

Developing Science Education Game Based on Internet of Things (IoT): Materials and Methods Overview

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ABSTRACT

Making education media particular serious game for learning science based on technology trend need more notice and discussion. So that, the aim of this article was discuss what we need to develop education game engage IoT ecosystem. This research method is content analyse which analyse some research about IoT, IoT gamification, and IoT education. There is compatibility from student and teacher need when run and after run IoT as their game platform on classroom. The result of this research are how to build and what are guidelines of developer and teacher. In addition, the challenge and solution of establishing IoT such as security term was founded. Therefore, the general guidelines and requirement can be reasoning for developer or teacher who interested to exercise IoT on game based learning.

Keywords: *Internet of things (IoT), Game based learning, Science education*

1. INTRODUCTION

Game based learning is a serious game developed in education and training [1]. Game-based learning was originally a training medium for American soldiers, but as it developed, game-based learning was designed to be a combination of learning instruction and fun entertainment for its users, especially students [2], [3]. Game based learning is a learning system to train individual skills to understand the learning context[4]. Game-based learning is a technological innovation in education for fun and meaningful learning science [5], [6].

Game based learning facilitates students to learn through games. The opportunity for students to play can activate the motoric and cognitive sensors of students in identifying the images that appear so as to train students to be responsive to symbols as in real conditions packaged in games[7]. Real conditions that are expected to be recognized by students are included in game-based learning with clear instructions to improve the quality of learning science [2][8].

Game based learning must be integrated from a cognitive, motivational, affective, and sociocultural perspective. Cognitive meaning includes context in the situation, building feedback, representation of information, meaningful interactions, gesture and movement. Motivation consists of expectancy-value theory, self-determination, the ability to achieve the desired goal or result, connection, goal oriented, interest. Affective involves emotional design: emotional representation, emotional design: interaction of emotions, attitudes. Socio culture includes social context, participatory learning culture, social agency, observational learning, relatedness, and social interactions [4].

The main attribute needed in developing game-based learning is the gameplay data which is used as a reference for managing student data and student activities [1], [9], [10]. Learning science with games will be maximized if the teacher is the instructor, someone has to play the game first to become familiar with it. Teachers do not need to have the ability to get high scores, but it is important to fully understand how scores are calculated to answer student questions. The

teacher is expected to be able to direct students to know the target and get it. [11]

According the advantages and needs of serious game, it can be established with technology advance and trending that is important to get innovation learning such as IoT. IoT(Internet of things) is the interconnected of internet global system and computer networks that use the standard Internet protocol suite (TCP/IP) to serve billions of users worldwide [12]. To know how to build education game with IoT is discussed on section 3.

2. RESEARCH METHODS

This study method is content analyzes to analyze qualitative data which concern on the IoT game based learning. The research aim is to answer the following question: "What we need to build game based learning in nature science using IoT?"

First, a literature review in the current implementation of IoT on teaching and learning science will be conducted to find best practices of IoT on learning science especially on secondary education. Secondly, articles which discussed about item and system of IoT basic was reviewed to know how to build IoT game in classroom correctly. Additionally, Connecting IoT and game based learning study was discussed in this study.

3. RESULTS AND DISCUSSION

In this section will discuss IoT in three part. Part I explain the current implementation IoT on education. Second part define the system an item that will be useful when develop IoT on classroom. The last part want to interpret the framework on further research in IoT on game based learning.

3.1. *IoT on Education*

Innovation teaching and learning which made use of information technology was abundant on every level of education. One of the innovation was application internet of things (IoT). IoT could increase the school management [13], [14]. They used IoT to collect data of student activity on school bus, school environment, and classroom, so it ease teacher to know whom student attend class, collecting task and skip class. IoT was took on school library too. It was help librarian and language teacher to know book types that interested by student. [13], [15], [16], [17]

The utilization IoT on school laboratory has been practiced in variant laboratory. On science laboratory, IoT device used to collect data of temperature, water

debit, light intensity when studied photosynthetic, ecosystem even farming etc.[18], [19], [20], [21]. Body temperature, systole, diastole and heart rate when learned about transportation system in human body [17]. IoT device also conduct to learn science and engineering which start how to make electrical circuit or build a simple technology for individual or group [22], [23], [24]. These study appear that IoT gave real data experiment when they collected and analysed data to exercise science concept, theory, and law. It show that IoT help student found the concrete evidence from environment which is necessity in contextual learning science.

