A Hybrid Connected Approach of Technologies to Enhance Academic Performance

Sushil Kumar Mahapatra, Binod Kumar Pattanayak, and Bibudhendu Pati

Abstract The technological advancement in every filed has a great impact on education system to modernize the teaching and learning approach. The traditional teaching and learning system fails to cope up with the advancement of technology. As the technology is changing in a rapid fashion, the need of a dynamic educational system is highly necessary that can satisfy the need of real-time learning scenario. Our proposed learning model is a hybrid approach of the recently popular learning methodology, i.e., case-based learning, flip learning, and gamification of courseware. This hybrid model can satisfy the student's expectations by driving them to face the real-world problem with the help of cutting-edge technology such as IoT, blockchain, and machine learning. The proposed learning methodology is presented within a learning management system (LMS) by exploiting the features of Internet of things (IoT). IoT in integration with LMS enhances the real-time scenario for the learning of students. As a result, students can face the different case studies using their critical and innovative thinking. This paper also reveals the factors that influence the student's learning capability by utilizing IoT. This paper presents a real-time framework for enhancing the learning and teaching methodology with the different features of the model and its benefits of utilization.

Keywords Educational system · LMS · IoT · Blockchain · Flip learning · CBL · Gamification · Academic performance · Air quality index · Air pollutant

S. K. Mahapatra (✉) · B. K. Pattanayak
Department of Computer Science and Engineering, Siksha O Anusandhan Deemed to be University, Bhubaneswar, Odisha, India

B. K. Pattanayak
e-mail: binodpattanayak@soa.ac.in

B. Pati
Department of Computer Science, Ramadevi Women's University, Bhubaneswar, Odisha, India

1   Introduction

Since the evolution of Internet in late 90s, some researchers have speculated the potential of Internet. They suggested that the Internet was not only meant for the data sharing, but it can also be utilized for the services. Later in 1999, Kevin Aston, a businessman and researcher in the field of supply chain optimization, first initiated the term "Internet of Things" which can provide data sharing and services by connecting things of the Internet [1]. Therefore, depending upon the potential of utilization of IoT, it is defined by various names by different researchers and global IoT leading companies as Internet of Everythings (IoE), Internet of Services (IoS), Internet of Data (IoD), Internet of Anything (IoA), Internet of People (IoP), Internet of Signs (IoSs), and Industrial Internet of Things (IIoT) etc.

According to CISCO, a global networking company, IoE has the capability to bring all together, i.e., people, services, data, and connected things to give a new means to the Internet [2]. This new means to the Internet is not only capable of creating new business opportunities but also capable of turning the information into an intelligent actionable services.

Nowadays, the demand of automation in every field is increasing exponentially. So the IoT along with some cutting-edge cloud services like Microsoft Azure, IBM Node Red, and Amazon Web Services comes into picture, and the demand of these technologies is increasing rapidly [3]. One of the researchers from the USA named as Gartner who is leading a research and advisory company predicts that at around 27 billion devices with around 2 zettabytes of data storage will be connected to the Internet cloud by the end of the 2025 [4]. Therefore, the key challenges for implementing and maintaining such a huge number of IoT devices are its privacy and security. Along with these challenges, some other challenges are scalability, trust management, reliability, mobility, and interoperability [5].

On the other hand, pandemic-like events have recently compelled educational policymakers to shift the educational system from face-to-face (f2f) to the virtual mode of instruction. However, virtual courses face several problems such as a lack of network infrastructure, network connectivity, data security and integrity, attendance and class records management, and taking feedback, to name a few. Aside from all of these elements, environmental, social, and economic indicators are also important. The Internet of things (IoT) combined with blockchain (BC) in a learning management system (LMS) would be a superior answer to all of the difficulties listed above. Many academics have recently suggested that because IoT devices are small, portable, and inexpensive, they may be used to collect data on the environment, social, and economic backgrounds of students in various geographical locations. The blockchain, on the other hand, maybe used in LMS to ensure data security and integrity. LMS may also be utilized to help with IoT and BC. When combined with IoT and BC, several instructional learning techniques such as flip learning, blended learning, and gamification of course components can improve academic achievement in LMS. The proposed work is to deliver an effective LMS with cutting-edge technology to enhance academic performance.

