

## **Internet of Things for Education in the Digital Age**

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### **Abstract**

The use of Internet of Things (IoT) has a fundamental impact on every aspect of the way we live and work nowadays. In the education sector, IoT has brought a huge change and new opportunities. As seen, IoT provides new ways of teaching students, such as smart boards, digital textbooks, and increases safety within schools and colleges, such as smart door lock, face recognition, asset tracking. However, IoT in education still faces some challenges. Teachers, administrators, and stakeholders should beware of the advantages and limitations of IoT so that they can use IoT effectively in the education system.

*Keywords: Internet of Things, IoT, IoT in education, advantage of IoT, challenge of IoT*

### **1. Introduction**

The continuous progress of Internet of Things (IoT) and digital technology has impacts on every sector—be it economy, society, healthcare, business, science, agriculture, government and education. The advancement of IoT has brought in changes in education. It facilitates teaching and learning modes, and helps solve various education problems. These changes are still ongoing due to the rapid growth of digital/ smart devices. In this transformed context, learning can occur at anytime and anywhere. Traditional teaching and learning modes cannot create interest and enthusiasm in students. Applying technology into education systems in the digital age appears a great challenge for educators to ensure efficiency and effectiveness of learning management.

Global IoT connections are predicted that there will be more than 25 billion by 2025, up from about 7 billion in 2017. The Asia-Pacific region is forecasted to become the largest global IoT region in terms of both connections and revenue by 2025. However, the education sector has a little IoT revenue portion compared with other industries (Rishi & Saluja, 2019).

### **2. What is IoT?**

IoT is the connection between machines or other everyday objects with sensors to the Internet ranging from toothbrushes to shoes or umbrellas. This connectivity allows things transmit information remotely over the Internet (Mitew, 2014). For consumers, IoT provides many solutions to solve pain points in their daily life and improve energy efficiency, security, health, education and so on. For enterprises, IoT has the potential to deliver solutions which improve decision-making and productivity in manufacturing, retail business, agriculture, healthcare and other sectors (GSM Association, 2014).

“Things” as a term in IoT, is the device which has four characteristics (Palma et al., 2014).

1. The device must be capable to collect and transmit data. IoT devices need to exist in environments where information can be collected and sent to other devices or directly via the Internet.

2. The device must have ability to respond. IoT devices can be programmed to act according to specific conditions.

3. The device must have ability to receive information. IoT devices can receive information from the network.

4. The device must have communication capability. IoT devices belong to a network of devices which can communication with each other within the same network.

IoT is transforming connectivity among devices and objects. It helps people to get remote access easily. IoT system comprises on the key 4 main components on which IoT works on as below (Dataflair team, 2018).

### 2.1. Sensors/Devices

Sensors or devices connected directly or indirectly to IoT networks after signal conversion and processing. They help collect data from the surrounding environment for smarter decision making. These collected data can have various types. It may be just simple data, such as temperature, humidity or it is very complex data such as full video. One device can has multiple sensors. For example, smart watch has multiple sensors such as GPS receivers, accelerometer, gyroscope, pedometers, heart rate monitors and the like.

### 2.2. Connectivity

All collected data must be sent to a cloud infrastructure and it needs a medium for communication and transport, such as Low Power Wide Area Networks (LPWANs), Cellular networks (3G/ 4G/ 5G), Bluetooth, Wi-Fi, and RFID. Each connectivity technology differs in power consumption, range, and bandwidth so it has its strengths and weaknesses in various network criteria and is best-suited for different IoT use cases.

### 2.3. Data Processing

The data is collected by the sensor devices and stored in the cloud service for processing acquired data into the required information by software. For example, checking the temperature reading on air conditioners requires whether they are within an acceptable range. Monitoring soil condition, such as humidity or temperature works in a similar way.

### 2.4. User Interface

Data captured by the IoT system makes available to the end user in some way, such as sending notification via mobile applications or emails. Some IoT sensors/ devices allow users actively check, control and perform action on their IoT system. So developers must create user interface of IoT in which a user and a computer system interact with IoT solutions. For example, a user has a tracker installed in his valuable asset, he might want to know its whereabouts any time. This device helps the user to track down accurately an asset if it gets stolen.

## 3. IoT in Education

Nowadays, IoT is gaining popularity and increasing in use rapidly. Many of the IoT solutions appear in the education system. For example, learners use a wearable device with a sensor for connecting and transmitting information. A smart door lock can help to verify people who are allowed into the room or school building. Using IoT in

education enhances the quality of learning, provides security benefits for educational institutions, reduces costs and important resources. Teachers can access information, create the instruction media, gather information, analyze and evaluate learners' achievements. Technology accommodates individuals with flexibility in learning styles and can attract the attention of students through multimedia. It undeniably plays an important role in today's education system.

