The Influence of IoT Simulation in the Learning Process: A Case Study

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ABSTRACT

Internet of things (IoT) is a relatively novel technology which provides connection between things. It was presented for the first time by Kevin Ashton in 90 ś.The software and hardware development of IoT is not growing as the same rates as the implementations of its applications in the human life such as: education, administration, business, health, security and our social life. Education is one the most popular field which IoT is presented. This research is a concise survey of a real case which studies influence of the IoT in the learning process. A theoretical revision along with a statistical analysis of a real case is discussed in this work. Finally, the results revealed several attractive impacts of the IoT simulation in the learning process which be outlined in details along the paper.

CCS Concepts

• **Computing methodologies→Simulation evaluation**

Keywords

Internet of Things (IoT), E-Learning, Real Implementation, Simulation, Learning process.

1.INTRODUCTION & BACKGRAOUND

Internet of things (IoT) is a prevalent technology which provides connection between the physical things which is uniquely identifiable by its name or symbol in its embedded [30].It is growing very fast in size, implementations and dimension of the application in various parts of the human life such as: education, security, energy management, governance, business, health and our social life [1]. It was pronounced for the first time by Kevin Ashton in 90 ś c. Primarily the IoT history goes back to the time which the using of the RFID tags was expanding in the business sectors [2][26]. On the basis of the basic idea of Internet of things, all stuffs will be able to connect with each other physically [3]. IoT structure is based on the obtaining the information sent by actuators, sensors, tags, and storing the data in a cloud structure. In this simple structure the things are interacting between themselves such as the thing to thing, thing to Machine, Machine-to-Machine, and Object- to Machine or Object-to-object types [4][25]. The scope of the IoT is expanded from a small smart home project to the advanced health applications. It can cover almost all aspect of the human life. One of the most visible applications in our daily activities is teaching and learning, or in a summary: "Education". IoT has a significative influence in shaping the traditional e-learning model to a smart and form innovative in the close upcoming [5][1][14]. In case of Education, IoT as a prevalent phenomenon can offer a wide range of services and facilities by joining and connecting several IT technologies which is changing the future educational system. The upcoming education center will be prepared with the many previously connectionless objects which are enabled to connect with other things by IoT[14]. A said, various IoT designs, as well as the other communication technologies, are involved in nearly all human activities such as "Education". Education is one of the most visible applications which IoT can be involved in [1]. It could have the significant influence on, converting the shape of traditional education to a novel form in the close future [6] [7]. IoT is a phenomenon which can support creativity in many fields by integrating with other technologies. As IoT can be joined with other IT technologies such as WSN and RFID [8] and supporting educational processes, it can offer a variety of the e-educational services, tools and utilities which can transform the current forma of the educational systems. The educational centers will be equipped with smart and online things. Students and instructors can validate their validity of as users passing finger-prints in front of an electronic reader and/or QR mobile checking in order to enter to the smart classroom or electronically accessing to the e-school system [8][5]. IoT also can provide the online connection between many objects. This permits the educational objects, such as teachers and learners, connecting to the resources such as online-labs, library [8] didactic materials and online-assessments and evaluations in a large-size virtual platform. It means in a novel form of e-learning system all learning functions and activities will be considered as the "objects" [9].

The traditional e-learning, as a digital methodology, can offer a enormous virtual access environment for learners, but at the same time there are some limitations. The geographical position, face to face communication between objects, and effective cooperation between virtual and physical agents are supposed to be the main limitations in e-learning. Applying smart objects in the learning environment is one of solution for the mentioned issues. IoTs is considered as the main provider of smart agents for e-learning ecosystems [10]. It can present two essential elements into the traditional e-learning that are smartness and object interaction (things to things, machine to machine) [11]. A huge platform for learners and instructors with a wide variety of distance learning devices and objects is provided by IoT. High interaction between

ICIET 2020, March 28–30, 2020, Okayama, Japan

ACM ISBN 978-1-4503-7705-8/20/03…$15.00
DOI: https://doi.org/10.1145/3395245.3396427

virtual and physical objects can generate a great number of collaboration environments [10]. But always there are many challenges in this direction. Simulation of the educational process implemented by IoT technology is one of these challenges. Implementation of the IoT covers a vast field of the objects. Management & implementation of the IoT applications running over heterogeneous platform is complicated. Thus, the simulation modeling of the IoT set-up is the most appropriate replacement strategies to cope with some limitation of IoT implementation [12].

