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Internet of Things

The Inevitable Technology for Provision of Effective Quality Education

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In recent times the Internet of Things has witnessed high level of adoption in the world of technology. It is a hot research topic in the world of computing. It is made up of billions of “smart” devices from miniscule chips to mammoth machines that use wireless technology to communicate with each other. It is a highly efficient integration of product, information systems and physical systems, which is becoming widely used in education for quality and effective learning; the Internet of Things affects the way we see and do things in our day to day life. This article describes the Internet of Things and analyzes case studies done on its use in education setup; the paper describes its application in the learning environment; It further explores the implications of internet of things in terms of quality, security, efficiency, and financial aspects in learning environment. The paper shows that, the use of Internet of Things in learning environment can drastically improve the quality of training and learning; it finally proposes more research to be undertaken on this area in order to avail the hidden potential of its application in education.

1.0 Introduction

The Internet is moving to an ever wider array of “smart devices” for increasingly diverse purposes and applications. Among the purposes is the education sector use. The internet of things in a nutshell is “a network of physical objects that produce and communicate data with each other over the Internet. This is needed for student and personnel data collection in education setting. It has continued to open tremendous opportunities for large pool of applications and promises to improve the quality of lives (Xia F. et al, 2012). Much attention has been put on it around the world as noted by Xia et al, 2012. It should be noted that the internet of things embeds some intelligence in internet connected objects to communicate, exchange information, take decisions, invoke actions and provide various services. Internet of Things enables computing paradigm to go beyond traditional mobile computing scenarios that use smart phones and portables, and evolve into connecting everyday existing objects and embedding intelligence into the environment.

Though much has been done on the application of Internet of Things, less has been done on education setting, especially in training. This paper therefore has identified the areas that Internet of Things can be applied in education setting and has shown the possibility of using Internet of Things to improve the quality of education and content delivery.

The purpose of this paper is to research on the use of Internet of Things technology as a tool to deliver quality and effective learning. The researcher used case studies to show the impact of Internet of Things use in training. The paper further identifies various applications of Internet of Things in education. Challenges and social implications of Internet of Things are also identified.

The analysis and review of case studies done on the internet of things in education clearly shows that, the use of Internet of Things in learning environment can drastically improve the quality of training and learning. Socially the Internet of things demonstrates better access to education resources, better content delivery, and better security among others.

The rest of this paper is organized as follows: part 2 presents definition of internet of things, part 3, discusses the case studies and Internet of Things and its use in education; part 4 gives discussion on application of Internet of Things; part 5 discusses the implications of Internet

of Things; part 6 discusses the challenges of implementing Internet of Things in education; and part 7 gives conclusion and recommendations.

2.0 Definition of Internet of Things

The term internet of things was coined by Kevin Ashton in 1999 in the context of supply chain management. Since then the term has drawn its definition in different perspectives. In this paper the researcher will draw the definition from various researchers and later have a working definition for this paper. Internet of things refers to networking of physical objects through the use of embedded sensors, actuators and other devices that collect or transmit information about the objects (Baner et al, 2014). According to He et al. internet of things involves connecting physical objects to the internet which provide opportunity to build intelligent systems and applications by leveraging RFID, NFC, wireless sensor network and universal mobile accessibility advanced technologies. On the other hand, Mathias et al. defines it as worldwide network of interconnected objects uniquely addressable, based on standard communication protocols.

Internet of things links objects of real world with virtual world, thus enabling anytime, anyplace connectivity (Friess and Santaci, 2010). According to Fries et al, “A thing is a real/physical or digital/virtual entity that exists and move in space and time and is capable of being identified. Therefore, Internet of Things refers to a world where physical objects and beings, as well as virtual data and environments, all interact with each other in the same space and time. Upon connection, things are expected to become active participants in business, information and social processes where they are enabled to interact and communicate among themselves and with the environment by exchanging data and information “sensed” about the environment, while reacting autonomously to real world” events and influencing it by running processes that trigger actions and create services with or without direct human intervention.

In the paper, the internet of things: survey by Luigi et al, (2010), Internet of Things is defined as a worldwide network of interconnected objects uniquely addressable based on standard communication protocols. Manyika et al, 2015 sees internet of things as sensors and actuators connected by networks to computing systems. For the purpose of this paper, Internet of

Things is objects embedded with sensors and actuators to networks to enable communication with the environment.

