KMAN PUBLISHING INSTITUTE
Journal Website

Article history:
Received 27 January 2024
Revised 11 March 2024
Accepted 02 April 2024
Published online 10 May 2024

Journal of Adolescent and Youth Psychological Studies

Volume 5, Issue 5, pp 136-145

E-ISSN: 2981-2526

Investigation of the Role of Learning Management Systems in Education Based on the Internet of Things

Reyhaneh. Fatehi[1], Moslem. Cherabin[2*], Mohammad. Karimi[2], Ahmad. Zendehdel[2]

[1] Ph.D Student, Management Department, Neyshabur Branch, Islamic Azad University, Neyshabur, Iran
[2] Assistant Professor, Management Department, Neyshabur Branch, Islamic Azad University, Neyshabur, Iran

*** Corresponding author email address**: Moslemch2015@gmail.com

A r t i c l e   I n f o

Article type:
Review Article

How to cite this article:
Fatehi, R., Cherabin, M., Karimi, M., & Zendehdel, A. (2024). Investigation of the Role of Learning Management Systems in Education Based on the Internet of Things. *Journal of Adolescent and Youth Psychological Studies, 5*(5), 136-145.
http://doi.org/10.61838/kman.jayps.5.5.16

A B S T R A C T

This review study investigates the role of Learning Management Systems (LMS) in education within the context of the Internet of Things (IoT). Higher education institutions, particularly universities, must adapt their contents, activities, and methods to function more efficiently in a digital context. LMS is a tool for creating, distributing, tracking, and managing educational and training materials. IoT, a transformative technology, significantly impacts various aspects of human life, including security, healthcare, recycling, and environmental monitoring. This paper addresses the significance of IoT technology in education, particularly in enhancing the efficiency of teaching and learning. The framework for an IoT-enhanced LMS is part of a three-year research project at the Arts, Sciences, and Technology.

Keywords: *Learning Management System, Education, Internet of Things.*

1. Introduction

The past century has seen rapid advancements in information and communication technologies, profoundly impacting various fields, with learning environments being among the most affected. Technology has become a basic necessity, driving educational and learning centers toward their future goals and visions. Modern teaching and learning environments must move beyond traditional methods, as knowledge and awareness expansion is now closely linked with the effective application of information and communication technologies (He et al., 2016; Moreira et al., 2018). The internet revolution has enabled connectivity anywhere and anytime, not just through personal computers but also via mobile phones and laptops. The next logical stage of this revolution involves connecting objects to communication networks, allowing new forms of communication between people and objects, and even among objects themselves (Tu et al., 2017).

This evolution is known as the Internet of Things (IoT). While many potential applications of IoT are still being explored, the technology is expected to revolutionize smart homes, factories, farms, offices, transportation systems, hospitals, and learning environments. Research indicates that IoT can significantly improve the quality of teaching, learning, and management, thus enhancing educational standards (Gunawan et al., 2017; Hawari et al., 2019).

In recent years, countries like the UK, the USA, and various European nations have integrated digital and network technologies into their classrooms. Advanced countries aim to provide internet access to every student, educational center, and family, promoting digital education initiatives. Experts believe IoT will be as crucial to 21st-century education as books were in the 19th century. The rapidly changing technological landscape raises a fundamental question for education: "How can today's learning environments be transformed to meet the needs of the current information society, encouraging learners to use these technologies to enhance productivity, creativity, and learning while addressing globalization challenges?" (Moradi & Fard, 2019; Moreira et al., 2018; Taajamaa et al., 2017).

Emerging technologies play a central role in our lives, influencing personal and societal aspects. These technological advancements facilitate and regulate daily life across various fields, including economic, industrial, agricultural, medical, and social sectors. In education, the correct and appropriate use of new technologies can significantly enhance teaching and learning processes, creating powerful learning experiences and strengthening educational affairs (Hawari et al., 2019; He et al., 2016).

A Learning Management System (LMS) manages comprehensive learning processes by generating electronic content, simplifying education and training implementation. LMS software, widely used in universities and scientific centers, allows learners to access resources, upload assignments, take tests, and share information using personal devices, thus creating a dynamic learning environment. LMS automates learning by registering users, tracking courses, recording data, and managing reports. It comprises a server component for core functionality and a user interface that operates as a web service. Implementing an LMS offers benefits such as centralized learning, reduced time and costs, and enhanced tracking and reporting capabilities (Moreira et al., 2018; Ralhan, 2017; Taajamaa et al., 2017).