So, in this work after presenting a basic system architecture of an IoT and discussing the advantages which bring out in e-learning process several scenarios of IoT simulation which we developed and used will be presented for further analysis.

Firstly, a basic IoT set-up structure is defined firstly in the next section.

1.1 Basic IoT Structure

A Basic structural design of IoT is shown in Figure 1. Based on the Figure, the IoT system comprises three basic layers: application layer, network and perception layers [13]. The application layer is regard as as an interface between the Network layer and the user. The network layer offers connection between stations and gateway spot. The gateway spot is considered as an intermediary point between user application and the layer of perception, responsible for collecting data sensed from the nodes sending the sensory information to a cloud DB section. The perception layer includes the physical things or nodes which can sense an incident [14][27].

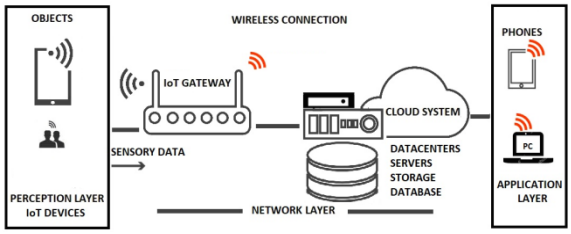

Figure 1. A simple architecture of IoT scenario [14]

1.2 Learning Process and benefits of the IoTs

Internet of things is a technology which can provide high efficient connection between things. It also enables to offer a global communication of the points, educational centers, and organizations which can change the actual pedagogy models [15]. Actually more smart things are customized to the different scenarios becoming more ubiquitous in various parts of education [16][23].On the other hand, considering the student ś engagement in the learning process as a degree of interest it can increase their level of enthusiasm while they are using a novel and interactive technology that facilitate more participating in the learning process [17][19][29]. Also, the impressive technology developments and communication tools facilitate online learning through the enormous e-learning environment (Internet). IoT can provide an addition of the learning collaborative system in the e-learning process [18][28]. In general, IoT as the advanced ICT technology can facilitate the students to access to the huge educational resources any time studying, doing homework, investigating subjects of interest, forming workgroup, doing the projects in group, sending or receiving any material and feedback to teachers. These factors can improve the performance of the students [20][21][22].

Considering the mentioned possible advantages of the IoT in the educational process, using the IoT applications or simulation can help in the latest models of e-learning procedures [14]. As the hardware development of the IoT applications is not easy, in many cases, IoT simulations can bring out the benefits which inherit from the real implementations in the educational process.

Principally, this paper explores some advantages of IoT simulation on the E-learning process. In order to survey various advantages which can bring out the IoT simulation scenarios in the learning process several scenarios are developed. The students simulated these situations and presented to the whole group. The main idea in this work was as they are learning about the IoT basic concepts they can simulate different IoT situations and applications to extend their knowledge about IoT. After experiencing the simulated cases, a statistical survey was applied to evaluate the user experiment perception.

In the following section several simulated IoT scenarios (by students) will be presented.

2. Simulated IoT scenarios

The simulated IoT scenarios which will be presented in this section are:
Figure 2 and 3, demonstrate a smart parking IoT system simulated in the packettracer program. In this scenario there are several sensors that can detect different vehicles which try to enter to the parking. They pass through a gateway check-point equipped with RFID detectors after receiving the message of availability. As they are trying to enter, they look for a free place to parking, the sensors located in the car and walls guide the driver to find a place.

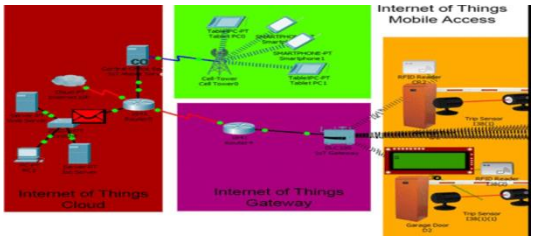

Figure 2. Smart Parking Topology in Packettracer

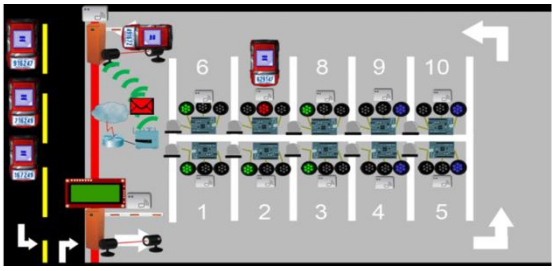

Figure 3. Smart Parking by using IoT sensors

Figure 4 is a simulated case in which shows the status of the different type of the sensors used in the vehicle. There is a panel in front of the driver. The driver can monitor, in real-time, the state of the gas level, break status, the tubes and the liquids of the breaks. All data related to the obtained data from the sensor are able to be sent through the wireless connection to the station or a mini-cloud system to further process.