3.0 Case Study of Internet of Things and its Use in Education

In order to leverage the use of internet of things in education, quality education will be described. According to Adams, 1993, the terms efficiency, effectiveness, equity and quality are used synonymously. A paper presented by UNICEF in June 2000, proposed that the definition of quality should be open to change and evolution based on information contexts, and new understanding of the nature of education's challenges. Adams further asserted that quality education includes: quality learners, quality learning environments, quality content, quality processes, and quality outcomes. To determine the extent to which technology would be used to provide quality education, Internet of Things technology has been considered. Case studies reviewed in this paper shows that application of Internet of Things is being used in education sector to determine quality in education in the following areas: as a management tool, as a course or component of a course; as a security tool; as a tool for content delivery, and as a better resource access tool.

In this paper the listed issues will be reviewed to determine the need of Internet of Things in provision of quality education.

3.1 Internet of Things as a management tool

Internet of Things is for interconnection of objects for identification, communication, sensing and data collection (Oriwoh E. et al 2013). Oriwoh further says that, Things in this context ranges from traditional computing devices (PC) to general objects embedded with capabilities for sensing and/ or communication through the use of RFID. In their paper, Oriwoh et al, identifies three ways of directing and controlling things: through direct touch; remote control and through learned action. Each object has an association with virtual object to provide information that allow student to reach a learning achievement (Gomez J. et al, 2013)

A case study by two undergraduate and one student at Kerinesaw State University (He et al, 2015) showed that it is possible to connect office chair to assist in class management. The occupancy data is collected and stored in the cloud. This data would then be accessed by authorized users at any time anywhere. The data accessed would then be used for resource

management, tutor time tracking management, student attendance checking among others. Zebra technologies suggests that with RFID equipped backpacks, students can automatically be checked in as they board bus, and also proliferation of smart ID cards and wrist bands would enable the automatic recording of students as “present’ as they walk through the class door.

He et al, proposes that the smart chair would solve the problem of effective management of classroom, halls, offices in an organization and enable efficient and effective communication and solution. In current scenario, in most of the institutions, student’s attendance is taken by them signing an attendance sheet or trainer marking the attendance register. This method is time consuming and unsecure way of managing classroom. As technology improves, RFID and smartphones based methods are investigated (He et al) to track the facial and voice recognition. This then brings the question of classroom coverage and the need of students click on the smart phone.

The smart chair automatically checks whether the chair is occupied or not by using remote sensing technologies, the student’s identification would then be collected automatically using RFID technologies (He et al, 2015). The use of timestamps would then assist in noting the lateness and leave early information.

On the paper “how the Internet of Things is transforming Education”, the author enunciates that “asset intelligence enables institutions to make more informed decisions in an effort to improve student learning experiences, operational efficiency and institute/campus security”. With Internet of Things, items like projectors or laboratory equipment can be equipped with RFID readers so that their movement and whereabouts are visible all times. This reduces time for items search hence allowing more time to trainers in classroom and hence improving performance and delivery.

With Internet of Things, trainers are freed from managing classroom procedures to focus more fully on learners (Meyers Max, 2014). As Meyers (2014) puts it, as the students walk into the classroom, attendance is logged automatically using a device such as the Nymi, and identification taken with a wearable “smartband” that uses the wearer’s ECG pattern.

All these cases show that Internet of Things is a technology to improve institute's management either in asset, resources and personnel (i.e students and staff).

3.2 Internet of Things as a tool for content delivery

A study done by the University of Cordoba, Columbia (Gomez J. et al 2013) tagged internal parts of the computer system with Near Field Communication (NFC) and Quick Response Code (QR CODE) to allow association with virtual objects. This study divided the learners into two groups; experimental group and control group. Experimental group accessed Internet of Things whereas Control group used traditional methods in accessing the course content.

It should be noted that tags contain a unique data that identifies the object and can be used to link to the virtual one.

The laboratory was labelled with NFC tag which transferred information to mobile device. System recognized that student was on site and his/her device had instant information about those physical objects in the laboratory and the systems starts to show the activities which are sent to the mobile device, explaining how the component operates, how it is installed for normal operations among others.

The experiment showed that experimental group performed better than the controlled group as shown in figure 1. This study concluded that better results can be realized when new tools of Internet of Things are employed (Gomez. J et al, 2013).

