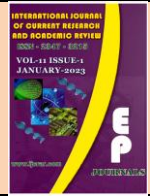




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## Internet of Things (IoT) and its Applications in the Development of Intellectual Education

J. Shrilekha and I. Kamila Sharmin\*

Department of Bank Management, Anna Adarsh College for Women, Chennai, India

\*Corresponding author

### Abstract

The IoT and cloud computing technologies are effectively utilized by the Smart Education System to track and manage many elements of the educational system. To maximize the IoT nodes' battery life, the systems must provide access to nodes and gateways. To do this, they must propose an architecture that enables not only the newest wireless and wired technologies to offer a reasonable communication range but also lower energy consumption. The education sector is no exception to this, as are other industries integrating intelligent cultures. The Internet of Things (IoT) affirms its significant contribution to social development and information and communication technology. As more educational gadgets are connected, campus leaders will be able to gain even more benefits from the never-ending flow of data and knowledge, assisting them in changing their interactions with students, teachers, administrators, and providers from transactional to iterative. Smart campuses will be able to complement and integrate into a larger smart environment strategy with the help of a modest, people-centered environment, which will also help institutions increase productivity, support sustainability, and empower their constituents. To perform this study secondary data has been collected through the scanning of several papers published in journals and online sources. This study aims to show how IoT is used in the creation of smart educational systems. This investigation has the drawback of ignoring the item's physical component in favor of concentrating on its application component.

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### Keywords

Internet of Things (IoT), Smart Education System, Technology, Teaching and Learning.

### Introduction

The Internet of Things (IoT) has grown in prominence recently since it provides worldwide networks. The Internet infrastructure connects various objects and things. Thus, the IoT makes it possible for items and people to connect at any time and everywhere, which leads to the identification of as well as the global generation of new knowledge, knowledge integration, and intelligence. In this circumstance, universities will no longer need to place a heavy focus on the use of

information and communication technologies (ICT).; instead, they will need to focus on how to adjust to the changing demands of a knowledge worker, to new types of labor, and to the economy of the future. Intellectual education systems must support the integration of activities such as lifelong teaching, research, and learning, as well as their integration with the systems of national education and the tools that link them to the job market. The IoT will simultaneously bring about a number of changes in the field of education, including technological changes (Cloud/Fog Computing,

instructional technologies, mobile apps), educational reform, changes in teaching and learning, practical and experimental changes, and more. The Internet of Things (IoT) will connect people, processes, devices, and data, making it simpler for those involved in education to turn the data gathered from sensors and portable devices into valuable information and to take meaningful decisions based on that information. It is crucial to consider the potential effects of IoT adoption in order to understand the advantages and difficulties of IoT in education, especially given that IoT is still in its infancy within the educational system. Numerous advantages of the IoT include the development of intelligent interactive classrooms, the ability to create interactive models where students take an active role in the learning process, the stimulation of the creativity, and real-time reporting on the cognitive processes of the students.

The COVID-19 epidemic has significantly increased the emphasis on research and the potential use of new technology in education. The number of publications on the use of the IoT in education has increased, which indicates a greater interest in this area of study, whilst existing activities in education are a concrete indication of such interest.

Uskov *et al.*, (2016) The Internet of Things (IoT) is transforming many facets of our daily lives. IoT technologies are different from earlier inventions since they are pervasive and promote intelligent and autonomous solutions

The conceptual base for the new learning model was thought to be ubiquitous sensors and the capacity to connect the physical and digital worlds. The capacity to integrate sensors into any object and use Machine-to-Machine (M2M) communication to connect billions of objects/devices to the existing Internet infrastructure is the idea underlying this major paradigm change. The physical world as a whole is quickly going online.

Abdel-Basset (2019) There are several signs that the Internet of Things will transform various industries, including higher education, particularly universities. Universities now have the chance to take the lead in IoT technical development and innovation models, develop future IoT leaders, and handle TIPPSS threats, which stand for Trust, Identity, Privacy, Protection, Safety, and Security in relation to IoT

Wan and Zeng (2015) The Internet of Things (IoT) is a physical global network that links devices, items, and things to the Internet infrastructure in order to exchange

information through information-sensing devices in accordance with predetermined protocols and to interact with the internal and external environments as shown. In order to reach the goal of intelligently recognising, tracking, and managing things, IoT is enabling connectivity for everything and for anybody to be networked throughout the world anytime, anyplace utilising any network or any service

Gul, (2017) The IoT vision is based on the conviction that the unwavering advancements in communications, information technology, and microelectronics we have seen in recent years will last into the foreseen future