The IoT environment enhances language learning through images, objects, and videos in the classroom, adding cultural dimensions to students' education. Learners can access resources using their devices, facilitating peer communication, assignment submission, and test-taking, creating a dynamic learning environment. This paper focuses on integrating IoT services within LMS, proposing a future LMS framework enhanced by IoT. We define several existing LMS services and explain how IoT integration will transform these services and introduce new ones. For each proposed LMS service, we outline its implementation, integration with other LMS services, and its use on university campuses to enhance teaching and learning.

2. IoT and LMS

The concept of IoT in learning environments is often associated with electronic learning, though they are distinct concepts. While IoT can impact learning quality, similar effects may be found in other technological systems like distance learning and virtual education.

IoT's most significant impact on education is expected in universities. At the 1998 UNESCO World Conference in Paris, it was stated that higher education institutions should be the first to benefit from new technologies, creating new educational environments. Students increasingly use laptops and tablets instead of paper and notebooks, accessing more information and learning quickly, both at home and university (Maksimović, 2017c). This shift makes teaching more efficient, as professors can distribute digital materials instead of paper-based ones. IoT facilitates personalized education, allowing teachers to collect data about each student and adjust lesson plans accordingly. Universities can also use IoT to monitor students, staff, and resources, reducing operational costs (Taajamaa et al., 2017; Tu et al., 2017).

IoT enhances learning by integrating into daily activities, with smart devices transforming LMS usage. IoT in education addresses problems and breaks barriers, allowing teachers and students to use tablets, smartphones, VR helmets, and webcams for remote teaching. IoT also enhances campus security through facial recognition systems (Burd et al., 2017; Gul et al., 2017).

2.1. Advantages of Using LMS

Reducing training costs, transportation, and workshop facilities.

Reducing users' time waste.

JAYPS Adolescent and Youth Psychological Studies
E-ISSN: 2981-2526

Training many users quickly.

Reducing administrative issues and costs related to registration and course selection.

Providing timely training through online courses and programs.

Increasing users' ability and skill in learning information.

Offering educational measurement and evaluation systems.

Enhancing graphic presentations with art, charts, and photos.

Facilitating active participation through chat rooms and other shared tools.

Providing supplementary educational materials without needing to visit a library (Maksimović, 2017b; Moreira et al., 2018; Veeramanickam & Mohanapriya, 2016).

However, conventional LMS has limitations, such as poor user interaction, teacher-centered education, course orientation rather than user orientation, lack of independent learning skill development, predetermined activity constraints, lack of user independence, and failure to organize courses and activities (Moreira et al., 2018).

To address these issues, this article proposes an IoT-based LMS. IoT can enhance educational systems, and the work in this field will be reviewed. Traditional classrooms do not record activities and lessons, as they typically use tools like blackboards and projectors. Enhanced devices and IoT can transform traditional classrooms into smart classrooms, recording teaching activities and providing remote functions. These include pre-lecture setup of lighting, projectors, and room temperature, saving energy and time. Each IoT-controlled device must be capable of receiving commands to perform these functions (He et al., 2016; Maksimović, 2017a).

Figure 1

Smart classroom

3. Implementation of the Experimentation Section

The proposed LMS integrates three primary elements for the experimentation section: the Robotic Arm package, the Arduino Lab Controller package, and the Remote Service package (Burd et al., 2017; Taajamaa et al., 2017).

Robotic Arm Package: This package, running on the Arduino microcontroller, defines the physical components of the robotic arm, such as the number of motors, arms, weight, and sensor placements. It executes commands sent by the Lab Controller package to the robotic arm (Gul et al., 2017; He et al., 2016).

Arduino Lab Controller Package: Also running on the Arduino microcontroller, this package manages the connections between the Arduino inputs/outputs and the robotic arm commands. It defines the specific tasks performed by the arm based on the commands from the Arduino (Gul et al., 2017; He et al., 2016; Maksimović, 2017a).

Remote Service Package: This package facilitates remote experimentation, allowing users to interact with and control the robotic arm through the IoT-enhanced LMS (Moreira et al., 2018; Taajamaa et al., 2017).