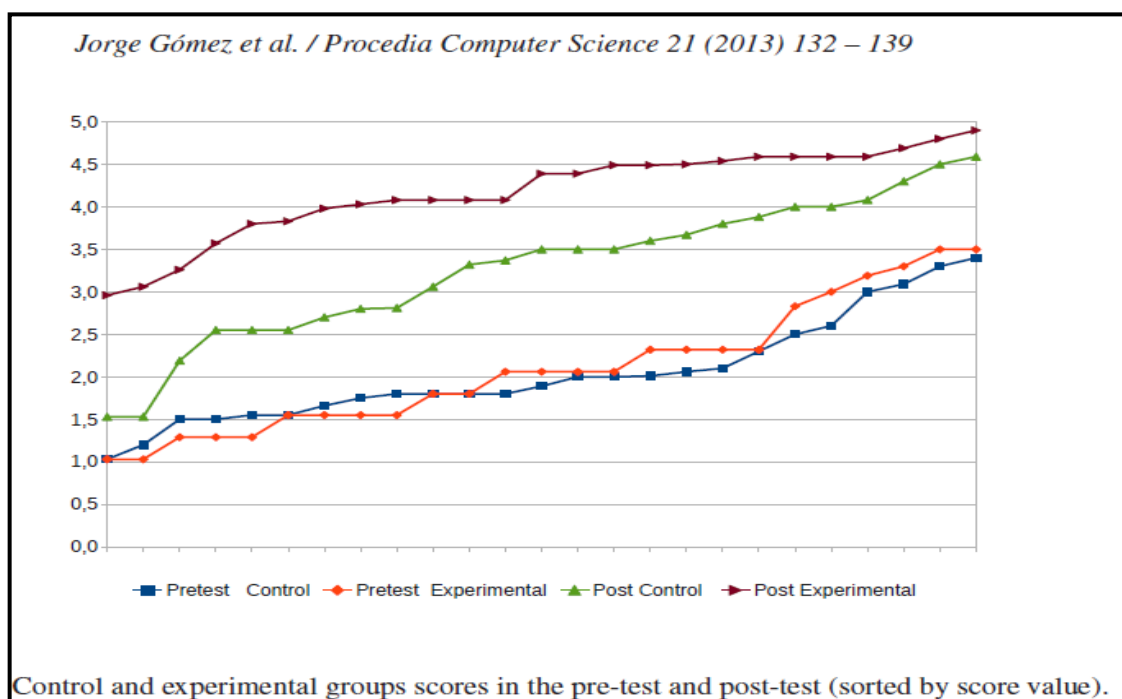


Figure 1

The experiment further showed that using real objects and associating them as a learning resource through internet of things facilitates meaningful learning as it links specific knowledge to real context.

Researchers note that learning takes place when there is interaction between individual and environment leading to knowledge (Yahya S. et al, 2010). It should also be noted here that learning by doing is the best way (Schank, 1995). According to Yahya S. et al, (2010), internet of things allows learners to be in the environments useful for their interests.

An exercise done by Yuen and Cheong during a conference proceeding on a single electrical engineering showed that with the traditional approach the student must be physically present in the laboratory to perform measurements, hence resulting to limited time for doing the exercise. To ensure that e-learning and lifelong learning strategy is taken. A fully automated Internet of Things laboratory exercise was performed. The exercise showed that students could easily access Internet of Things service, and adjust elements and reach needed values (Yuen & Li, 2015). This showed that students can access to their learning courses or laboratory exercises at anytime from anywhere they log on.

Use of digital highlighters like Scanmaker's air would drastically change the way learners take their short notes by shortening the process (Jeanette Cajide, 2015). This technology transfers wirelessly printed text into an application or web browser thus enabling the learner a faster access, anywhere access and any time access in future.

The Internet of Things would therefore scale teachers and best quality of instruction in any device anywhere and allow learners to learn at their own pace, focus on relevant content, richer and interactive content only.

3.3 Internet of Things as a course or component of a course

The developed countries have embraced Internet of Things as courses or course units in their curriculum. This has encouraged more research to be done on its use.

The Open University in UK started an introduction course; my digital life designed around Internet of Things concepts (Selinger et al, 2013). This placed Internet of Things at the core

of the 1st year computing curriculum and prepares students for coming changes in society and technology.

