IOT FOR SMART CLASSROOM IN IMPROVING TEACHING AND LEARNING APPROACH

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ABSTRACT
Internet, a revolutionary invention, is always transforming into some new kind of hardware and software making it unavoidable for anyone. The form of communication that we see now is either human-human or human-device, but the Internet of Things (IoT) promises a great future for the internet where the type of communication is machine-machine (M2M). Internet of Things (IoT) is very important sectors in teaching, learning and business today. The Internet of Things has changed the way people and objects interact with each other, and education has not been immune to this change, which has created new forms of interaction between teachers and learners that helps improve the teaching and learning process. In the field of education, students can now use new technologies to carry out projects and educational activities in and out the classroom. In this research, the focus is on the role of Internet of Things (IoT) for smart classroom in improving teaching and learning. This paper aims to provide a comprehensive overview of the smart classroom concept, IoT scenario and reviews its enabling technologies and the sensor networks. Also, it describes a Smart Education and Applications of IoT and IoT for Smart Classroom Teaching and Learning.

Keywords: Internet of things, Smart classroom, Smart Education, teaching and learning

Introduction

With the continuous advancements in technology a potential innovation, IoT is coming down the road which is burgeoning as a ubiquitous global computing network where everyone and everything will be connected to the Internet (Ovidiu, 2013). IoT is continually evolving and is a hot research topic where opportunities are infinite. Imaginations are boundless which have put it on the verge of reshaping the current form of internet into a modified and integrated version. The number of devices availing internet services is increasing every day and having all of them connected by wire or wireless will put a powerful source of information at our finger tips. The

concept of enabling interaction between intelligent machines is a cutting-edge technology but the technologies composing the IoT are not something new for us (Ovidiu, 2014). IoT, as you can guess by its name, is the approach of converging data obtained from different kinds of things to any virtual platform on existing Internet infrastructure (Vermesan, Friess, Guillemin and Gusmeroli, 2011).

ICTs have great power to improve the outcomes of teaching and learning. The realization of this power depends very much on how the teacher uses technology during the learning sessions, knowing that the education is a powerful path for social change, social mobility, it helps develop and build a new generation of our nation. In this context, smart classes play an important role in the transformation of traditional education into modern education, which offers opportunities for improving the quality of education and academic achievement, access to education and equity, through mobile devices, classes that integrates many different types of computer hardware, including computers, tablets, interactive whiteboards, smartphones, and many computer technologies that are Used for teaching purposes. When talking about intelligent classes, we must evoke the notion of the Internet of objects (IoT), which represents the universe of connected objects in all domains, such as the field of education.

Teachers are faced with classroom issues such as excessive talking during instruction, getting out of seat without permission, throwing objects across the room, sleeping during classroom instruction and disrespect to the teacher. It is important that teachers find creative ways to deal with the issues as well as provide quality instruction in the classroom.

The Internet of things (IoT) is the network of physical devices, vehicles, home appliances, and other items embedded with electronics, software, sensors, actuators, and connectivity which enables these things to connect, collect and exchange data, creating opportunities for more direct

integration of the physical world into computer-based systems, resulting in efficiency improvements, economic benefits, and reduced human exertions. IoT involves extending Internet connectivity beyond standard devices, such as desktops, laptops, smartphones and tablets, to any range of traditionally dumb or non-internetenabled physical devices and everyday objects. Embedded with technology, these devices can communicate and interact over the Internet, and they can be remotely monitored and controlled.

Technology in education has played a significant role in connecting and educating the students. IoT technology has an important impact on education field. IoT has not only changed the traditional teaching practices but has also brought changes in the infrastructure of educational institutions (Serrano, 2015). IoT technology is playing an important role for the improvement of education at all levels including school, college and university teaching. From student to teacher, classroom to campus, everything can get benefited with this IoT based technology in education society.