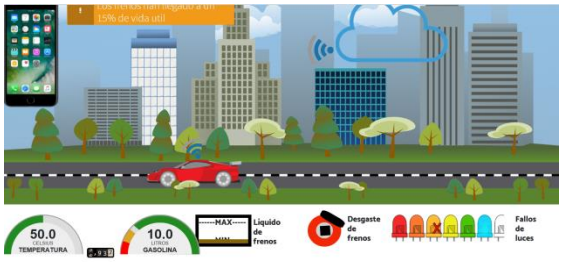

Figure 4. IoT Vehicle state

Figure 5 and 6 show a simulated hospital and smart health scenarios. In these cases, all process related to the attendance of a sick person are simulated. An automatic alert message received by reception and an ambulance will be sent to the sick location. Other process like checking, opening a real-time file, medical process, etc, are simulated and the data will be sent to a private cloud. Doctors and other relevant administrative personals can get access to the history information of the people connecting to the DB.

Figure 5. An IoT Hospital scenario

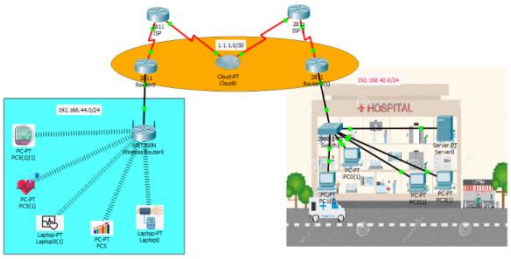

Figure 6. IoT Smart Health

Figure 7 shows the picture of a simulated dam scenario. In this case, some variables like the amount of entrance water, density of the water and some other variables are monitored and controlled by sensors and information sent via Internet to a mini-cloud. The users can get access to an application which administrates and give related orders to the actuators.

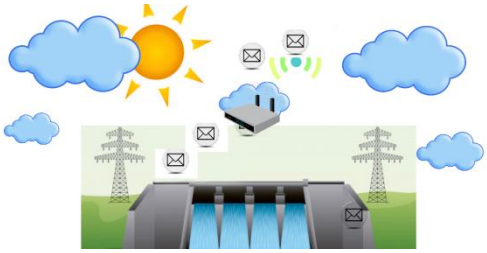

Figure 7. A Dam scenario controlled by IoT

Figure 8 is another sample of a basic simulator which can simulate activities of a soccer player. By setting up the various types of sensors, data related to the pattern of the player will be sent for further process.

Figure 8. Path of the player

Figure 9, is a simple scenario in which a plane hangar is simulated and some variables such as the physical place are monitored.

Figure 9. Plane Hangar

Figure 10 shows an animal monitoring case which is simulated in a web-based application. In this application some characteristics of the animals are monitored and simulated.

Figure 10. Animal monitoring

3. STATISTICAL METHODOLOGY

A statistical methodology is employed in order to compare a real implementation of IoT and simulation type. A multi-items questionnaire is used to collect related data from students which simulate a scenario and experiment a real implementation of IoT. Table 1 and 2 are summarized of the single and multi-terms questionnaire used in this investigation.

Table 1. Two options questionnaire

	IoT Simulation	Real IoT
Help in permanent learning		
I feel, in general, I learn faster with		
Open the new horizons		
Generate more social interaction		
Generate more challenge		

Table 2. Multi-Options questionnaire

	Strongly Agree	Agree	N/A	Disagree	Strongly Disagree
Help me to have a preliminary idea about the problem					
Give me the opportunity of applying what I learnt					
Encourage me to know more about the subject					
Motivate me to experiment related to the subject					
Create me new horizons					
Design IoT simulation is difficult					
Affect the quality of learning process, effectively					
Help me in self learning					
general scientific and professional curiosity					
Generate new challenges					
Generate lots of interests related to the subject					

3.1 SAMPLING

Tables 1 and 2 show the designed survey. Table 1 describes the first questionnaire which is polling the influence of IoT and real implementation in five factors: Help in permanent learning, faster learning, opening new horizons, generating new challenges and social interactions.