Juniper Research, (2016) IoT will eventually consist of billions of physical objects with digital sensors that are connected to one another via any network, according to predictions made by a number of research groups and analysts on the future of the technology and its potential effects on the Internet. In 2015, more than the whole world's population, it is estimated that 13.4 billion devices were linked. According to research, this number is predicted to quadruple to 38.5 billion devices by 2020. Individuals can access an infinite amount of information at any time and from any location thanks to the possibility of engaging with many everyday objects that are connected to the Internet. The concepts and innovations that this perspective brings up are already being addressed by research academics

Abdel-Basset (2019) Technology has been continuously incorporated into educational institutions since it may be one of the most crucial elements for enhancing learning results. IoT has discovered that customers are interested in education in addition to hiring a teacher, submitting a library, or doing fieldwork. Examples of this desire include flipped classes, smart boards with VR and AR capabilities, or accessing secure learning environments.

### **Research Objective and Methodology**

This qualitative analysis is based on the educational industry's commercial model, The major goal of this research is to comprehend the circumstances that call for the introduction of IoT in education, the advantages of this integration, and the challenges in such an environment. Additionally, the purpose of this study is to serve as a backdrop for future research on this topic. In order to achieve its goals, this research developed the following questions

How have IoT applications influenced the development of smart and intellectual education systems?

What architectural and technological standards apply to the Smart and intellectual Education System?

### **IoT-Based Smart Environment**

According to Mark Weiser's philosophy of smart settings, there should always be smart environments and tools available for us to complete daily chores. Smart homes, offices, classrooms, and other intelligent spaces can all be considered smart surroundings. The main objective of IoT-based smart environments is to make daily tasks easier. All of this information can only be retrieved by speech thanks to sensors, actuators, and smart devices. Understanding, reasoning, and prediction are the three main objectives in the Smart world. In order to be able to adapt to an action or event, creative environments must understand how the world works and how people think. According to one definition, an intelligent environment is "one that can gather and utilise information about the world and its inhabitants to enhance their experience in this region."

### **Smart Education Environment**

Everything becomes a smart entity as Internet of Things, changes every aspect of existence. This also applies to the educational environment, where one comes across a real chain in which energy is cleverly transferred from smart education, smart universities, smart classrooms, smart teaching, and smart learning all the way up to smart evaluation.

### **Smart education**

Smart technologies such as cloud computing, big data, and the Internet of Things enable the transformation of education into smart education and play a significant role in the development of a smart education environment. The goal of smart education is to prepare the workforce with 21<sup>st</sup>-century skills and knowledge that will enable it to deal with societal concerns. The IoT infrastructure, which consists of sensing devices, user applications, and communication links, is necessary to realise smart education. Because students will learn more quickly and the teaching staff will be more effective, the application of the IoT in the educational environment will improve the quality of the educational process.

### **Smart classroom**

A smart classroom is a place that contains all teaching programs that use technological devices such as digital

screens, video projectors, and internet-connected devices. A smart classroom is a physical classroom area used to teach content, where class management, access to learning resources, and interaction are achieved and combined with contextual awareness. A smart class is based on mobile technologies, mobile learning, and automated communication devices along with video projectors, cameras, sensors, facial recognition algorithms, and other modules that monitor various physical environment factors.

### **Smart teaching**

Smart teaching differs from traditional education, particularly in how knowledge is presented via various technological devices. Additionally, learning is adaptive and the content is accessible around-the-clock. The IoT may provide access to the real world through sensing devices, which makes teaching a difficult experience because it must be tailored and adapted, involve various teaching methods, and address students who have learning challenges (impaired vision, hearing, or locomotion, as well as hyperactivity disorders).

### **Smart learning**

Electronic gadgets serve as the channel for the adaptive process known as "smart learning". Smart learning is described in as a learning process that places the students and the subject matter at its center. It is less device-focused and depends on the ICT infrastructure for its efficacy, intelligence, and adaptability. The Internet of Things-based e-learning applications are essential, especially for setting up a virtual classroom and developing a competitive learning environment on a local and international scale. As students can connect to any lab or library in the globe to participate in experiments, collect data, receive and submit homework, or for self-assessment, the IoT also promotes online self-teaching.

### **Smart assessment**

Smart assessment goes beyond the conventional assessment framework, which is based on knowledge development or multiple-choice assessments. In a smart environment, assessment develops within the framework of a real IoT ecosystem and becomes an ineluctable process based on ICT. The appropriate tools that can record students' behaviour in online learning assessment strategies must be included in modern learning systems. The ability to evaluate a student's attentiveness, which is

crucial for evaluating education, is possible with IoT devices. Smart education also entails novel approaches to teaching and learning that are compatible with fresh approaches to assessment and/or other factors to take into account when formulating assessment procedures.