Many studies have been carried out to determine the relationship between environmental conditions and academic achievement [6]. Environmental factors such as air pollution concentrations, temperature, humidity, and so on. An air pollutant in a specific region is the primary cause of respiratory-related health issues. The influence of these contaminants, on the other hand, is producing cognitive problems in children, which is reducing their attention levels [7]. The goal of this study is to see how air pollution affects a student's educational results by utilizing the Internet of Everything (IoE) to measure their attentiveness in class. Because the influence of ambient air quality differs from place to place, the research was carried out in several parts of Odisha, India. This study found that high concentrations of PM_{10}, $PM_{2.5}$, NO_2, and SO_2 can negatively influence a student's cognitive response, but O_3 had no effect on cognitive response and, hence, academic achievement.

Keeping track of student attendance at VC is a challenging endeavor. Because the students are not there in person, there are several technical options for manipulating attendance. IoT is utilized in this suggested project to collect real-time data from students and to track their actions during the VC. While, BC is used to prevent data tampering as well as to ensure the integrity and dependability of the data stored [8].

The traditional teaching and learning system is unable to keep up with technological advancements. Due to the rapid evolution of technology, a hybrid LMS is presented that incorporates lately popular learning methodologies such as case-based learning, flip learning, and gamification [9, 10]. This hybrid system can meet students' expectations by forcing them to confront a dynamic challenge using cutting-edge technology. The suggested hybrid LMS system makes use of IoT characteristics to boost student motivation and learning capacity.

2 Related Works

This section describes about the recent advancement of the educational methodology using IoT. As the technological advancement is in flow, the IoT recently gets more attention due to its diversity in every field. Nowadays, IoT also plays a significant role in the field of education by developing the infrastructure as well as by improving the teaching and learning methodology. It is transforming the traditional learning system to an interactive and intelligent learning system. IoT helps every entity of the educational system starting from the administrator to the student as end user. It has a significant impact on all the stakeholders of the educational system. Some researcher has presented a model to correct the pronunciation and shape of the mouth while learning English language using IoT gadgets [11]. The authors in [12] use the IoT to deliver the concepts of programming language. Some researcher has developed a learning management system (LMS) to analyze the student's learning method using analytics [13]. They presented a real-time case analysis model to use cloud computing and IoT in the structure of educational resource. The authors in [14] deliver a comparison of utilizing the IoT, cloud computing, data mining, and triple-play for the distance mode of education. Vo et al. presented a qualitative study to

evaluate the instructors designed blended course by conducting a semi-structured interview. Here, they have presented a content construction communication platform as an evaluation tool [15]. In another approach, Ozqur et al. show a relationship between different ways of thinking and computational thinking skill along with the demographic variables. This is to predict the student's skill in accordance with the some variables by the help of structure equation model [16]. Magiera et al. explore the students and teachers' ability to explain the solution of different problems and also express the critiques to others solutions [17]. A study was conducted by Seage et al. to evaluate the impact of traditional science teaching and the innovative blended learning approach over the elementary school students of lower socioeconomic class [18].

Recently, so many researchers have been addressed to improve the attendance system using different embedded technologies such as RFID, GPS, and Bluetooth. All these technologies have been tested in monitoring the student's attendance in traditional classes for its efficiency and reliability [19]. Initially, some researcher presented a RFID-based attendance system [20]. But the main disadvantage of RFID is that it can be used by any person, and this system is not tamper-proof. A location-based attendance system is proposed in [21] using GSM module to validate whether an employee is present at the designated place or not. Many works have been carried out by using face recognition system, but it requires a very precise algorithm to record and detect the faces [22]. However, the authors in [23] introduce an iris recognition system to record the attendance. Abubakar et al. have presented a system which uses a finger print module based on IoT [24].

On the other hand, an effective attendance monitoring system and a good learning management system are not enough to improve the student's academic capability. Some authors have identified some external factors such as environmental factors that are influencing the student's academic performance. Ham has investigated in the area of California and found the inter-relation between the different air pollutants with the test score [25]. He also revealed a close inter-dependence of AQI with the academic performance. Carroll shows that the continuous exposure to the different air pollutants beyond the permissible limit of the WHO could create severe health issues and, hence, increases absenteeism in the class [26]. Hence, this would decrease the academic performance.