Statement of the Problem

Teaching and learning are two words that go hand in hand in the classroom. The traditional classroom is a kind of teaching learning environment which is static in nature. In the traditional classroom, accessibility to education is limited in terms of geography. The learning process is conducted through face to face system, that makes it impossible for students to be able to join learning from anywhere, anytime with the internet connection. Also, in the laboratories where most of the equipment and facilities are in a dilapidated state, practical can not be conducted and problem cannot be solved. Through practical problems are solved in learning.

Student data in the traditional classroom are still operated manually which makes it difficult for improved teaching and learning. For improved teaching and learning, the teacher must understand the kinds of learners. The teacher gets to know the learners properly through the learners data. Hence, this paper examine IoT for smart classroom in improving teaching and learning approach.

Concept of IoT

The concept of IoT dates back to 1982 when a modified coke machine was connected to the Internet which was able to report the drinks contained and that whether the drinks were cold (Serrano, 2015). Later, in 1991, a contemporary vision of IoT in the form of ubiquitous computing was first given by Mark Weiser. However in 1999, Bill Joy gave a clue about Device to Device communication in his taxonomy of internet. In the very same year, Kevin Ashton proposed the term ”Internet of Things” to describe a system of interconnected devices. The basic idea of IoT is to allow autonomous exchange of useful information between invisibly embedded different uniquely identifiable real world devices around us, fueled by the leading technologies like Radio-Frequency IDentification (RFID) and Wireless Sensor Networks (WSNs) which are sensed by the sensor devices and further processed for decision making, on the basis of which an automated action is performed (Ovidiu, 2013).

Internet of things (IoT) is a network of physical objects. The internet is not only a network of computers, but it has evolved into a network of device of all type and sizes , vehicles, smart phones, home appliances, toys, cameras, medical instruments and industrial systems, animals, people, buildings, all communicating and sharing information based on stipulated protocols in

order to achieve smart reorganizations, positioning, tracing, safe & control & even personal real time online monitoring , online upgrade, process control and administration (Ovidiu, 2013).

Internet of things is an internet of three things: (1). People to people, (2) People to machine /things, (3) Things /machine to things /machine, Interacting through internet. Internet of Things (IoT) is a concept and a paradigm that considers pervasive presence in the environment of a variety of things/objects that through wireless and wired connections and unique addressing schemes are able to interact with each other and cooperate with other things/objects to create new applications/services and reach common goals. In this context the research and development challenges to create a smart world are enormous. A world where the real, digital and the virtual are converging to create smart environments that make energy, transport, cities and many other areas more intelligent and (Ovidiu, 2013). Internet of Things (IoT) is the transformation process in numerous aspects of our daily life. IoT technologies differ from previous innovations as they are ubiquitous, and encourage solutions to be intelligent and autonomous, (Siddiq, Scherer, and Tondeur, 2016).

IoT is developing quickly and becoming an increasingly growing topic that creates excitement and anxiety around the world (Mershad, and Wakim, 2018). The IoT which links people, processes, devices and data augments the quantity and value of the information we can collect, allowing the stakeholders of educational sector to turn data into valuable information as never seen before. With the initiation of mobile technologies, the educational institutions can now keep track of overall resources pertaining to education. IoT is playing the key role in teaching, Learning and even in assessment. From KG to PG in all aspects of the education institution, the IoT is becoming the need of the hour. The implication of IoT will help the overall delivery of the

resources in an innovative manner to the participants. The IoT has the potential to impact every aspect of student learning. This insight provides stakeholders with a real-time view of students, staff, and resources. It helps in decision making, automatic execution and providing security features. (Van Dijk, and van Deursen 2014).

IoT affects the education sector directly and indirectly. Mainly it does the overall work ease and upgrades the quality of education. It affects the teaching and learning process broadly. The assessment area of education needs the real treatment and IoT is well suitable for the real implementation in this sector. Once the core areas such as teaching, learning, assessment are taken into consideration, the major aspect will be upgraded (Cata, 2015).