The impact of learning and teaching science using IoT is not only to ease student involvement on real environment but also to ease teacher collect, monitor, and instruct student task and activity which record on IoT storage device. Therefore it will afford data that can be analyzed by teacher to evaluate learning and teaching which a basis to increase learning system become. [13], [25], [26]

The most notice on applying IoT in education are security and curriculum. Student privacy is considerate to safe the student from technology information harm because the data could be spread on internet and public. The study of security on IoT Eco structure developing resolve that IoT system required malware and programing security test. The other side when the student safety was established, the curriculum turn out the limitation of IoT developing on teaching and learning. [14], [15], [26], [24], [27].

The IoT device should be familiar or connected to the science object. The IoT device and programing must record the student activities on classroom to know who was participant and what was worked by student. So, the developing of IoT on education demand to explicit the best system management and device which useful. It will be discussed on part II.

3.2. *System and Item of IoT*

In this section, there are many enigma to develop IoT such as what we need to build IoT, what we do to start the design of IoT. Design of technology will be rated and evaluated the function of technology. After that, whether the component of IoT on education especially education game is practical to be developed need to be discussed. An ecosystem definitely has layer or part. In general physical or platform layer, networking or middleware layer, and application layer. [28], [29]

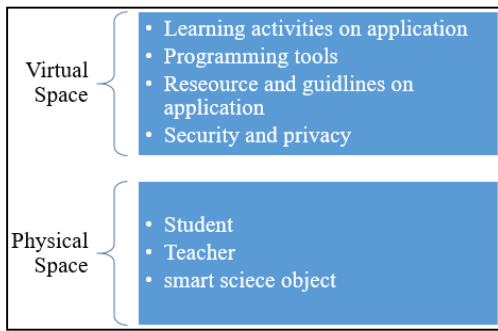


Figure 1 The model of IoT needs on game based learning

There is VAC (virtual academic community), a model that integrate environment and application design based on IoT system [13] is divided two space, virtual and physical space or layer. The first discussion on this segment is physical layer of IoT ecosystem. On physical part contains mostly not only one object because one of the aim of IoT is object connecting each other. There are sensors and smart objects. The sensor on IoT could be physical sensor, audio sensor, movement sensor which depend on data requirement [20], [30]. For example, we want to record what material which student use to solve a problem of course we needs a physical sensor. Here in after on physical device, RFID (Radio Frequency Identification) which is known as a chip [12], [31]. It serve transmission from sensor detection to server so it is the gateway to collect data [32], [33].

After data delivered, the networking layer consist of programming, data mining, cloud computing, and also social network [28], [34]. There are the key to connect platform to application. The connection of objects read and processed on this layer [30],[35]. Storage of data which has been analyzed or read could be saved on data storage and data mining by cloud computing or on server computer which programming take on the social network building [31], [36]. There are item of general programming IoT that was describe by Ng, Wu, Pi, Cheung [28] which discussion on the following sentences. The internet protocol (IP) as a network base to construct IoT. It was supported by Open Systems Interconnection (OSI) model, encompass Physical (PHY) layer to balance communication and data and Medium Access Control (MAC) layer to scheduling and synchronization program. To convert and translator IP need global IP which contains an Access Address Identifier – IPv6 (AAID-IPv6). The last programming item require to transfer all data to web application, it was Constrained Application Protocol (CoAP) which is designed for resource-constrained networks as a light-weight version of Hypertext Transfer Protocol (HTTP). The

semantic approach was appropriate to accurate with data fusion, and reliability with error detection, heterogeneous system handled directly via math and graphic mechanism[33]. In this layer security and privacy term must be regulated directly on programming [37], . It was complicated, but there are many research and simple application which contain this layer such as sifteo cube [20] if it will be matching with your product.

Here after, the session of virtual or application layer come into being interface service. The architecture of application can be two dimension, three dimension, even four dimension. It depend your requisite but the important is application of IoT must be structural, interesting, and user friendly to integrate and associate the data on the system. That is all general framework to establish IoT, however it was so involute, the data interpretation has analyzed, so it will ease teacher or researcher to evaluate and analyze their learning program. [29], [38]

According on system and education term, implication of IoT must be integrated with both. The programming planned is based on learning plan. Previously take action on programming, first the activity which student will do must be record whether by physical sensor or sound sensor even both of them to collect data of student learning progress. After that, to correlate and run of programming layer and platform layer require to build interesting application so that it can be IoT ecosystem on classroom platform. So than, how about IoT gamification moreover on education will be constructed programming layer. It will be described on the next section.

3.3. Game Based Learning Connecting IoT

Developing game based learning main goal is to connect cognitive and affective term of student when learning and playing. The acquisition of collaboration skill, teamwork, communication skill should be hooked to creativity, critical, problem solving, and others system thinking[39], [3], [4]. That is, the first step to engineer the game which will be played by student demand the skills that will be trained on. Next, the interesting atmosphere of game is also the primary things. That occur when making social environment condition like in the real condition, it enhance student learning [40].