3   Proposed Methods and Materials

3.1   A Hybrid LMS System

Kindly, nowadays, the flip learning in conjunction with CBL draws the attention of many researchers. It has gained its popularity when it is used with the IoT. The proposed LMS is presented in Fig. 1. In flip learning system [9], the course materials are provided to the students in the form of video lectures, online lecture notes along
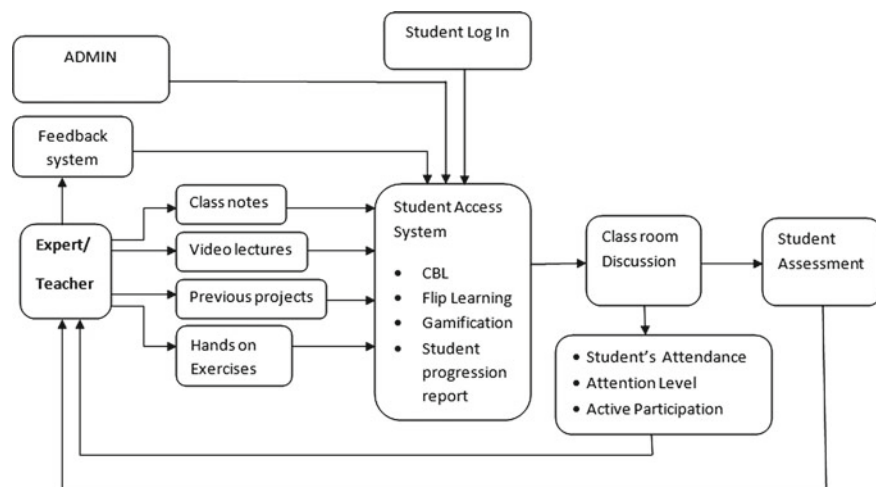
Fig. 1 Proposed hybrid learning management system using flip learning, gamification, and CBL

with some questionnaires. The students first came across these online course materials in the first stage. After completion of introductory part, the domain expert will assign some task to the students. Then, each individual student or a group of student will try to solve it depending upon their prior knowledge. In the third stage, classroom discussion will be carried out in either online mode or offline mode with the domain expert. The domain expert clarifies all the questionnaires raised by the student. In the fourth stage, the students give their assessment report to the expert. The expert evaluates the report and gives his feedback to the student. Meanwhile, the students are also asked to submit their feedback about the online course materials and classroom experience. All these workflows are governed by the administrator through an online portal. The assessing policy for the expert and students is designed by the administrator. The administrator is held responsible for the data security and privacy of the students as well as domain expert. Different application delivery approaches are employed here such as public, private, and hybrid. For example, the course material application assess is kept under public assess policy. The content of course material preparation, updating, evaluation process, and feedback to the student application is coming under hybrid policy for the expert and the administrator. The overall maintenance and monitoring application policy is kept for the administrator assesses policy. In this approach, the student will have exposure to the real-world problems. Here, their problem-solving capability will improve which leads them to solve their domain complex problem by creative thinking [27].

In this modern era, students are getting attracted more to the laptops, palmtops, and mobile phones. They spend more time in these gadgets round the clock rather than the text book. So this shifts the learning trend from the text book to the mobile phone. Here, by introducing the gamification learning mode in the learning methodology, the educational institutions can attract the students and create more interest among

students by transforming the course module to a gamified course module [28]. This method will enhance each students thinking process and progress their skill for a given task. As the traditional teaching method fails to bind the students in this rapid change of technological era, gamification learning approach not only creates the interest but also improves critical thinking. The gamification facilitates the knowledge transfer, micro-learning, assessments, and competition among the students [29]. It also engages the students at their maximum level of concentration through the rewards points at different level of gamification process.