4. IoT-Enhanced LMS as a Data Hub

The IoT-enhanced LMS can serve as a data hub for lessons or projects. Students can gather data from various sources, such as the Internet, books, CDs, nature, and sensor readings, and store it in the LMS for filtering and processing. When students need real-life data from original sources, they can use the IoT module to record, filter, and generate data patterns before saving it into the LMS. The IoT module can collect diverse data types, including digital camera images, sensor readings (temperature, pressure, humidity, distances), and sound waves captured by ultrasound sensors (Moreira et al., 2018).

Students connect required sensors provided by the university to the IoT module, following university regulations. The data recorded and processed by students aids their learning and holds value for research and industrial communities. The IoT-enhanced LMS facilitates collaborative learning by allowing students to share their data and experiences with the class (Moreira et al., 2018).

5. Remote Lectures

The IoT-enhanced LMS will leverage a future IoT network on campus to efficiently transmit lecture materials and live video streams to students. Communication towers capable of transmitting data and multimedia to distant locations will record and transmit lecture content, interactive exercises, and other materials to students' LMS accounts. The university may establish lecture spots equipped with radio transceivers connected to communication towers via high-speed wireless connections. Students can connect from their mobile devices to these spots using Wi-Fi, 5G, or future communication protocols to watch lectures, save content, and interact with instructors and classmates (Maksimović, 2017c; Moradi & Fard, 2019).

Future classrooms will feature IoT devices connected to webcams, microphones, speakers, smart boards, printers, scanners, and other lecture capture facilities. Registered students can access lecture resources, watch real-time recordings, and interact with data created or shared during lectures through their LMS accounts (Maksimović, 2017a).

6. Campus IoT Network(Moradi & Fard, 2019; Moreira et al., 2018)

Many wireless carriers are developing new cellular networks to support IoT communications, targeting Human-to-Machine (H2M) and Machine-to-Machine (M2M) interactions. These networks use mostly unlicensed wireless spectrum to support small-size message transmission over long distances by trading range for bandwidth. Many universities have installed distributed antenna systems (DAS) to improve cellular service, ensuring reliable connectivity for research and study. Future DAS will support both cellular and IoT communications, facilitating various applications and operations on university campuses (Gul et al., 2017; Taajamaa et al., 2017).

5G technologies, designed to support M2M and H2M communications, will enhance these interactions. A mesh network of high-speed radios can be deployed across campuses to capture data from IoT and mobile devices, relaying it to IoT-DAS towers and vice versa. This network ensures coverage in difficult-to-reach areas, such as underground floors or isolated laboratories (Burd et al., 2017; Tu et al., 2017).

7. Remote Lecture Application

The "Remote Lectures" application will function as follows:

Lecture Recording and Transmission: Cameras in the lecture room will record the lecture and transmit it to the IoT-DAS system via the radio mesh network. Simultaneously, lecture-related data gathered by smart devices will be grouped by the main IoT module and transmitted to the IoT-DAS system .

Data Integration: The IoT-DAS system will send the data to the university's central server, which will integrate it into the LMS accounts of all registered students. Students can access lectures remotely by logging into their LMS accounts, downloading lecture resources, and livestreaming the lecture (He et al., 2016).

On-Campus Access: Students on campus can access lectures more efficiently via the IoT-DAS system. They will connect to the IoT-DAS system via the nearest radio, authenticate their identity, and receive lecture multimedia and resources via high-speed wireless radio (He et al., 2016).

IoT-DAS Service: An IoT-DAS service integrated within the LMS will execute a communication program to exchange data with the wireless radio. This service allows students to livestream high-quality multimedia and interact with instructors and classmates through their LMS accounts (Gunawan et al., 2017; Hawari et al., 2019).