An education is the single most powerful tool we have at our disposal. By educating more people in a better manner, the society can drive greater positive social and technological change, and, therefore, create a more prosperous future. It's important that the society constantly strive to enhance education in terms of quality and access. IoT can help make education more accessible in terms of geography, status, and ability.

Essential IoT technologies

Five IoT technologies are widely used for the deployment of successful IoT-based products and services: Radio frequency identification (RFID)

RFID is the key technology for making the objects uniquely identifiable. Its reduced size and cost makes it integrable into any object, (Stojkoska and Trivodaliev, 2017). It is a transceiver microchip similar to an adhesive sticker which could be both active and passive, depending on the type of application (Krajčovič, 2013). Active tags have a battery attached to them due to

which they are always active and therefore continuously emit the data signals while Passive tags just get activated when they are triggered. Active tags are more costly than the Passive tags however they have a wide range of useful applications, (Krajčovič, 2013). RFID system is composed of readers and associated RFID tags which emit the identification, location or any other specifics about the object, on getting triggered by the generation of any appropriate signal (Mershad and Wakim, 2018). The emitted object related data signals are transmitted to the Readers using radio frequencies which are then passed onto the processors to analyze the data.

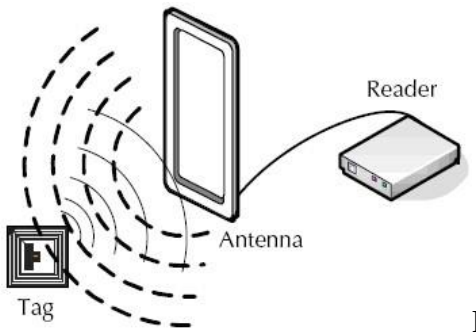

Fig. 1. RFID Scenario

Radio frequency identification (RFID) allows automatic identification and data capture using radiowaves, a tag, and a reader. The tag can store more data than traditional barcodes. The tag contains data in the form of the Electronic Product Code (EPC), a global RFID-based item identification system developed by the Auto-ID Center. Three types of tags are used. Passive RFID tags rely on radio frequency energy transferred from the reader to the tag to power the tag; they are not battery-powered. Applications of these can be found in supply chains, passports, electronic tolls, and item-level tracking. Active RFID tags have their own battery supply and can instigate communication with a reader. Active tags can contain external sensors to monitor temperature, pressure, chemicals, and other conditions. Active RFID tags are used in manufacturing, hospital laboratories, and remote-sensing IT asset management. Semi-passive

RFID tags use batteries to power the microchip while communicating by drawing power from the reader. Active and semi-passive RFID tags cost more than passive tags.

Wireless Sensor Networks (WSN)

WSN is a bi-directional wirelessly connected network of sensors in a multi-hop fashion, built from several nodes scattered in a sensor field each connected to one or several sensors which can collect the object specific data such as temperature, humidity, speed etc and then pass on to the processing equipment (Edward, and Donald, 2015). The sensing nodes communicate in multi-hop. Each sensor is a transceiver having an antenna, a micro-controller and an interfacing circuit for the sensors as a communication, actuation and sensing unit respectively along with a source of power which could be both battery or any energy harvesting technology (Macías, 2014). However, Krajčovič, (2013), has proposed an additional unit for saving the data, named as Memory Unit which could also be a part of the sensing node.

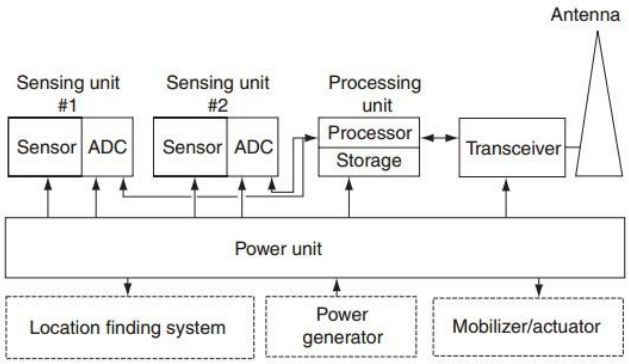

Fig. 2. A typical sensing node

Wireless sensor networks (WSN) consist of spatially distributed autonomous sensor-equipped devices to monitor physical or environmental conditions and can cooperate with RFID systems to better track the status of things such as their location, temperature, and movements (Atzori,