3.2   Effect of Environment on Academic Performance

Nowadays, air pollutants are increasing in different areas whether it is a metro city or a rural area. These air pollutants not only create respiratory diseases but also are responsible for the cardiac problems. The constant exposure to these pollutants like PM_{10}, $PM_{2.5}$, CO_2, SO_2, and NO_2 etc., can degrade the cognitive response of a child, and it also degrade its academic performance [30]. Thus, this study is to find out the inter-relationship between the air pollutant and academic performance of a student. This work also reveals the variation of test score with the different level of air pollutant in different region as well as in different season. The proposed air pollutant measurement system consists of different low-cost sensor network to measure different air pollutant like PM_{10}, NO_2, SO_2, etc., and the air pollution measurement system is shown in Fig. 2. These sensors network is connected to IoT devices to send the collected data to the IoT cloud. The sensors network is kept across a specified area generally a state or a country. The collected data is further analyzed by different machine learning algorithms like SVM, KNN, NN etc., for categorizing the student's attentiveness during a specified AQI level. Furthermore, at that specified AQI level, the test scores of the students are collected and analyzed to see the influence of different air pollutant over student's test score.
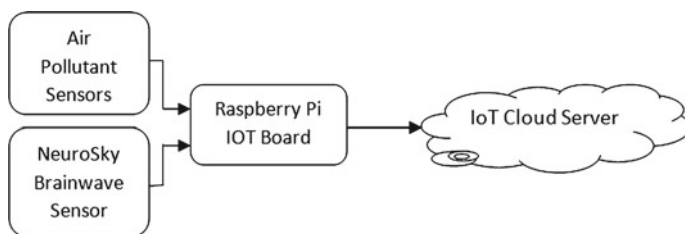

Fig. 2   Air pollutant measurement system using IoT

3.3 Block Chain Supported IoT-Based Attendance Monitoring System

Throughout the journey of modern educational system, the attendance plays an important role in achieving the academic goals. In recent years, as virtual classes are becoming an effective tool to deliver the class content, it is very interesting issue to monitor the student's attendance in virtual mode of class. Some researchers are carried on to monitor the attendance without human interference by utilizing RFID tag, face recognition, biometric sensors, etc. [31]. But all of the above-discussed attendance monitoring systems are based on face-to-face mode of class. Furthermore, they are silent about the data privacy and integrity of the collected data from these devices. After collecting these data from a device, these data can be manipulated at the server end, and hence, the academic outcomes may differ as expected. To resolve this issue, a hybrid approach is presented by utilizing blockchain along with IoT for student's data security and integrity.

In this proposed approach, face recognition and finger print algorithm are utilized to monitor the attendance. While along with these algorithms, a Python code is utilized to monitor the network status. When there is any issue with the network, it will be log in a file and send it to the server. The continuous attendance monitoring system is presented in Fig. 3. In the server end, all the attendance of a particular course for a specified time is logged, and a block is created within the blockchain. This private blockchain is integrated within a LMS system. All the attendance along with the activity of a particular student can be monitored by the faculty or by any academic council member.
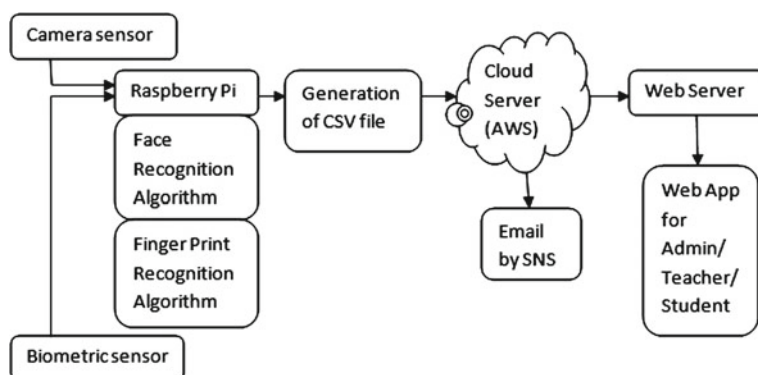
Fig. 3 IoT-based continuous attendance monitoring system

4 Conclusion

This work is emphasized on the different approaches to improve the academic outcomes. This work also reveals the different factors that are influencing the academic performance. To improve the academic performance, a hybrid teaching learning method is presented. Furthermore, to effectively monitor the attendance as well as performance of a student, a secure LMS system is presented utilizing blockchain with IoT. This work further investigates that how the pollution level at different areas also affects the academic performance and the diversified utilization of IoT in the field of education to improve its performance.

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