

# IoT Based Framework to Increase Student Success in the Classroom of Tertiary Education in Sri Lanka: The Smart Classroom

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**Abstract** -- The smart classroom concept has appeared in the literature as an Internet based remote education system; or as intelligent environment equipped with an assembly of many different types of hardware and software components. In the process of everyday teaching, lecturers are usually trying to find out if the students were satisfied with the lecture, which part of a lecture was interesting, which presentation techniques and approaches were more attractive and effective than the others, which groups of students need more help regarding the lecture. The goal of this research is to track the attention level and performance of students and identify different groups of students according to their level of engagement to the lecture and thereby increase the interactivity of them during the lecture hours. Also offering help by lecturer to students who need more help by tracking down their learning patterns is considered. Furthermore personalizing lecture in order to reach out for these different groups of students is suggested in this research. This will empower lecturers to constantly deliver good presentations and make better impact, while the audience will benefit from interesting lectures thus making the learning process interactive, more efficient as well as more pleasant and even entertaining.

**Keywords:** *Smart Classroom, IoT, HCI, education, interactive learning,*

## I. INTRODOCUTION

Introduction of IoT has affected numerous aspects of society in beneficial ways. It has advanced the living quality of humans immensely.[18] IoT is a cutting edge technology which connects physical objects, machines, computing devices and people and allows them to transfer data amongst them without any human to computer or human to human interaction.

With the dawn and growth of the IoT, physical atmospheres are becoming smarter and more interconnected than ever before. This has transformed the human lifestyle by enlightening sustainability, effectiveness, accuracy and economy in almost

every feature of their life. IoT has been leveraged in many industries such as healthcare systems, traffic management, energy management, education, environment monitoring, smart homes and smart cities.

### A. EFFECT OF IoT ON EDUCATION

Many educational organizations are using IoT to rationalize procedures, influence data and uphold sustainability. [1] The practice of smart objects and wearable devices is well recognized in a number of universities. Empowering technologies like sensors, chips and other wearable devices that are all well understood by many, effortlessly mass-produced, and low-cost have become abundant in education and used broadly in classrooms.

Education has transformed from a knowledge-transfer model to a dynamic cooperative self-directed model by the disruptive influence of technology in educational institutions at present. This has enforced many institutions to reconsider teaching and learning. The inspiration of technology can be seen in many phases of education from student commitment in learning and content formation to help teachers deliver custom-made content. Many educational organizations are using IoT to rationalize procedures, influence data and uphold sustainability. The practice of smart objects and wearable devices is well recognized in a number of universities. Empowering technologies like sensors, chips and other wearable devices that are all well understood by many, effortlessly mass-produced, and low-cost have become abundant in education and used broadly in classrooms. Hence this paper presents a framework to increase student success in the classroom in Sri Lanka aiming tertiary education.

## II. LITERATURE REVIEW

The perspective of the existing work is concerned with digitalization of the ambient, conversion of written materials into electronic form, tele-education, human to computer interaction, web based distance learning etc. Among the researches that has been done in order to apply IoT concepts to

education to increase the quality of learning and teaching process, following are the ones that were highly related to this research. Subsequent sub sections A to E explore and analyze five selected researches conducted in IoT.

- a. The Effect of the Internet of Things (IoT) on Education Business Model
  - 1). Campus Energy Management and Eco-System Monitoring
  - 2). Secure campus and classroom access control
  - 3). Student's health monitoring
  - 4). Improving Teaching and Learning
- b. Smart Classroom: Real-Time Feedback on Lecture Quality
- c. Smart Classroom Roll Caller System with IoT Architecture
- d. Towards a Smart Campus with Mobile Social Networking
- e. The Research of Smart Campus Based on Internet of Things and Cloud Computing

*A. The Effect of the Internet of Things (IoT) on Education Business Model*

This research which is based on the recent IoT projects in education, researchers categorize the application of IoT in education into four groups: energy management and real time ecosystem monitoring, monitoring student's healthcare, classroom access control and improving teaching and learning. The researchers have investigated and analyzed how this platform has transformed the Education Business Model and added novel value proposals in based on the Canvas Business Model.