That goal is materialized easy by IoT because game is the great area for human and technology interaction on IoT implementation [18]. IoT not only interactive but also automatic when monitor and collect data of student activity. First, the interaction

can be recorded when student interact with mobile application, their friend and science smart object, than it is saved automatically on data storage. Second, the data storage could be analysed by programming system [35]. When student take action on device, it is analysed directly by network communication. The last, the analysed data appear on teacher mobile application which is called a server on IoT ecosystem.

The classroom layout and game rules on learning plan act as interesting social environment creating to manage learning process when they play game. The position and design of IoT device must be appropriated by student requirement such as cognitive foundation, affective foundation, motivation foundation, and sociocultural foundation, illustrates that many existing theories can be used to inform the design of games for learning. However there are many new technology IoT supporting, using the simple object science and familiar on their life is easier student to execute the game and appreciate the game. Furthermore, game rules plus additional instruction such as procedure how to play the game could handle the student activity on social environment in their classroom. They could be student guidelines to do something on game. The time and how much activity during the game running must be controlled too because they have curriculum competency standard which considerate it. That is why the limitation of developing IoT is learning plan based on curriculum. [31], [41], [42], [43]

After comply the goals of game based learning, the security of student privacy must be noticed. It was the challenge of developing IoT because IoT and human are connected each other [43]. In addition, the data storage on IoT saved even monitored the human doing when took on IoT environment [21], [34], [41], [44]. However the data is general like name, score, and some action which is processed by teacher, student need privacy from others. As a matter of fact, hacker may take a violence to student and teacher at the time or after school. It was not necessity because there was many research about security term such as SCR or E-SDA. SCR (Security with Complexity Reduction (SCR),) to resist different wormhole, sinkhole, denial of service attacks, as well as physical attacks too [45]. E-SDA(Efficient Secure Data Aggregation), it was constructed review the scenario that is true or false programming may bother or contaminate data aggregation [46]. Using malware was appropriate to save the data storage and running analyses. Username and password are important to safeguard student privacy with their friend as well as to facilitate data synchronize. The security impendent will be prevented if the programing system got an analyzed. Furthermore, that is all can be systematic on figure 2.

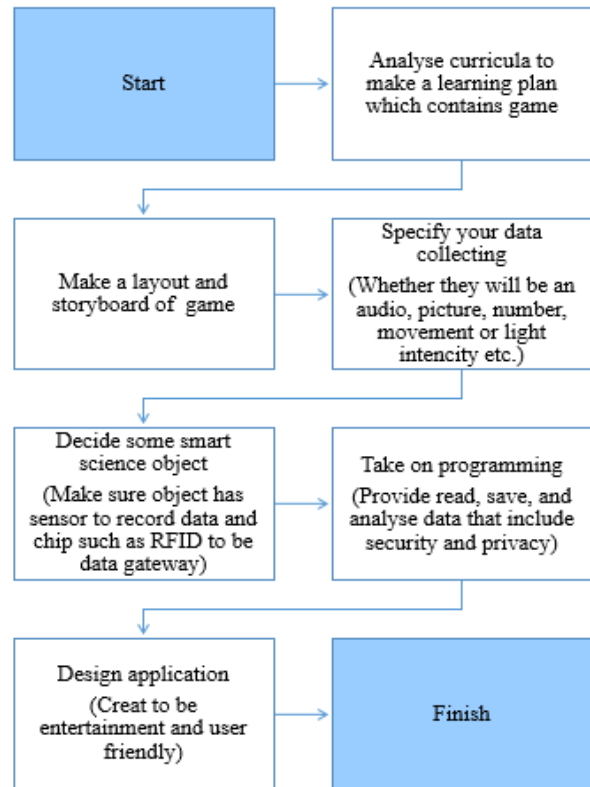


Figure 2 Systematic step to develop IoT on education game

4. CONCLUSION

The material and step on developing IoT will be systematic when the physical and virtual space was integrated by learning plan because it brought out what student needs, programming design, class layout, and also evaluation the learning. It match on teacher need to teach contextual science and engage social learning when student collaborate with others[47]. In addition, the most important things when it is established is whole design to boost student interest [48]. It means the design of learning plan especially game draft is the key performance of all IoT ecosystem will be build. Furthermore, the characteristic of IoT ecosystem is automatic system such as the automatic data analyse which help teacher assess their program and student progress to develop new technology or system on education.

AUTHORS' CONTRIBUTIONS

Main author conceived of the presented idea and analysed the materials of developing IoT from literatures. Then, Main author wrote the manuscript in consultation with second author.

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