Applications of Internet of Things in E-Learning

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Abstract - **Internet of Things (IoT) is the network of all kinds of things embedded with sensors, electronics, software, and etc. connected to the Internet, based on the International Telecommunication Union's Global Standards Initiative. Gartner forecasted that 4.9 billion connected things would be in use by the end of the year 2015 and would reach 25 billion by 2020. The World Bank estimated that over the next 10 years there will be two million unfilled ICT-related jobs. So, IoT and eLearning will have to be used to educate more people in ICT as well as other fields. This paper will discuss IoT in eLearning and instructional design, training employees on IoT technology, six skills for IoT applications, Internet of Learning Things, IoT potentials to transform education, and IoT to improve student performance.**

Keywords - **Internet of Things, IoT in eLearning, IoT and instructional design, IoT and training, Skills for IoT, Internet of Learning Things, IoT to transform education, IoT to improve student performance**

I. INTRODUCTION

Internet of Things (IoT) is the network of all kinds of things embedded with sensors, electronics, software, and so on, connected to the Internet, based on the International Telecommunication Union's Global Standards Initiative [1, 2]. From Gartner report entitled "Gartner Says 6.4 Billion Connected 'Things' Will Be in Use in 2016, Up 30 Percent From 2015" [3], it was reported that the number of things in IoT will be 20.8 billion by 2020; and that in 2016, 5.5 million new things will become connected every day. In the year 2020, IoT spending will be 3,010 billion US$ (about 1,534 billion US$ in the category of "Consumer", and about 1,476 billion US$ in the category of business).

This paper will discuss IoT in eLearning and instructional design, training employees on IoT technology, six skills for IoT applications, Internet of Learning Things, IoT potentials to transform education, and IoT to improve student performance.

II. IOT IN ELEARNING AND INSTRUCTIONAL DESIGN

Many favorable comments have been made about using IoT in e-learning. Three examples will be presented here. The first example is the article "IoT and e-Learning" [4] which presented the potential ways to leverage IoT in eLearning. The second example is the article "eLearning and the Internet of Things" [5] which presented a good impact of the Internet of Things on eLearning. It said that in the case workers in a dangerous factory environment wore activity trackers that sensed when they performed tasks incorrectly, in ways that could endanger themselves or other workers. The activity tracker would send data about an employee's erroneous action back to the company's learning management system (LMS). The LMS then automatically assign a refresher course on safety procedures for that employee. The third example is the article "The Internet of Things in E-Learning" [6] which stated that IoT can enhance eLearning in improving completion, reducing costs, and improving learning outcomes.

One of the most important part of eLearning is "Instructional Design" and IoT can definitely be used in Instructional Design as discussed in the article "How will the Internet of Things affect your instructional design?" [7]. There are three features of IoT information. They are 1) Spatial information (place), 2) Temporal information (time), and 3) Persistence information (history). The three features of information should be used in instructional design to show the place and time of the student taking the course and compare with the historical data to select the most appropriate part of the learning to be done next, either in providing repeated learning of the previous topic or in proceeding to the next topic.

III. TRAINING EMPLOYEES ON IOT TECHNOLOGY

With IoT becoming more and more popular, employees should get training about IoT technology. The article "5 Crucial Steps for Training Your Employees on IoT Technology" [8] proposed five steps. The first step is to present the whole picture of IoT to the employees rather than to present IoT in the "need to know" fashion. The employees should learn how IoT can improve safety, customer services, productivity, efficiency, and etc. The second step is to emphasize security leak because IoT network includes a lot of data. The third step is to help the employees to understand that data should be applied only where it is needed and when they are alerted by IoT. The fourth step is to let employees understand that IoT will make them know to prepare to provide service even before the customers call them. The fifth step is to let employees know that they are constantly monitored by IoT so that they will try to improve their performance.