This study [1] is a qualitative research that emphasis on the education business model. The goal of this research is to give a solution to the following question: "How has the emergence of IoT affected the education business model in higher education?" According to this research and several other researches, the researches has identified following applications of IoT in higher education

*1) Campus Energy Management and Eco-System Monitoring*

Internet of things has been functional in energy management and Eco-system monitoring for years, in order to deliver energy effectively for a more ecological future. This has caused in the

introduction of Smart Grid. Many service companies can efficiently balance power generation and energy usage to deliver more efficient procedures by addition of intelligence to the current set-up. Energy consumption data will be collected automatically to improve economy, efficiency and reliability of the systems through sensors and actuator systems. This concept permits universities to produce a green campus environment by decreasing CO2 releases, observing and adjusting energy and water usage to provide a healthy atmosphere for teaching and learning. The design of a green campus has been suggested to manage computers and air conditioning systems in order to save energy. A practical example presented in this paper is, COMFORTSENSE which is another energy management project employed in Campus Luigi Einaudi, University of Turin. This project takes benefit of IoT technologies to improve building energy efficacy and security.

*2) Secure campus and classroom access control*

Constructing a safe and secure place in universities and managing students' access to classrooms, laboratories and other places in the university is a challenge addressed in this context. This is done by fetching new technologies into education such as RFID (Radio-frequency Identification) and NFC (Near Field Communication). The authors in [3] has developed a classroom access control method over NFC to make a real time classroom control instrument. This classroom registration system is based on a network of connected sensors that can gather classroom access information and show the status of the classroom on both a web based application and university TV panels. The author in [4] has suggested a technique for observing student attendance by using RFID tags in student ID cards. This system registers student IDs when they arrive the classroom and tracks their present location in the campus by the usage of geofencing technology. The Sookmyung Women's University (SWU) has implemented access control systems in the campus based on IoT and converted the university to a smart model by installing sensors and NFC tags. Students can check the availability of free desks in the library and reserve suitable seats [5]. The Bournville College has applied Cisco Physical Access Control Technology to control access to different parts of campus. This has helped to handle access to 400 doors in the main campus. This also observes foot-traffic patterns and sends notifications to the building management system. According to a survey carried by the Bournville College, 95% of the students has agreed that the system makes a safer learning environment for them.

### 3) *Student's health monitoring*

The IoT applications are seen in an extensive range of healthcare applications, from observing patients to avoiding disease. It upgraded access to a higher quality health care and also condensed the cost of care. The student health state is an important factor in determining the student's overall academic performance and therefore admission to an eminent health care service is important in any educational organization. A commonly seen application of IoT in healthcare is the use of wearable technology. Wearable devices can monitor physiological signals over long periods of time in a non-invasive and non-obtrusive way. The most common examples of these wearable devices are smart watches and fitness bands. A study has shown how RFID technology is used to implement an eHealth resolution which is called Electronic Medical Records or EMR in order to observe students at risk of high blood pressure through by using wearable devices [6]. The Oral Roberts University is trying to use the wearable technologies to monitor satisfactory health and physical education progress for online students. The wearable device will alert students to get up and move after long periods of sitting as many online learners undergo back pain and neck pain and other similar problems. The university will also analyze the collected data to understand if the smart watch has inspired online students to do more exercise.

### 4) *Improving Teaching and Learning*

IoT can support organizations to advance the quality of teaching and learning by providing a more affluent learning experience and real-time actionable insight into students' performance. It can generate a smart learning environment where students are able to customize the environmental variables such as room temperature to their best choice. Bob Nilsson [7] claimed that IoT devices like e-books, tablets, sensors, fitness bands, virtual reality headsets are being used in education at present in order to track and observe students in various traits like understanding students' learning patterns. In another research [2] a smart classroom has been suggested which can measure and analyze the effect of various parameters in the physical environment like temperature, noise and CO2 level on students' attention. A smart classroom system will decide in real-time whether the environment is enhanced to make the most of student's ability to focus on a lecture at any given time. Also using wearable technology in the educational setting can improve the lecturing procedure with minimum disturbance in the classroom [8]. In another research [9] it was mentioned the potentials of using wearable technology to obtain and process data to improve knowledge

in higher education. For instance, Google Glasses and Sony smartwatch are used in the Universitat Politecnica de Valencia classrooms to allow the lecturer to gather important information about student knowledge building process. Students can receive data from neighboring sensors outside the campus, in historical and urban locations or in the public gardens.

In this research which was carried out by BAGHERI and the team, a contrast between the new and the traditional education business models is done. It demonstrates that IoT can offer numerous benefits for educational organizations. These benefits can be summarized as follow: reducing cost, personalized learning, time saving, enhanced safety, improved comfort and collaboration. This has also caused in new customer relationships and channels by forming a virtual and personalized relationship.