Iera and Morabito, 2010). WSN allow different network topologies and multihop communication. Recent technological advances in low-power integrated circuits and wireless communications have made available efficient, low-cost, low-power miniature devices for use in WSN applications (Gubbi, Buyya, Marusic, and Palaniswami, 2013). WSN have primarily been used in cold chain logisticsthat employ thermal and refrigerated packaging methods to transport temperature-sensitive products (Hsueh and Chang, 2010; White and Cheong, 2012). WSN are also used for maintenance and tracking systems. For example, General Electric deploys sensors in its jet engines, turbines, and wind farms. By analyzing data in real time, GE saves time and money associated with preventive maintenance. Likewise, American Airlines uses sensors capable of capturing 30 terabytes of data per flight for services such as preventive maintenance.

Middleware

Middleware is a software layer interposed between software applications to make it easier for software developers to perform communication and input/ output. Its feature of hiding the details of different technologies is fundamental to free IoT developers from software services that are not directly relevant to the specific IoT application. Middleware gained popularity in the 1980s due to its major role in simplifying the integration of legacy technologies into new ones. It also facilitated the development of new services in the distributed computing environment. A complex distributed infrastructure of the IoT with numerous heterogeneous devices requires simplifying the development of new applications and services, so the use of middleware is an ideal fit with IoT application development. For example, Global Sensor Networks (GSN) is an open source sensor middleware platform enabling the development and deployment of sensor

services with almost zero programming effort. Most middleware architectures for the IoT follow a service-oriented approach in order to support an unknown and dynamic network topology.

Cloud Computing

It is an intelligent computing technology in which number of servers are converged on one cloud platform to allow sharing of resources between each other which can be accessed atany time and any place (Liljeberg, 2018). Cloud computing is the most important part of IoT, which not only converges the servers but also processes on an increased processing power and analyzes the useful information obtained from the sensors and even provide good storage capacity (Alotaibi, 2017) . But this is just a beginning of unleashing the true potential of this technology. Cloud computing interfaced with smart objects using potentially millions of sensors can be of enormous benefits and can help IoT for a very large scale development so researches are being carried out since IoT will be totally dependent on the Cloud Computing.

Fig. 3. A typical Cloud Computing Scenario

Cloud computing is a model for on-demand access to a shared pool of configurable resources (e.g., computers, networks, servers, storage, applications, services, software) that can be provisioned as Infrastructure as a Service (IaaS) or Software as a Service (SaaS). One of the

most important outcomes of the IoT is an enormous amount of data generated from devices connected to the Internet (Gubbi, 2013). Many IoT applications require massive data storage, huge processing speed to enable real time decision making, and high-speed broadband networks to stream data, audio, or video. Cloud computing provides an ideal back-end solution for handling huge data streams and processing them for the unprecedented number of IoT devices and humans in real time.

Concept of Smart Classroom

Since the late 1990s, many governments increased their investments in educational technologies, with the assumption that use of technology in schools could enhance teaching and promote learning outcomes (Huang, 2010e). However, since the beginning of the investments, some researchers argued the effectiveness of technology in classroom. Researchers had also seen the modest use of technologies without significant influence on teaching and learning in most schools and classrooms (Cuban, 2009; Ramsden, 2011). Organization for Economic Co-operation and Development (OECD) released a report with the conclusion that investing heavily in school computers and classroom technology did not improve pupils' performance (Finch, 2018). The modern classroom started at the end of the sixteenth century when classroom teaching was invented, with instructors lecturing from raised platforms and pupils sitting at fixed desks many rows deep (Song, Hlaing, Tin, KoKo, and Si, 2014). Rows of seats, instructor front and center, student eyes trained on the teacher, this classroom model worked well for centuries. However, traditional approaches were ineffective for today's needs (Finch, 2018).