IV. SIX SKILLS FOR IOT APPLICATIONS

There are many suggestions for using IoT successfully in any field including eLearning. As an example, six skills are suggested in the article "Six Essential Skills for Mastering the Internet of Connected Things" [9]. The first skill is to envision your connected things to take into account the capabilities and characteristics of the thing, the data flowing to and from the thing, and the applications able to access the thing. The second skill is the flexibility in modeling things with new things and applications regularly coming online, each needing to fold seamlessly into the network. The third skill is the richness in modeling connections relying on having a detailed understanding of both the things and their connections. The fourth skill is in conquering the query which may be in SQL or graph database. The fifth skill is in capturing and mastering the massive amounts of data because each sensor and thing is continually capturing and transmitting real-time data coming from the sensors in the IoT. The sixth skill is in building connected applications by knitting everything together to create the right applications.

V. INTERNET OF LEARNING THINGS

It has been fashionable to put the word "Smart" in front of the thing using IoT, such as "Smart home" for home using IoT, and "Smart City" for the city using IoT. Another alternative is to combine the word "IoT" with the "Thing" using IoT such as "Bank of Things" or "Internet of Banking Things". Therefore, the use of IoT in "learning" may be called "Internet of Learning Things". From the article "Internet of Learning Things" [10], it was stated that "eight schools in the UK would take part in a $1.2 m scheme to find out how 'Internet of Things' can enhance learning in Science, Technology, and Geography. Students and teachers would be taught to measure and share data – using new Internet of Things technology – in ways that help make learning fun, link directly to the curriculum, and ultimately inform the design of the next generation of schools". As an example of "Internet of Learning Things'', the Parrot AR.Drone2.0 [11] shown in Fig. 1,"enables students to survey an area using a mobile phone. HD video is shot and stored on a USB memory stick, or relayed directly back to the phone. In one package, Science (e.g. physics of flight); Technology (e.g. OS, networking, control); and Geography (e.g. surveys, observations) can be delivered, in a way that is completely engaging for children of all ages.".

Fig 1. Parrot Drone 2 Controllable
thru Smart Mobile Device
(Source: Parrot AR Drone 2.0 Image search from Google.)

VI. IOT POTENTIALS TO TRANS FORM EDUCATION

The article "Internet of Things in Education: The possibilities are numerous" [12], the author suggested four points to consider in using IoT to transform education. The first point is that "IoT will enable students to connect with teachers and access to full-time educational tools. It will also facilitate collaboration with teachers and other students. Parents can also have access to learning analytics through IoT". The second point is that "Schools are vulnerable places, as some events in the U.S. indicate recently. With IoT possibly, we can reach a stage that with just the hit of a button a lockdown system can be initiated which can be used in case of an emergency. Moreover, the system can send alerts to the police, fire stations and hospitals to fasten the response in case of an emergency. Surveillance will become extremely easy with IoT. The third point is that "IoT can help schools streamline mundane operations such as 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". The fourth point is that "Children with special needs can also benefit from IoT. Specialized software can help students with specific problems. For example, it can recognize visually impaired or hearing impaired students and make changes accordingly such as increasing font size or more visual cues. It will also save valuable time of the teachers which can be used to enhance the teaching experience."

VII. IOT CAN IMPROVE STUDENT PERFORMANCE

In the article "Interaction System Based on Internet of Things as Support for Education" [13], it was stated that IoT could provide motivation and could allow students to be playful. IoT also allows teachers to teach students according to their aptitude. Teachers can choose the basic materials to suit students. Students also learn at their own pace according to their capabilities, so they are not limited by a one-size-fits-all program. The authors of the said article conducted an experimental validation which yielded evidence that IoT could improve the student's learning outcomes.

VIII. CONCLUDING REMARKS

Internet of Things (IoT) is the network of all kinds of things embedded with sensors, electronics, software, and so on, connected to the Internet, based on the International Telecommunication Union's Global Standards Initiative. Gartner reported that 6.4 billion connected things will be in use in 2016. The number of things in IoT will be 20.8 billion by 2020; and that in 2016, 5.5 million new things will become connected every day. In the year 2020, IoT spending will be 3,010 billion US$. IoT has also gained popularity in e-learning. This paper presented IoT in e-learning and instructional design, training employees on IoT technology, six skills for IoT applications, Internet of Learning Things, IoT potentials to transform education, and IoT to improve student performance. However, IoT in e-learning is progressing very fast and so, all parties concerned should search Google regularly to find up-to-date information to study for the benefits of themselves, their organizations, and their countries.

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