Many institutions in the world utilize new technologies, such as IoT, AI, big data, cloud computing to use in the education system. For example, Curtin University in Australia has the vision and goal of developing an innovative city by 2030 as part of building a university image as "Greater Curtin" with IoT as one of the key qualities of this vision (Kent et al., 2018). Siam Technology College (STC) in Thailand has declared to be "Smart Campus" and established IoT laboratory. Staff members and students have been encouraged to join in IoT activities of several international learned societies, such as the Institute of Electrical and Electronics Engineers (IEEE), the Association of Computing Machinery (ACM), and the Internet Society (ISOC). Moreover, more than 200 global educational institutions are now offering IoT and digital technology in academic programs (Charmonman&Mongkhonvanit, 2016). For example, the Faculty of Engineering, Bangkok University in Thailand has now a new department of computer and robotics engineering which provides knowledge and soft skills covering both hardware and software in terms of Programmer, IT, Smart System, Robotics and Automation, as well as related technologies, such as IoT, AI, machine Learning, and big data (Bangkok University, 2019).

In the field of education, technology applications can be divided into three types: (Deloitte China, 2018)

1) Indirect auxiliaries. They refer to the use technologies, such as adaptive learning, smart robot, online education, mobile application, VR/ AR education to support teaching and learning. These indirect auxiliaries are to increase student performance and develop students' self-learning ability.

2) Direct learning. It deals with applications of technological programs including STEAM education, maker education, robot education, 3D printing teaching in teaching and learning to develop innovation and practical ability of students.

3) Basic operation. It means utilizing technologies to improve school management and enhance teaching quality; for example, the establishment of smart campus which has smart teaching resources, smart teaching environment, smart campus management, smart campus service, and information security system.

#### **4. Using IoT application in education**

The utilization of IoT application in basic operations of education can improve the quality of education in many aspects. It gives rise to multiple applications. Here are the examples of using IoT in education (Joshi, 2019).

##### **4.1 Smart Classroom**

Smart classroom is a technology-enhanced classroom which promotes teaching and learning opportunities and improve the quality of education by integrating learning technology. Smart classroom combines various types of hardware and software modules. For example, teachers will know the feeling of students via connected wearable devices with the Internet. They can decide to take a break or reschedule the lecture if they find that students tired and are not interested in their lessons. Teachers can use interactive whiteboards and other classroom equipment in order to create interaction between teachers and students. They can operate an interactive display of these whiteboards

connected to a computer and Internet with a finger, pen, or stylus. Moreover, interactive whiteboards will also record all the notes taken in a class. Smart classroom helps teachers to deliver good presentations and better learning experience to students. In other words, students can access interesting lectures to support their overall learning process (Temkar et al., 2016)

#### 4.2 Student Attendance

IoT can help to reduce a time-consuming routine task and eliminate human errors, such as using IoT to check student attendance. Teachers can check and monitor attendance tracking by using face recognition technology, wearable devices, or trackers. These devices can be used to detect students in a classroom or in the school. It will send notification to parents in case a student is absent. Teachers can know the number of students in attendance in real time via an application on smart phones or tablets. This solution helps teachers maintain attendance logs and evaluate their student time attendance.

#### 4.3 Disability Assistance

IoT helps disabled students to have the learning opportunity like others. It reduces communication gap between teachers and disabled students. For example, deaf students can wear gloves connected to a laptop or smart phone. These gloves and smart phones can work together to translate sign language into words. With this method, teachers can better communicate with their students and listen to feedback about their teaching methods. In this way, teachers can provide the best sign language education to their students. The other interesting example is IoT smart book reader for visually impaired students. Its size is only a credit card, and it is easy to carry out anywhere. This device can capture pictures on the book's pages by using a camera and book reader. After processing the images via software, a book reader will read it aloud to blind students without touching with their fingertips. This IoT solution helps them to acquire knowledge from reading both hard copy and soft copy books without resorting to Braille language. (Harum et al., 2019)

#### 4.4 Cashless Vending Machines

Schools and colleges can use IoT cashless vending machines to facilitate the purchase of goods to their staffs and students. These machines can be connected to a centralized system in an educational institution, and administrators can monitor transactions in real time and generate purchase report to plan stock and order goods. This IoT application can help institutions save the cost of staff and improve their inventory management system.