#### *B. Smart Classroom: Real-Time Feedback on Lecture Quality*

The objective of this paper [15] is to find out how intelligent ambient can be used to give real time, automatic feedback on the quality of the lecture based on a number of parameters. The researchers have addressed the prospective of using IoT to build a smart classroom, i.e. a classroom that can give real-time, automatic feedback on the quality of a lecture, i.e. about the present level of interest of the auditorium and the level of satisfaction of the auditorium with the lecture and the lecturer. Such real-time feedback will facilitate the lecturer to adjust the lecture during the presentation to attain the maximum impression and also to alter the following lectures based on the "lessons learned" from the previous circumstances. Researchers mentions that this is the first effort to state the problem of live feedback on lecture quality and analyze the requirements. In another research automated capture of audio, video, slides, and handwritten annotation during a live lecture has been proposed [10]. Podiums developed at MIT can measure several features of interaction, including nonlinguistic social signals by analyzing the person's tone of voice, facial movement, or gesture utilizing wearable device [11]. A related research was done [12] where wearable sensors were used to create a social index of interest. These devices must be worn in order to provide parameters for measurement. This is not the most conspicuous solution as the entities are not behaving naturally when they know that they are being observed. However, earlier work can be a good opening point for future research. The researchers address the problem of real time feedback on lecture quality, by observing the parameters available in audience and their digital representation in time scale in this research paper.

### C. Smart Classroom Roll Caller System with IoT Architecture

This paper [14] states that smart classrooms are normally differ from other ubiquitous information technologies such as RFID. Also it shows the absence of one effective procedure to collect the 100% student real attendance in time at the end of every period of class by the academic office. In this paper, they propose an efficient mechanism by IoT architecture for this purpose which is the Smart Classroom Roll Caller System (SCRCS) that installed at every classrooms of university and read the student's ID card progressively to present the total number of the actual attendance on the LED display of SCRCS at the start of every class and let the all ID cards be visible on the multiple slots of SCRCS. Lastly, the academic office will gather every student's attendance at every class on time and help students have decent study performance. Fundamental aim of this paper is an attempt to solve the problem of completing the every undergraduate student's 100% attendance every day. In fact, these smart students usually ask their classmates to bring their student's card to roll call for every lesson. Therefore, the traditional RFID roll call system cannot void this event. Also there is no automatic tool to confirm the real time attendance or to double check every hour attendance of two/three hours lesson. This paper is proposed an investigation of making roll call for every student's attendance easily by SCRCS.

No doubt this solution would decrease the general absent rate. This is one successful tool to help students study well enough to compete after graduation. There is a causal effect of absence on performance for students: missing class leads to poorer performance according a study [13].

### D. Towards a Smart Campus with Mobile Social Networking

The growth of wireless communication, the fame of smart phones and the increasing of social networking services had made mobile social networking a hot research topic. The features of mobile devices and necessities of services in social environments increase a challenge on building a platform for mobile social services. In this paper, the researches intricate a flexible system structure based on the service-oriented requirement to help social interactions in campus-wide environments. They have designed a mobile middleware to collect social perspectives such as the proximity, the cell phone log etc in the client side. The server backend, groups such contexts, examines social connections among users and offers social services to facilitate social interactions. A prototype of

mobile social networking system is deployed on campus. Also several applications are employed based on the proposed architecture to exhibit the effectiveness of the architecture.

Campus is basically a social environment where lots of social connections happen. To bring more suitability to campus life and enhance social relations, they propose to build a smart campus based on mobile social networking. [16]

### E. The Research of Smart Campus Based on Internet of Things and Cloud Computing

Smart campus is proposed to be built by embracing internet of things, cloud computing & virtualization technology based on existing network and by analyzing present state of digital construction and network development in Wuhan University of Technology. This is done by combining with the building situation of domestic institutions.

The most important part of building smart campus is the infrastructure construction. This article primarily discusses the construction of Internet of Things based on ubiquitous network and the construction of cloud data center. A more humane and high-efficiency learning and living environment can be built by forming Internet of Things based on ubiquitous network since it can convert traditional passive service to active service. In the meantime, building cloud data center by utilizing virtualization can bestow it with storage capacity and computation capacity which are more extensible and more efficient. Also features, such as robustness, reliability and security, can also be improved greatly. Nevertheless in this research there are still other technical details which need to be studied further. For example, how to enhance performance and how to assign scheduling resources reasonably after storage and server devices of different brands and different types are pooled? What are matching problems between important applications and general applications? And which are key computing methods of service discovery and service providing within IoT system etc. Those are key aspects for future work. [17]

### III. CONCEPTUAL FRAMEWORK DERIVED FROM THE LITERATURE REVIEW

The primary purpose of this framework (figure 1) is to monitor the attention level of the audience during a lecture and improve interactivity of the students with students and with the lecturer using smart devices. The monitoring part will be done using IoT devices.