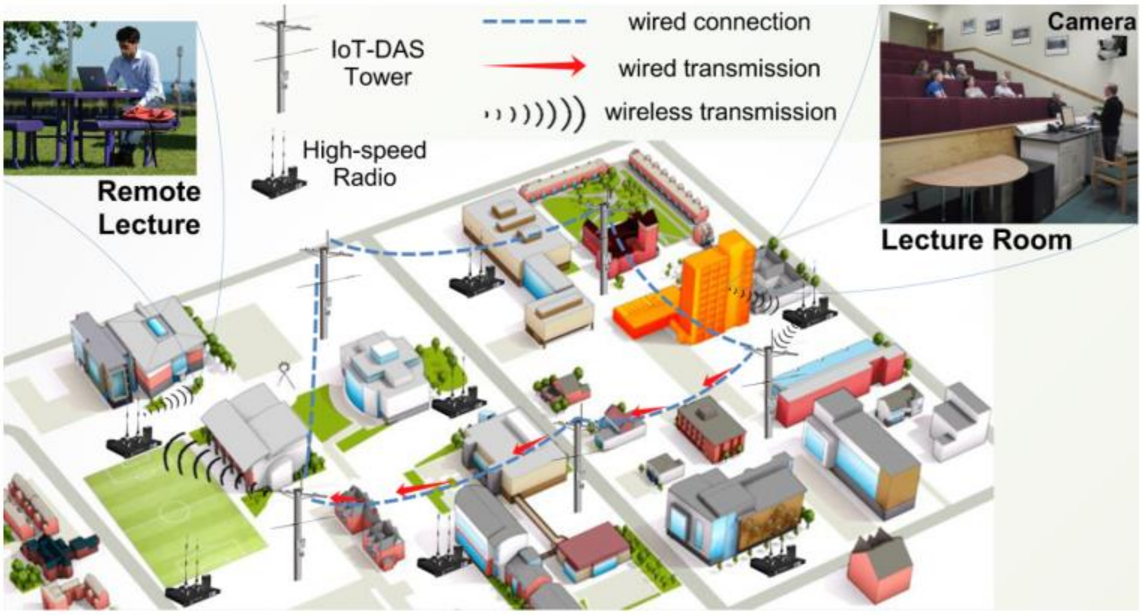
An overview of these operations is depicted in Figure 2, illustrating the comprehensive integration of IoT

JAYPS Adolescent and Youth Psychological Studies
E-ISSN: 2981-2526

technologies to enhance educational experiences on university campuses.

Figure 2

Smart classroom (2)



8. Future Classroom Technology

Future classrooms are anticipated to be equipped with a variety of sensors managed by the university administration. These sensors will read and transmit data about classroom events to the university's main server. The data will be classified as restricted and secured for access exclusively by the university administration through the university's LMS services. This information will be instrumental in enhancing classroom management. The IoT sensors in classrooms will collect data to assess parameters such as class organization, student interaction, and the extent of teamwork (Ahmad et al., 2022; Maksimović, 2017a).

9. Privacy and Feasibility

Installing cameras to monitor instructors and students during lectures is generally considered intrusive and impractical. Instructors may feel uncomfortable, and students may raise privacy concerns. Additionally, having teaching experts watch all lectures to identify issues related to teaching methods, communication skills, or student engagement is not feasible (Abomhara & Køien, 2014; Awotunde et al., 2024; Kim, 2019; Virat et al., 2018).

10. Data Analysis with Machine Learning

IoT sensor data will be analyzed using machine learning algorithms to identify various classroom issues. Different types of sensors will help achieve this objective. For example:

Position Sensors: Detect student placement and measure the percentage of time students spend in group learning or collaborative activities.

Sound Level Meters: Identify occurrences of clutter or disorder.

Voice Sensors: Determine which students are actively participating in discussions, and identify those who are inactive for extended periods.

CO2 Gas Sensors: Measure CO2 concentration in the classroom via the air conditioning system to gauge concentration and excitement levels. Variations in CO2 levels can indicate levels of student engagement.