### **Important Components of IoT in Education**

IoT could contribute to greater regional accessibility, capability expansion, and status for education. There are countless possibilities for integrating IoT-enabled technologies into the educational setting. These provide a solid foundation upon which to build a thorough grasp of their use in education. Furthermore, rather than recruiting new people, technology can enhance instruction. For certain teachers and students to demonstrate their teaching abilities, technical assistance is required. IoT Solutions for Education is aware of this and offers solutions to raise educational standards everywhere. The opportunities that earlier belonged to pupils in good health were now equally available to those with disabilities.

### **Digital classroom**

IoT-equipped classrooms can be used to monitor and assess students' progress and efficiency. The attendance of students will be automatically tracked by IoT devices. Tests and assignments must now be given remotely by educators and teachers. IoT wristbands can also be used to keep an eye on the security of the students. It is also possible to manage and adjust ventilation, air quality, temperature, and humidity for each potential learning location inside the classroom. As a result, the facilities will operate efficiently and tailored active learning will be

### **Smart boards**

Students now enjoy smarter boards than blackboards since times have changed. An image of the topic is projected on a smartboard, which is an interactive whiteboard. Let educators and students engage with it. Simply walk in or switch seats. It appears to be more enjoyable and exciting now. It is customary to wonder if a smartboard can ever truly replace a chalkboard. Yes, it is the answer. The words and pictures in textbooks and on blackboards aren't long enough to convey the idea of the text in a few short minutes. Conflicts in perception grow frequently, and the classrooms become muddled ponds. Learning and information exchange are now simple, fascinating, and participatory thanks to the use of

IoT in education. Teachers can relax by using a smartboard. Mathematical infographics, tutorial films, and complicated formulas can all be resolved fast

### **Attention to Attendance**

The educational setting differentiates the rules. Some believe that the exam should be taken by a specified number of pupils. Managers can discover precise attendance data with IoT. The data contains no human mistake. The location of the hostel's residents in real-time can affect their level of safety and happiness. The administration finds it difficult to track attendance. Students may easily compute attendance as well as regularity, punctuality, and personality reports thanks to the IoT-based attendance system. On the happiness of lab workers, time reductions can have a significant impact. Additionally, IoT has recognised the necessity of using digital attendance records to encourage students to attend classes more frequently. A quick electronic notice will be issued to the parents if a pupil disappears from school for whatever reason. This is a very effective security measure.

### **Significant Protection**

The lab has a short circuit, and the IoT sensor detects it instantaneously and provides an instant alarm to correct the situation. This happens regardless of the fun form of security for emergency indicators, audio upgrades, Wi-Fi watches, and deaf notifications. An "auto" real-time alarm will also be sent if someone becomes locked in the elevator. The enormous effects of globalisation are seen in numerous forms of the world in our note of service. The likelihood of an earthquake is abruptly altering due to harsh weather and is becoming more frequent. This is due to the fact that when concerns about natural disasters arise, schools and other educational institutions purchase IoT sensors and meters.

### **Adjusting Disability**

A few years ago, it was very difficult for children with disabilities to learn and reflect on new things. Modern technical design allows them to learn and perform new things just like any other skilled student. Some segments of the population are challenged with hearing loss. With an integrated glove and tablet system, conversations can be translated into sign language. The incentive to convert words into written words is noteworthy. IoT devices enable the effective provision of educational support to children with impairments, making the future for these

kids bright. It directs their intellect and zeal for insignificant success.

### **Tablets and mobile apps**

The usage of devices ought to be limited among millennial pupils. But sadly, smartphones, tablets, and other screen-based technologies seem to be the center of many contemporary students' life. This particular attention has been turned by IoT experts to educational themes in gaming and social networking technology. Now, it is simpler to involve others worldwide who share your objectives and passions. Data is gathered by the Internet of Things of Education sensor, which then offers to pupils seated on the other side of the screen certain academic subjects. The use of tablets and cell phones improves pupils' grades nearly immediately.

### **IoT's Participation in Education**

IoT enhances schools and lowers costs for physical services and systems, which is a very clever feature of today's universities and classrooms. The benefit of an elusive university is that it is simple to offer a higher degree of information to the individual.

The Wi-Fi network is used by smart devices all throughout campus to communicate information and receive orders. Additionally, the computational IoT devices for buildings and learning facilities support the development of smarter lesson plans, coordination with important resources, and enhanced admission records, as well as the design of safe campuses, among other things.