#### 4.5 Security systems

IoT application can be used in schools and colleges to improve the security system. IoT effective solutions help educators and parents to ensure safety for their students. Moreover, IoT can help institutions implement more effective security systems. For example, smart cameras can be used to monitor all day and night for any activities. If they find malicious activity, they will send notification to persons in charge of monitoring.

## 5. The Advantage of IoT in Education

### 5.1 Data Collection

IoT helps the management and teachers to gather valued data. It collects and manages four key aspects: managing energy and monitoring real time ecosystem, monitoring students' healthcare, controlling classroom access, and improving teaching and learning (Bagheri et al., 2016).

## 5.2 Personal Learning

IoT provides new ways of teaching students. It helps learners to participate in learning and sharing. It also encourages personal learning and creates enthusiasm in learning, with learners being the center of teaching and learning activities. Students are able to learn outside of the classroom using Internet-connected devices, allowing unlimited access to information from anywhere, anytime, in a customizable learning manner (Pervez et al., 2018). IoT also introduces remote learning opportunities for disabled students who cannot attend class. Teachers can connect with their students via IoT to share lessons via video conferencing or let students access learning materials via the Internet (Peterson, 2019).

## 5.3 More Human-to-Machine Interaction

In a traditional classroom, one teacher can teach a large number of students. It is very difficult to focus students individually. It is primarily human-to-human interaction. IoT transforms the learning style and method from human-to-human interaction to human-to-machine interaction so that students can access learning materials via digital devices, such as computers, tablets, smart phones, and digital books. Students can submit their assignments via email or application instead of paper work; so, teachers can easily check homework, record scores and evaluate performance.

## 5.4 Security

IoT enhances the security systems in schools. Smart door locks and smart cameras can monitor movement and control the function of open, close, lock and unlock doors by zone to keep out unauthorized people. Administrators and staffs can maintain security for their students. Using tracking devices and application, teachers can take students' attendance. In addition, they can track students from the bus to the classroom and back to the bus; so school administrators and parents know exact location of their children in real time. Moreover, trackers can be used to track movement and location of buses and other school assets for monitoring and preventing thefts (Trojecki, 2019).

## 5.5 Energy Conservation

IoT conserves energy in the educational institutions. For example, smart meters monitor their energy consumption in real-time. They can provide insights into power consumption and notify in case of a power failure; so educators and administrators can use these data to manage and control the use of energy efficiently. In addition, educational institutions can install other IoTs in powered appliances, particularly smart light bulbs to save cost.

# 6. The Challenge Issues of IoT in Education

## 6.1 Privacy and Security

IoT provides individual real time data for tracking loved ones. It is useful to locate people who have been lost, abducted, or got an accident. However, all tracked people have to sacrifice their privacy. For security, it is one of the most critical issues of the IoT system. IoT has a large network and utilizes various devices connected with each other. It allows permanent data sharing between related devices. It is important that IoT contains security components: authentication, confidentiality, and access control in guarding off hackers (Angelova et al., 2017).

## 6.2 Fuels Global Inequality

IoT supports students' education worldwide with the use of smart phones and computers. It is noted that many students in underdeveloped countries may be digitally handicapped--not having smart devices and IoT infrastructure to access online courses. Richer educational institutions can help provide IoT devices to narrow the digital gap

(Intharotom, 2019). As surveyed, Thailand shows a gap in the use of digital devices and Internet between residents in Bangkok at 46.50%, and those in outer regions, like the Northeast region at 23.60%. (Office of National Statistics Thailand, 2018). Since the IoT devices give people the opportunity to easily reach sources of knowledge and new technologies, it is important for the local government to try to narrow down the existing digital gap, particularly in the area of education.

### 6.3 Financing Issues

The education budget from the local government in many countries around the world has shown a decreasing trend. For example, the Thai government has decreased its budget on education since 2016. (Thaipublica, 2019). However, information technology hardware and software tend to decline in pricing. It is therefore a challenge for the local government to provide for IoT infrastructure in support of quality education via IoT systems and needed devices.

## 7. Conclusion

As described in this academic paper, IoT brings new opportunities for all relevant stakeholders in the education system. It can facilitate teaching, help administrators and staffs to reduce resources and ensure security for buildings and assets. Students can get better learning experience and opportunity to learn anytime anywhere. It should be noted that the integration of IoT in teaching and learning still has some challenges in the digital gap. In this regard, educational administrators and teachers in the digital era need to make sure that IoT be provided sufficiently and managed efficiently for quality teaching and learning.

## 8. The Author

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