Enhancing Student Focus

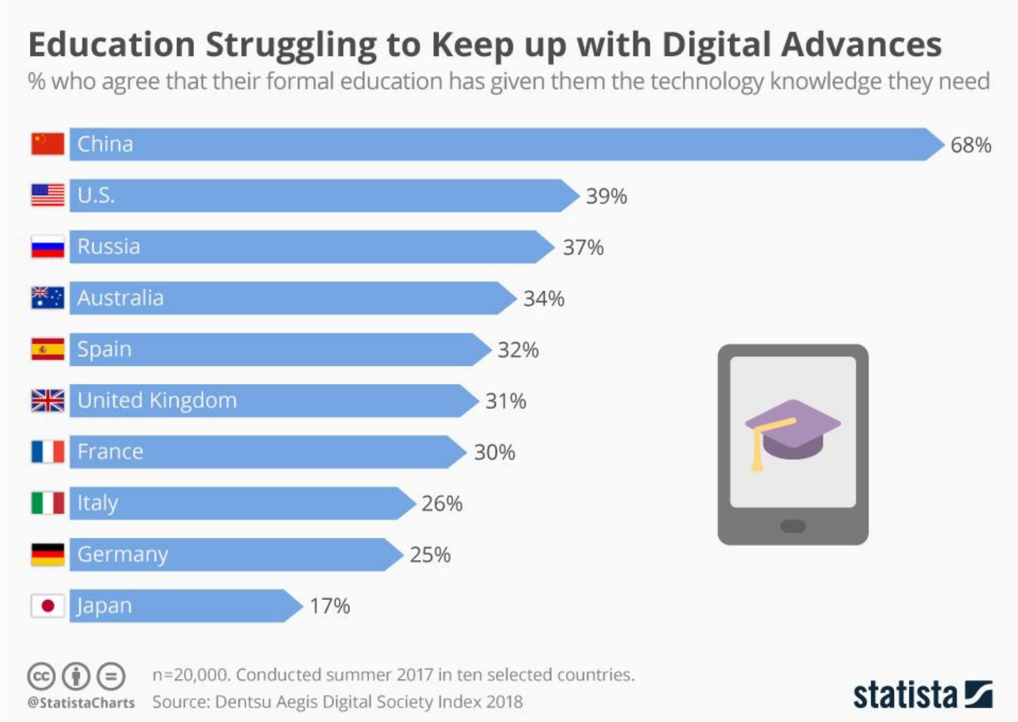
When students use laptops or tablets in the classroom, smart headphones like Mindset, equipped with electroencephalography sensors, can measure their focus levels (Barron, 2022; Cheng et al., 2021).

11. Addressing Educational Management Challenges

Modern educational management faces complex, multi-dimensional challenges that require advanced problem-solving, critical thinking, and interpersonal skills. Approaching educational management from a theoretical perspective offers educational managers, planners, students, and practitioners an environment conducive to professional development and reflection (Figure 3).

Figure 3

Education struggling to keep up with Digital advances



The applications of IoT in education are vast and already evident in some smart schools today. However, we are just beginning to explore its potential in learning applications. While IoT devices require significant initial capital investment, their long-term benefits, including enhanced learning processes for students and reduced operational costs, can outweigh the drawbacks.

12. Classroom Applications

An important aspect of modern learning is the self-directed learning pedagogy, where instructors allow students to discover and learn course material in ways that best suit them. This method often combines with interactive learning, where students engage with the material using modern technological tools designed to teach concepts through interactive activities. The IoT-enhanced LMS will help instructors track and monitor student activities during self-directed interactive learning. This paper explains two classroom applications related to this topic (Maksimović, 2017a; Mohammadian et al., 2022).

13. Adaptive Learning Digital Textbooks

Adaptive learning digital textbooks are a crucial tool for tracking students' understanding of course content and providing supplemental material or practice activities in various forms, including video, text, experiments, and virtual online 3D tours. These textbooks can be integrated within the LMS, and their feedback can be enhanced by analyzing data collected by IoT devices. For instance, a digital textbook might include an interactive experiment for the student to execute. The steps taken by the student are recorded by the textbook, while IoT sensors record the time taken and the student's reactions, indicating the level of difficulty faced (Moreira et al., 2018).

A machine learning algorithm analyzes the feedback data from the digital textbook and the sensor data from the IoT module. The algorithm's results help the adaptive digital textbook suggest the next steps for the student, whether revisiting a previous topic, providing additional material, or moving to the next topic. A link to these results will be

JAYPS
Adolescent and Youth Psychological Studies
E-ISSN: 2981-2526

available on the instructor's LMS, enabling the instructor to understand the student's progress and offer additional help or switch the student to an intensive course or training if needed (Cheng et al., 2021).