Though much attention has been given to Internet of Things, researchers realize that it has not been adopted as a course major in institutions (Ning and Hu, 2012) due to lack of systematic curriculum, training materials and Internet of Things trainers. According to Ning and Hu (2012), the ministry of education China announced a list of newly launched undergraduate majors that included Internet of Things major. This move saw at least 100 colleges in China introduce Internet of Things as major courses in curriculum. As Ning and Hu note, Internet of Things cannot be separated with training. Shortage of qualified personnel is an important factor affecting Internet of Things development in the industry. This called china to urgently reorganize its systems and train internet of Things personnel for development.

3.4 Internet of Things as a security tool

Video based Internet of Things integrates image processing, computer vision and networking frameworks (Gibbi et al, 2013) Camera network appliances help track targets, identify suspicious activities, detect left luggage and monitor unauthorized access. Zebra technologies say that Internet of Things' has the ability to track objects, students and staff, and connect devices across institutions hence bringing new level of safety to institutions (Robert Lutz, 2016). Smart ID cards and wristbands enable educators to store the last known location of the student or visitor. This allows institutions to identify the right people in the right places and hence increasing security. With better security, learning takes place in a conducive environment and hence better performance.

With Internet of Things administrators could connect everything on the institute everywhere through one secure, unified network to manage institute lighting, parking, and cameras and to provide valuable data and analytics on traffic patterns, usage, and areas of resource optimization (Asseo et al, 2016).

3.5 Internet of Things as a Better Resource Access Tool

Special card for visually impaired student is given. When registered by a computer, the computer automatically enlarges font size, rather than calling a trainer to assist. This builds self-confidence and promotes independence. On the other hand, students use RFID to tag sample specimens in the wild to enable them take notes without leaving the classrooms.

With the Internet of Things, institutions improve educational outcomes by providing richer learning experiences and by gaining real-time actionable insight into students' performance (Zebra technologies).

With the Internet of Things, learners are able to attend any class, at any time, from any device. This provides them with greater flexibility to consume content and knowledge when and where they would like. It removes the traditional barriers to teaching and learning, providing institutions with the same flexibility to provide better learning experiences for learners and allowing them to connect with experts from around the world and create robust, hybrid learning environments (Asseo et al, 2016).

4.0 Applications of Internet of Things

As noted earlier the term Internet of Things was first coined by Kevin Ashton in 1999 in the context of supply chain management. However, in the past decade, the definition has been more inclusive covering wide range of applications like healthcare, utilities, transport, etc. (Sundmaeker, H. et al 2010). Its use as extended to include education. Among the various applications of internet of things are in mobile use to connect staff and students in accessing full-time educational resources, facilitate collaboration among trainers and students. The Internet of Things has also been exploited in issues to deal with security (Robert Lutz, 2016). A lockdown system can be initialed to be used during an emergency. The systems can also send alerts to the place, fire stations and hospitals to fasten the response in case of emergency. Connected devices can help schools streamline everyday operations such as student attendance, fee alerts and student reports which can be automated easily. It can also bring down energy costs. Used wisely, it can also become a platform to conduct exams. To enable inclusive access to education, Internet of Things ensures that challenged students with special needs are not left behind. Specialized software can be used to assist students with specific problems for example recognizing students with visually impaired or hearing impaired by making changes accordingly such as increasing font size or give more visual cues.

5.0 Implications of Internet of Things

Implications of Internet of Things in terms of quality, security, efficiency, and financial aspects in learning environment.

Quality of education matters a lot and this quality will be determined by the learning resources accessed by each student. Internet of things not only brings advanced value to the physical structures and environment in schools but also improves education itself (Nilsson, 2015). Internet of Things technology is a help to a special need student who is visually challenged (Robert Lutz, 2016). A visually challenged student may be equipped with a special card connected to a computer. Whenever the student logs on to the computer, the computer font size increases (Robert Lutz, 2016) to enable the student have a better view of the content. This would eliminate a lot of time wastage waiting for the teacher to come and increase the font for the student. This can be extended to the student's laptop to enable her or him use anywhere anytime. The use of Internet of Things in curriculum promotes creativity (Nilsson, 2015). The gathered information about students creates an opportunity for students to learn from highly successful students hence benefiting the students' body. Internet of Things when used effectively increases students' engagement and provides a safer learning environment. Teaching take place in mobile and this ensures that learners have enough time to prepare for examination and assignments.