The second questionnaire includes several options: the first section compares several learning items in both simulation and real case. The central focal points are questioned in the second and third options. These options are designed to obtain various details of multi-choice survey. The last part includes questions related to the learning and teaching influence of the IoT simulation in the learning process. Assuming that the goal population is 100, 60% of the population participated in the survey.

3.2 RESULTS AND ANALYSIS

Data obtained in this survey is based on the perception of the university students which are taken course of Networking.

3.2.1 Learning related variables

In this survey, it can be found some direct learning variables related to the learning processes which are:

a. Give me the opportunity of applying what I learnt
b. Motivate me to experiment related to the subject
c. Affect the quality of learning process, effectively
d. Help me in learning alone
e. Encourage me to know more about the subject
f. Simulation of IoT help in Learning
g. Helping in the learning process (as tool)

3.2.2 Aggregate results

Figures 11, 12 and 13 demonstrated the aggregate results of the survey. Figures show a comparison between IoT simulation and real experiments in terms of some e-learning aspects. Based on these figures, in almost all cases the real case wins against the simulation of the IoT experiments, although, simulating of IoT can help in learning process and wouldn't generate the significant social interaction.

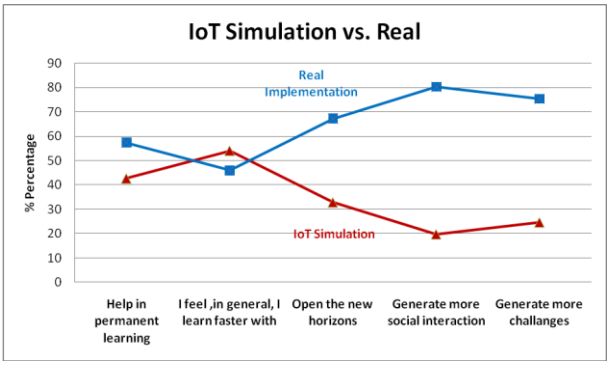

Figure 11. General factors questionnaire result.

Figure 11 demonstrates a comparison between the simulation and real case. In all situations the real implementation of IoT helps in the learning process which can generate more challenges and social interactions than the simulation case. More than 50% of the learner thinks that the simulation of an IoT scenario helps them to learn faster than the real IoT implementation cases.

Figure 12 is a detailed exhibition of the variables related to the simulation case. As shown in this Figure a highly percentage of the students agree with the fact that the IoT simulation can give the opportunity of the applying what they learnt. They think that with simulation of the IoT they could obtain a preliminary idea about the problems. At the same time they don't agree that simulating of an IoT scenario is difficult. A considerable percentage of the respondents are strongly agree with the opening the challenges of learning idea when they simulated the IoT scenarios and can motivate them to experiment more related ideas. Always there exist some respondents that don't believe that IoT simulation can help in the learning process and other general benefits.

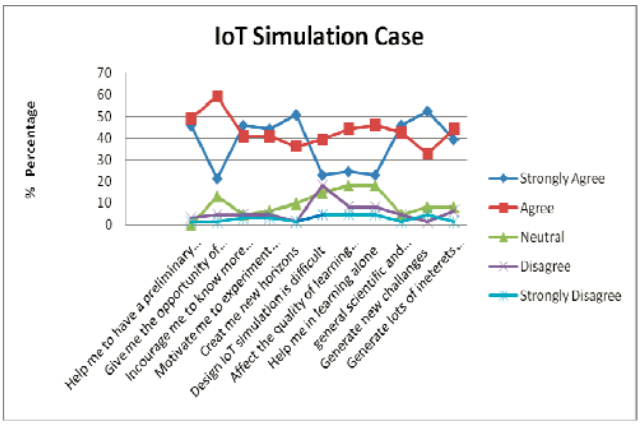

Figure 12. Detailed factors questionnaire results (IoT simulation)

Figure 13 is a graphical exhibition of the aggregate results for real implementation case. Figure 13 shows the survey results associated to the IoT real experiments.

Based on the Figure 13, more than 60% of the learners are strongly agree with these thoughts that real experiments of the IoT implementation can help in self earning process, it can generate the scientific and professional curiosity and create new challenges and interests. They believe also, the real experiments, especially in IoT, -no strongly- can encourage and motivate students to know more about the subjects creating new horizons about IoT subjects. A comparison between this situation and simulation scenarios can

confirm that students strongly believe in real implantation in most cases. But, at the same time they feel: simulating of the events offers themselves more opportunities of applying what they learnt than the real experiment cases.