### **Interactive education**

Learning now involves more than just reading text and looking at pictures. With the addition of videos, materials, animations, ratings, and other content to aid in studying, many textbooks have been uploaded to websites. It gives children a broader viewpoint to learn about new topics, including better comprehension and communication with teachers and friends. The education experts in the classroom debate real-world professional concerns, and the students come up with solutions.

### **Security**

Because so many student organisations attend classes, it is difficult to keep track of each student's whereabouts and activities. Institutional students are also more vulnerable than other workplace populations, therefore providing them with intelligent security can greatly

improve the security of IoT schools, universities, and other learning facilities. Students may be tracked around-the-clock and at any moment using techniques like 3D location. Additionally, these technologies can offer a sad button option for setting off alarms as necessary. Computer vision technology, which enables the fast monitoring of signatures, has recently undergone substantial advancements. By engaging in this activity, you can immediately stop unforeseen events from happening.

### **Application in education**

The Internet of Things' educational benefits are recognised as a potent creative tool, and teaching and learning approaches are evolving. In 3D graphic textbooks, both teachers and students can make and annotate notes using video. Due to the abundance of instructional activities, it offers, this software might be seen as a game-changer. There are several features available in these games that present engaging teaching and learning opportunities. It has elevated the allure of education.

### **Enhance performance**

Most schools spend a lot of money on activities that are unrelated to the reason for their existence. For instance, students must be present multiple times each day. Additionally, the central office must get this information for a specified reason. Using IoT, this ineffective system may be removed. Data interference is automatically avoided because the data is transferred to a central data server using IoT end devices. The arduous labour of instructors and kids may be lessened because to this innovative IoT development. As teaching and learning are the core of the educational system, students will pay more attention to them.

### **IoT – Important areas of application**

#### **Using posters as IoT-enabled boards**

The older presentation board in comparison to the modern multimedia poster board is unquestionably very problematic. Present-day multimedia poster boards compared to historical presentation boards. It is difficult to compare historical introduction loads with contemporary sight and sound notice loads. Web tools like Glogster have improved this ease of use and enable individuals to easily create digital posters by combining text, audio, video, and other media. Then, cohorts and

educators might receive such interactive boards via email.

### **Interactive knowledge acquisition**

It takes more than just a combination of images and text to become comfortable with the current world. It provides the pupils with a wider perspective to analyse situations with clarity and engagement with their teachers and peers.

### **Learning anywhere, at any time**

IoT is important in the development of a system that makes use of exceptional web-based frameworks. The ability to illustrate the progress of the researchers is given to the scholar by cutting-edge innovation. A fantastic tool for vocal communication between teachers and students is Edmodo. When not in the study hall or responding to posts, IoT enables teachers and students to transmit knowledge while reading messages and upcoming events simultaneously. Additionally, it allows a customer to save their personal ideas and class project without worrying and ensures their complete privacy.

### **Increased safety measures**

This application is important since it may help prepare the space and include the best innovative solutions inside the classrooms. This gives researchers and a variety of employees a sense of security by offering crisis indicators, sound amplification, Wi-Fi tickers, and hearing-impaired notifications. The IoT-enabled interchanges architecture may also be utilized in a variety of situations, such as coordinated worker and student gatherings during times of crisis using special crisis tones, live announcements, and pre-recorded instructive messages. A student GPS tracker is a tiny tracking gadget that may be put in the student's pocket, bag, or coat. Satellite-dependent technologies can be used to pinpoint a student's position

### **Significance of IoT in the Education Sector**

Education dissemination is the most important activity for each community in development. It follows that using

modern technology's cutting edge to enhance learning and make it more engaging for kids is a no-brainer.

### **Intelligent, automatic student tracking**

It probably won't be necessary for the students to be present at a specific time in a specific location to be marked present thanks to the system of smart automated student tracking. Additionally, it permits students to apply for their benefits so long as they are registered with the automated tracking system.

### **Individualized instruction**

Since no two pupils are alike, different approaches to learning can bring out the best in each person. Personalization can boost educational effectiveness and data maintenance, and in the absence of personalization, some students may find it challenging to maximize their potential.

For instance, although kids with dyslexia are typically academically equal to or superior to the majority of their peers, traditional learning methods are inappropriate for them.