Internet of Things increases security; levers or buttons throughout the school may be created. These buttons engage, initiate a customized lock down system which include features like automatic perimeter security, immediate notification of authorities and transmission of video to police to monitor intruder activities. Nilsson (2015) notes that since the Fraser Public schools in Michagan introduced Internet of Things by adding video sensors, incidence of fighting dropped drastically in these schools. Other than security the Internet of Things also assists in behavior change among learners.

In any institutional setting, efficiency is one of the key areas to consider. With the Internet of Things technology management of the finite resources will be considered, this is done by tagging the resources like projectors for easy identification. As Nilsson, 2015 states, resources such as projectors or lab equipment are equipped with RFID readers to track their whereabouts at all times. Other than this, student's attendance is automatically tracked using smart IDs and wristbands as they walk through class room door, testing is administered digitally, student's health is monitored closely, school's vehicles are monitored and tracked with smart phones applications. All these lead to efficiency.

6.0 Challenges of Internet of Things

Building infrastructure to support the data sharing and consumption inside a network is costly. This would therefore call for more budgetary allocation for the technology to succeed. Besides high cost of implementation, privacy is also a challenge in implementing the Internet of Things technology. The right of privacy is a basic and undisputable human right (Eeber. H., 2010). Without the knowledge of users, they can be followed since the attribution of tags to things/objects may not be known to users and there is no visual signal to draw attention of the objects to the user. On the other side, current internet architecture may be a challenge to many developing countries like Africa. This may be in terms of mobility, availability, manageability and scalability. A lot of data is collected in the cloud. This is a challenge especially when this information is to be mined to make a specific decision for the institution. Another emerging challenge is that the teacher must develop meaningful learning activities, and more importantly, can adjust to the individual learning styles of students in an Internet environment. Internet of Things technology being a new and emerging technology lacks enough human resources who can fully participate in content, activity, test development for online classes.

7.0 Conclusion and recommendations

The implementation of the study on various Internet of Things shows that effective and quality training can be achieved through technology. It also shows that Internet of Things technology has the potential to improve operational efficiencies, connectivity, security and collaboration in TVET institutions. Technical institutions and institutions of higher learning can also explore the possibility of starting courses geared towards internet of things. Further the researcher proposes that Technical institutions and institutions of higher learning should be lead the way in using internet of things and train staff on the same to leverage its use.

The researcher advocates for further research on Internet of Things use in education to explore more avenues. The emergency of u-computing web will be a key technology in future and the research encourages for more research to be taken on this area to identify the hidden potential of its application in education.

References

- Adams, D. (1993). Defining educational quality. Improving Educational Quality Project Publication #1: Biennial Report. Arlington, VA: Institute for International Research.
- Asseo, I., Johnson, M., Nilsson, B., Chalapathy, N., and Costello, T.J (2016), The Internet of Things: Riding the Wave in Higher Education
- Friess and Santuci (2010), Vision and Challenges for realizing the internet of things.
- He J., Atabekov A., Mwangi E., Toler D. (2015), Smart Chair: An Internet of Things Case Study for a Capstone Research Project.
- IEEE Internet of Things Journal. (2016). *IEEE Internet of Things Journal*, 3(5), C2-C2. <http://dx.doi.org/10.1109/jiot.2016.2599683>
- Jeanette Cajide (2015), The Connected School: How IoT Could Impact Education: Retrieved from: http://www.huffingtonpost.com/jeanette-cajide/the-connected-school-how-_b_8521612.html
- Max Meyers (2014), Can the Internet of Things make education more student-focused? Deloitte Consulting LLP.
- Nilsson Bob, (2015), Is Your School an Internet of Things Smart School? Retrieved from: <http://www.extremenetworks.com/is-your-school-an-internet-of-things-smart-school/>
- Ning, H. & Hu, S. (2012). Technology classification, industry, and education for Future Internet of Things. *International Journal of Communication Systems*, 25(9), 1230-1241. <http://dx.doi.org/10.1002/dac.2373>
- Nivas, H. (2016), Internet of Things in the Education Industry – Academics. Retrieved from: <http://InternetofThingsworm.com/internet-things-education-industry-applications-examples>
- Oriwoh E., Sant P., Epiphaniou G., (2013), Guidelines for Internet of Things deployment approaches – The Thing Commandments realizing the Internet of Things, Cluster of European Research Projects on the
- Robert Lutz (2016), The Implications of the Internet of Things for Education. Retrieved from: <http://www.systech.com/the-implications-of-the-internet-of-things-for-education>