientists need to examine the factors that affect its accreditation.

### 7.5. Adapt and Attract Education

Most students use multiple devices and social networks to connect their education to the Internet. More research is needed to understand how students connect to the Internet to increase their learning and application of knowledge. An effective digital curriculum model can guide the current work of using IoT in education. Scientific research aims to improve the existing teaching structure and forms to create personalized and digital curricula in effective manner for ordinary and disabled students to use in informal and formal education; what makes students more interested and attracted is that they go beyond the ideas that are be traditional and the concepts and learning activities to create something novel and meaningful things.

## 8. Conclusion

IoT improves learning, teaching, and management, and many educational activities. In this paper, a survey of IoT in education activities specifically, to study how this kind of IoT technology with its unique system functions (such as sensing and decision-making) supports and challenges the pedagogical process of all relevant participants (teachers, staff and students). In addition, IoT challenges are showed and explained. As a future work, it is possible to work on enhancing the current work by presenting IoT technologies and tools for each IoT services and opportunities for each participant in the educational process separately and proposed new techniques can solve the challenge of IoT in education.

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