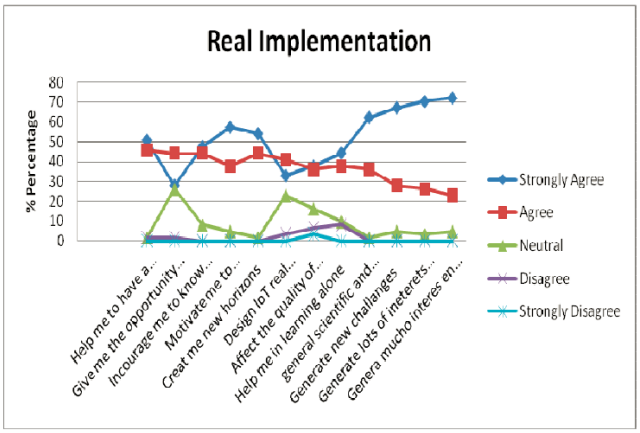

Figure 13. Aggregate results for Real case

Figure 14 represents the influence of IoT simulation in learning and teaching process based on the students 'opinions.

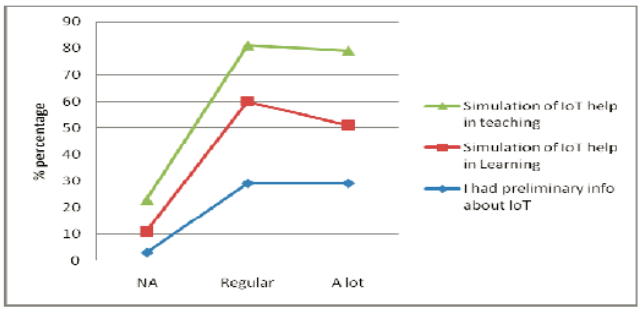

Figure14. Helping IoT in E-learning

Based on the Figure 14, most of the users which had preliminary knowledge about IoT think that the IoT simulation can help in teaching and learning, although this is not absolute value. Nevertheless, the people that didn't know about IoT don't believe that IoT can help in the e-learning process.

The last results of this research are shown in Figure 15.Figure 15 analyzes the effect of the IoT simulation as a toll in the learning process.

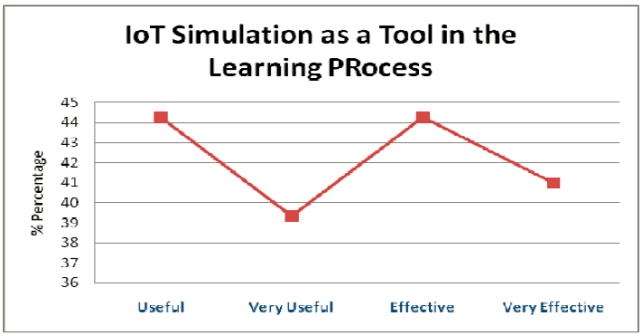

Figure15. IoT simulation as Tool

Based on the results, most percentage of the respondents believes that IoT simulation as a tool is useful and effective in the e-learning process. The surprised opinion is they don't think that the IoT simulation is a very useful and very effective tool in the e-learning process.

Based on the results in almost all of the cases, IoT simulation helps in the learning process, although its influence is not in the same level of a real implantation experiments but it is significant.

4 CONCLUSION AND FUTURE WORK

This research was a basic survey related to the possible influence of the IoT simulation in the learning process. Two scenarios were designed in order to study the predefined mentioned hypothesis. The results confirmed that the direct impact of the real experiments over the learning process.

In summary, most of respondents agree with this idea about the influence of a real scenario of IoT but no strongly. There are some situations in which they believed that a real experiment strongly cannot help in the speed of learning. On the other hands, the results showed that in almost all of the cases, IoT simulation helps in the learning process, although its influence is not at the same level of a real implantation experiments but it is significant. A comparison between two scenarios demonstrates that the simulation case can not generate the social interaction and challenges; it can help in permanent learning process.

Finally, depend on the preliminary knowledge of the people they have different view about the effectiveness of the IoT simulation as a tool in the teaching and learning process. Nevertheless, simulation of IoT scenarios always can be considered as a helpful support to the real implementation labs in the process of learning. Taking into consideration the importance of the IoT simulation, development of the customized IoT scenarios and its impact on the e-learning process will be the future investigation.

4. ACKNOWLEDGMENTS

I am particularly grateful for the assistance given by my students for their contributions to this project.

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