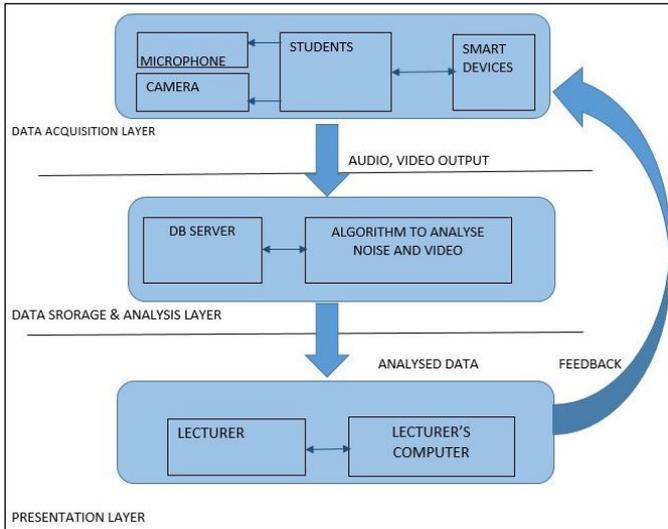


Figure 1. The conceptual framework

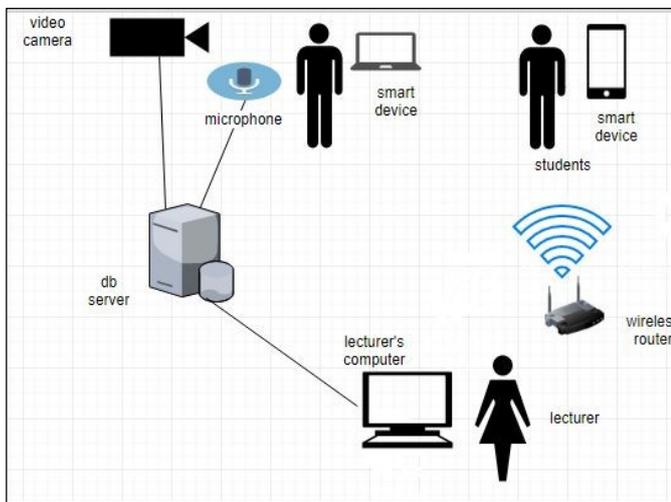


Figure 2. The system architecture

Mainly two parameters are considered to measure the attention level; Movements of students and the noise level in the classroom. The proposed high level architecture diagram is presented in the figure (2). According to the proposed system, to capture the movements, a video camera is used. Extreme movements are eliminated using a threshold to eliminate cases like, the lecturer walking in the classroom. Noise level in the classroom is monitored using several microphones. The data collected using IoT devices will be analyzed and the result will be presented to the lecturer on his computer in real-time. If the lecturer notices a less attention level among students he can change the mode of lecture or change current activity by sending a different activity to the smart devices of students to grab their attention and check their knowledge so far. Also students can participate in group activities using their smart devices to make the learning process more interactive.

#### IV. CONCLUSION AND FUTURE WORK

The smart classroom concept has appeared in the literature as an Internet based remote education system; or as intelligent environment equipped with an assembly of many different types of hardware and software components. In the process of everyday teaching, lecturers are usually trying to find out if the students were satisfied with the lecture, which part of a lecture was interesting, which presentation techniques and approaches were more attractive and effective than the others, which groups of students need more help regarding the lecture. The goal of this research is to track the performance and progress of students and identifying different groups of students according to their level of engagement to the lecture and thereby increase the amount of knowledge they absorb with the lecture hours. Also as a sub objective offering help by lecturer to students who need more help by tracking down their learning patterns is considered. Also personalizing lecture in order to reach out for these different groups of students is suggested in this research.

Merging the IoT technology with social and behavioral analysis, an ordinary classroom can be transformed into a smart classroom that actively listens and analyzes voices, movements, behavior, etc., in order to reach a conclusion about the lecturers’ presentation and listeners’ satisfaction. This will empower lecturers to constantly deliver good presentations and make better impact, while the audience will benefit from interesting lectures thus making the learning process shorter, more efficient as well as more pleasant and even entertaining. The implementation and testing of this system will be done as future work of this research.

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