Technologies in classroom shifted with time. Since chalkboard was introduced into classroom in 1890, technologies such as film strips, overhead projector, desktop computer, interactive white

board, smart phones and tablets were gradually used in classroom. With the use of these technologies, teaching in classroom has changed from "blackboard & chalk" mode to the "computer & projection" mode. Although technologies use in classroom had enhanced teaching to some extent, many predicaments still existed in today's classroom. First, multimedia console was fixed in front of the classroom, which limited the flexibility of teaching. In classroom, teachers were always busy with operating computers, with few gesture interactions or eye interactions with students (Finch 2018). Second, the unified and fixed classroom layout enhanced the didactic pedagogy, but hindered teacher's adoption of student-centered pedagogy. Research showed that classroom with the specially designed layout such as "X-shaped" or "round" shape could meet the need of student-centered pedagogies (Finch 2018). Third, the misuse of slides in multimedia classroom hindered student's knowledge processing. Slides used by teachers in classroom were normally filled with texts, with no figures, tables or multimedia materials. It was easily for students to distract their attention from slides where the learning contents were listed (Huang, 2010). Last, big gaps existed in teacher's technological pedagogy knowledge and the needs for using emerging technologies in classroom. For example, interactive white boards (IBW) were equipped to lots of classrooms, however, most of them were used just like a projector screen (Huang, 2010). To some extent, the plight of the technology-rich classroom had a close relationship with the design and equipment of the classroom environment. Acknowledging the challenges of technological use in classroom, scholars argued the need of shifting attention from technology and software and learning activities design in smart classroom (Simsek 2005; Aguilar, 2015). The phrase smart classroom had been used since 1995 in San Diego State University when they built the first smart classroom with the aim to enhance learning in big classroom by integrating technologies, like clickers, sympodium, multichannel

audio system, etc. (Frazee, 2006). In the following years until 2012, researchers investigated various technologies, like multimedia communicational supporting platform, Ambient intelligence (Augusto 2009), Internet of things (Temkar, 2016), etc. to make either physical classroom or virtual classroom smart. In this period, not many researches could be found on smart classroom, and smart classroom was not well defined. The existed research of smart classroom was mainly investigated from technological point, however, few studies focused on the pedagogical aspect. Huang (2010) defined smart classroom as a physical classroom space that was effective for showing teaching content, easy for class management, convenient for accessing learning resources, easy for instructional interaction, and combined with contextual awareness. Although the definition started to integrate the pedagogical issues into consideration, few follow-up researches were found on the design and evaluation of smart classrooms from both pedagogical and technological issues. Since 2012, smart classroom implementation "is mainly based on active use of mobile technology, learner mobile devices and automatic communications" (Jahnke, 2017). Now in a smart classroom, mobile devices are owned by students so that all students are able to contribute and become active agents (Jahnke, 2017). More and more research on smart classroom/ smart learning environments emerged since 2012. However, pedagogical changed such as innovation in the teaching role, or the new role students take, the role of the contents, who decided on the learning process, resources, etc., was usually overlooked (Bautista and Borges 2013).

Smart Education and Applications of IoT

The education system offers permanent opportunities for intelligent learning, content, pedagogy or values to convey. Generally, it is asserted that pedagogy is the way to transfer knowledge

between the teacher and the learners. At all times, the teacher must update his knowledge transfer methods and techniques. The integration of IoT gives the learner the possibility of being also the mediator of knowledge in order to reinvest in the class the knowledge and the strategies acquired outside the class and that the teacher is definitely the more the only mediator of knowledge, he will feel valued and will be more motivated.