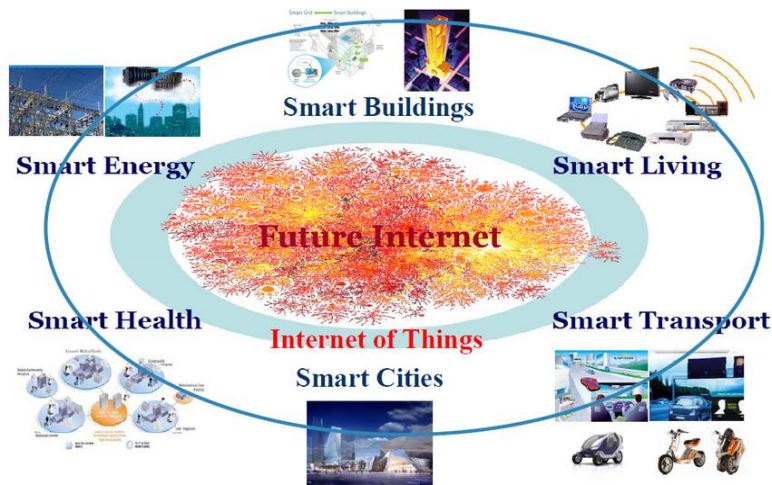
### **Smart boards with the Internet of Things capabilities and modern textbooks**

Imagine a scenario where a history teacher may use a smartboard to recreate the battle of Normandy while teaching World War I. On the other hand, kids can dissect virtual creatures while studying science. On the other hand, when learning geography, a class can really witness a volcano erupt in real time.

### **Supporting students with exceptional needs**

IoT can be helpful for pupils who require specialised care. While a visually impaired student can utilise VR headsets to view the smartboard, a hearing-impaired student can convert voice to text. Additionally, the IoT may reduce the need for developing distinct educational buildings and curriculum.

Fig.1



### Task-based learning

The flipped classroom allows students to learn the fundamentals of the subject matter before the class even starts. The learning activities in the classroom shift toward more task-based learning to validate the complete understanding of the subject. The IoT network-connected devices attest to the fact that students collaborate and share knowledge to better complete their assigned tasks. Additionally, it is ensured via IoT devices that students can access their teachers' assistance whenever and wherever they need it.

### Important components for Iot in education

IoT has a fundamental impact on learning, as was mentioned. These six fundamental elements will determine how effectively IoT is used.

### Storage

Many businesses put IoT applications on the hybrid cloud, which serves as their operating infrastructure. Tablets and other mobile devices are widely available, and this has created new opportunities for improving the effectiveness of commercial infrastructure, digital technology, research, and the educational ecosystem. In ubiquitous computing, service providers of information infrastructure can easily access and use cloud resources. While educational applications steadily migrate to public clouds, educational organisations are becoming more and more reliant on cloud infrastructures with private cloud computing services. Due to the demand for data and materials in instructional technology, the massive expansion in audio and video training, and the necessity

for networks, enterprise infrastructure in these firms must reduce latency.

### Educational Technology

More and more, learning management systems (LMS) like Moodle and Blackboard are being utilised to generate massive amounts of structured and unstructured data, including audio and video information. Therefore, there is an increasing need for classrooms to include cutting-edge technological tools like lecture recording systems and video sharing so that students can access educational content whenever they choose.

### Integrity and quality

In recent years, there has been a lot of discussion about the quality of both on-campus and online education as well as the rising expense of higher education. IoT has exceptional chances to give online training programmes. However, this frequently makes it difficult to maintain teaching standards and evaluate student work. IoT educational applications give students, teachers, and researchers access to resources and technology to enhance academic quality and solve ethical concerns inside the educational system.

### Safety

When children are involved, it is crucial to safeguard the partners and the data obtained. In addition to receiving a guarantee from the service provider, educational institutions and guardians also expect successful implementation of protection and safety measures. IoT should also address issues like responsibility for private

and public information before it can be used to great effect in the field of education.

### **Morality**

Additionally, it is crucial to ensure that the data being obtained is reliable. The appropriate technology should be applied. The use of a public platform that can be used by all parties involved without requiring extra investments will be a big step in this direction.

### **Education policy**

IoT is training as a fundamental transformation in how education is delivered and how learning takes place. Any revolutionary change must be implemented by skilled professionals who make strategic decisions. Due to the implementation of IoT in educational institutions, training programmes must promote the use of innovation in classrooms and other learning contexts. IoT is crucial to the realm of education since it helps students' study more effectively and easily. It can also modify a person's physical location since it brings about more change in the educational sector. By appropriately using IoT technology, the learning experience will be enhanced, and the learning environment will be conducive. The

objective is to evaluate the possible advantages of IoT in education and how it makes use of the sector while overcoming its difficulties and lowering related risks. The adoption of IoT in higher education should be the focus of our future effort.

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