IoT plays an important position in constructing a network through the use of special internet-based systems. A robust faculty attendance gadget guarantees the safety of an academic enterprise and may assist colleges and education facilities in many methods (Martinez, Taut, and Schaaf, 2016). In smart campus sector, the learning process is conducted through e-Learning system that makes it possible for students to be able to join learning from anywhere, anytime with the internet connection. E-learning equips with video conference facility so that it is possible for students to face the teacher from different place. Besides, virtual class feature can help simulation for students to solve problem in learning. Virtual class can be used for practicum lessons.

IoT can help us make education more accessible in terms of geography, status, and ability. IoT applications in education will be the foundation on which these classrooms operate. Students will be automatically counted as present or tardy when the bell rings. Wearable devices will determine when the class is too tired or disengaged and may need a break, and whiteboards will record all notes taken in a class. Smart microphones may even recognize when a teacher mentions there is a homework assignment due and update students' planners accordingly (Etesse, West, and Chasen, 2015).

Smart classroom is defined as a classroom equipped with a computer and audiovisual equipment that allows teachers to use a variety of media. The visual aspect of the smart class and different

media can bring a dynamic perspective to education, which provides a clear understanding of the subject. The use of the Internet is invaluable for students, as they are able to access data related to the subject(s). Online sources will create curiosity and interest to explore learning among students. Students can find answers to their questions immediately online and do not have to ask their teachers about it if they do not want to. They can also explore a variety of related information, which increases the engagement, learning, analysis, and create a better outcome, while also assimilating information conveyed via the teacher and other complementary tools used in the class. A smart classroom is suitable for students with different IQs, as it uses different forms of media and sources, which allow students to adjust and benefit from it. The smart class creates an interactive environment that increases the students' interest and engagement in learning inside the classroom. It will simplify the concept that is difficult for students to visualize without the use of the technology, which will subsequently improve learning and academic performance (Chachra, 2015). Kumari and Denisia (2013) indicated that smart classroom enables students to set his or her own pace of study, is interactive, encourage them to collaborate, encourage creativity, and students are able to use the web portal to search for information (Malik and Shanwal, 2017). From another perspective, smart classroom helps teachers develop students' abilities and performance, access multimedia content, and information that can complement teaching. Students can understand and visualize the context easier, which will subsequently improve their performance (Menon, 2015). As technology-rich classrooms, smart classrooms are equipped with digital cameras and recording devices, interactive whiteboards, mobile devices (such as tablets and/ or smartphones), wireless internet, and virtual learning platforms (Menon, 2015).

Advantages of IoT

Technologies can work wonders and application of IoT education proves it. In fact, IoT is a technology that has many ways to make use of, so everything depends on requirements of government or educational institution administration. Internet of Things predicts the future that, the advance digital world and the physical world will get linked by means of proper information and wireless communication system technologies. The machine-to-machine interaction provides better efficiency, hence; accurate results can be obtained fast. This results in saving valuable time. Instead of repeating the same tasks every day, it enables people to do other creative jobs.

IoT for Smart Classroom Teaching and Learning

Integration of IoT as a new actor in intelligent learning can facilitate the interaction between people (learners and teachers) and objects (Devices) in the school environment. This interaction means that objects can communicate with each other and with people who are in these educational environments.

Smart learning process lets learner complete their coursework on their mobile devices (Tablets, Smartphones, Laptop, connected objects…) and learners have complete access to their realtime class and collaborative learning from their mobile device.

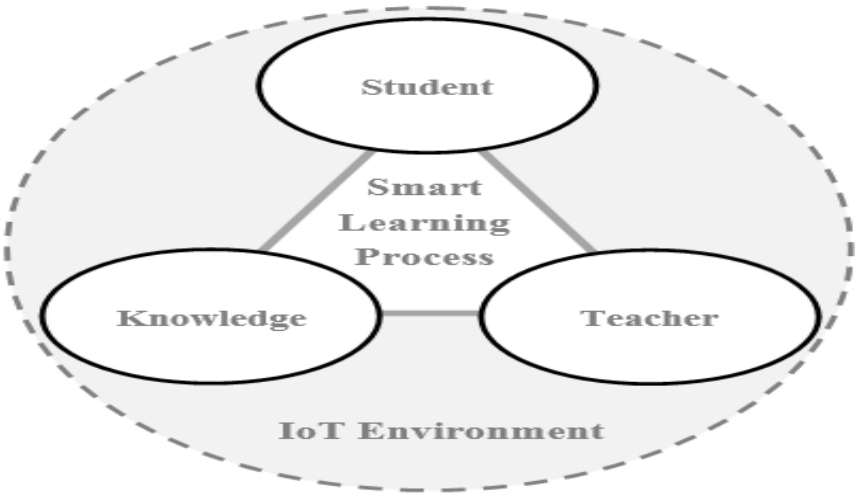

Figure 4: IoT in Smart learning (Finch, 2018)

The IoT for Smart Classroom: Teaching and Learning approach

The IoT Teaching and Learning approach based on connected objects in school, is represented by a pedagogical triangle, modified and surrounded by a sphere representing the universe of IoT. The IoT Learning model can be represented by the following diagram

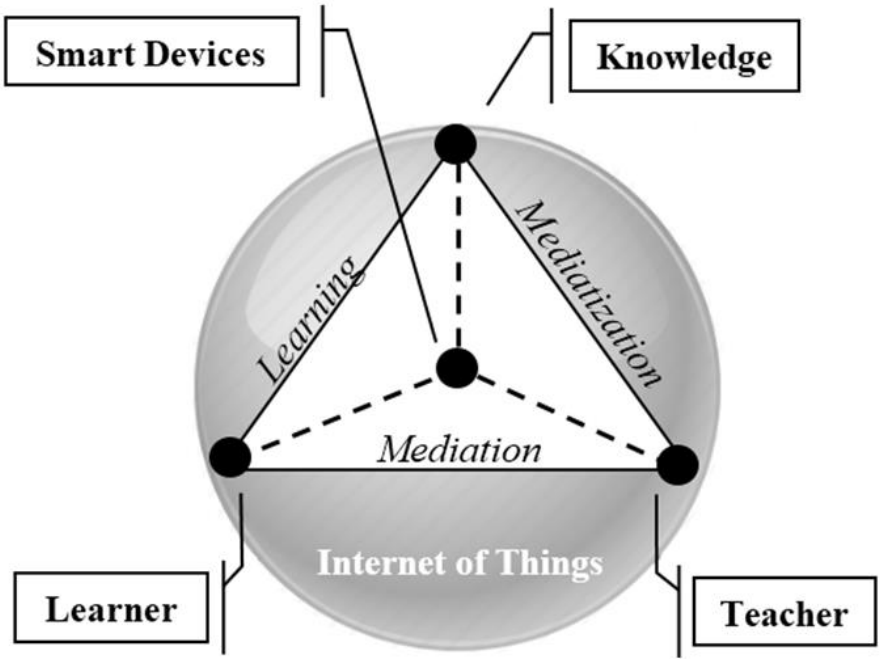

Figure 5: The IoT-Learning approach (Finch, 2018)

In the model the 'Devices' pole of the classic triangleis replaced by 'Smart Devices'.This is due to the logic of the fact that the pedagogical situation using ICT is essentially based on access to information. The teacher plays a dual role. It governs, on the one hand, the process of mediation, by which it ensures the pedagogical relationship in order to facilitate the acquisition of knowledge by the learner. It then fulfills a pedagogical function of management, interactive regulation of learning events. On the other hand, it assumes the process of medialization, by which it is responsible for transforming a part of collective knowledge into useful information for learning. In this sense, books, digital textbooks, posters and interactive boards, as well as the training system, the virtual campus, etc., appear as the result of the medialization process.

By adopting the power of ICT and the Internet of things in educational practice, learners benefit in many ways. Technology helps them to approach all learning styles, participate interactively and sharing, making learning personal, dynamic, collaborative and up to date. In addition, learning goes beyond class.

Interacting with so many everyday objects connected to the Web, students have access to unlimited course from anywhere, and anytime. The smart class system identifies each student already integrated into each student ID card. The system is expected to use IoT node transceivers, making it perfect for indoor location.

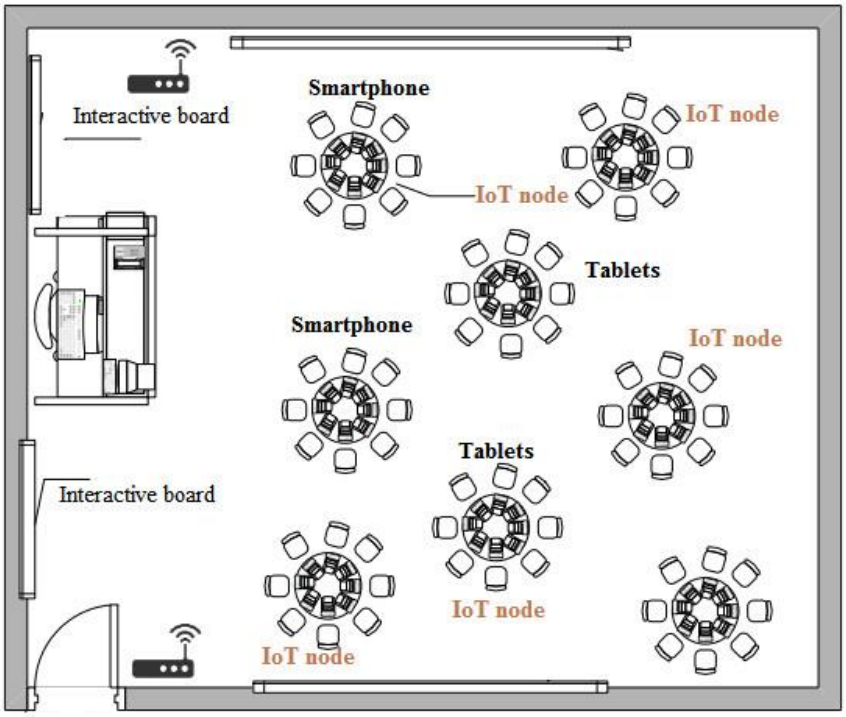

Figure 6: Architecture of the future classroom (Finch, 2018)

CONCLUSIONS

IoT can support classroom instruction by improving learning setting, enhance learning resources, improve methods and techniques of learning, raise management efficiency, and save management costs (Al-Fuqaha, Guizani, Mohammadi, Aledhari, and Ayyash, 2015). Smart classroom is an emerging and challenging concept for the technology to bring it in reality. The resources available for learning on devices, like ebooks, are more engaging and interactive. This research can learn the usefulness and applications of IoT and what is the effect of IoT technology in the field of education. The future work will be to find out how can apply IoT in higher education and challenges of IoT implementation in smart campus system that includes smart education development, smart parking and smart room.

Recommendations

The following recommendations were made:

1. Government should always provide fund for procurement of IoT enabled technology equipment in institutions so as to curb the constraints of inadequacy of IoT enabled technology facilities

2. The government through the ministry of education should conduct periodic review of IoT enabled technology facilities with a view to update them in institutions.

3. Higher institutions administrators should collaborate with non-governmental organizations to establish a good ICT centres in all the faculties of higher institutions.

4. The Federal Government should make the development of teachers/lecturers' ICT competencies a priority and set targets when all long serving and newly qualified teachers are expected to become ICT literate to mandatory standards.

5. The universities should form a consortium to purchase bandwidth. This will enable them purchase a greater volume which will lower the marginal cost of that bandwidth for IoT enabled technolgoy.

6. The university administration in conjunction with the government should put in place modalities to enable undergraduate students to acquire their personal computers. This will not only alleviate the problem of computer literacy, but also enhance students' access and use.

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