14. NFC Tags for Information Sharing

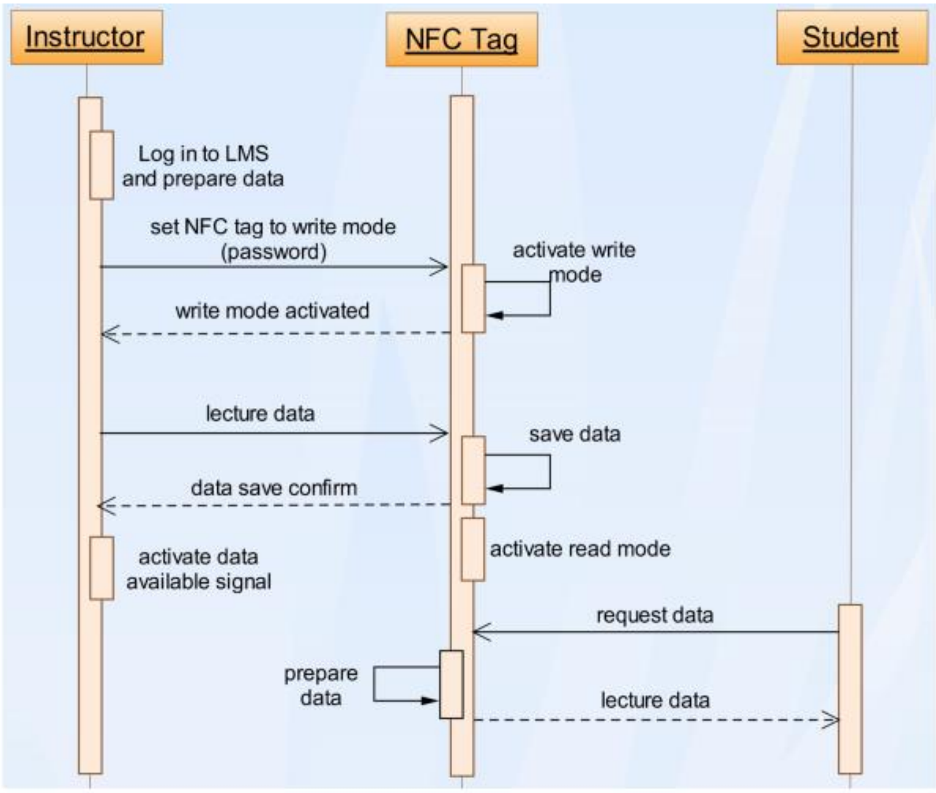
Another IoT application in the classroom is using NFC (Near Field Communication) tags to provide students with important information at the beginning of a lecture. Instructors often have information that students need to know before a lecture starts (Khedmatgozar, 2015; Zargar, 2019). An NFC tag placed inside the classroom can be programmed with the required information via the instructor's mobile LMS. Students can use their mobile LMS to obtain this information from the NFC tag upon entering the classroom. This process involves adding a utility service to the LMS for writing and reading data from an NFC tag.

If an instructor needs to provide last-minute data or files related to the lecture (up to 8KB, the maximum storage capacity of current NFC tags), they can access the NFC service from their mobile LMS upon entering the lecture room and transfer the data to the NFC tag. A sign near the NFC tag will indicate that new information is available for download. Students, upon noticing the sign, will log into their LMS accounts and use the NFC service to read the data from the tag, subsequently attaching the data to the corresponding lecture in their course (Endler, 2024).

Figure 4 illustrates the flow of events when sharing data between instructors and students using NFC tags. While previous works have discussed other NFC applications in the classroom, they often do not integrate the LMS.

Figure 4

Education struggling to keep up with Digital advances



15. Adaptive Learning

To implement the adaptive learning application, we will create a section called "Adaptive Learning" within the main menu of a Moodle course. This section will contain dynamic and interactive educational resources, allowing students to interact with the content, explore additional resources, and switch subjects as desired. The LMS will periodically ask students questions about the material, their interest levels, and any difficulties they encounter. These responses, along with timestamps, will be saved in their LMS profiles.

JAYPS Adolescent and Youth Psychological Studies E-ISSN: 2981-2526

Additionally, an IoT module will monitor student activities and reactions using various sensors. In our prototype, we will use the Empatica E4 sensor embedded in a wristband to measure stress and excitement levels. The wristband will transmit these levels to the IoT module, which will save the data in the student's LMS profile. At regular intervals, the IoT-enhanced LMS will execute a machine learning algorithm, such as deep Q-learning (DQN), to assess the student's satisfaction and understanding of the material. The results will be saved in the LMS central database, and a summary will be sent to the instructor's LMS (Veeramanickam & Mohanapriya, 2016).

16. NFC Tags

For the second application, we will integrate the nfc-pcsc library into the source code of Moodle Mobile 2, which operates on Node.js. We will create a new main section in Moodle Mobile called "NFC." When a user enters this section, the system will scan for a nearby NFC tag and display three options:

Set-up the NFC tag

Write to NFC tag

Read from NFC tag

If the user chooses to set up the tag, the system will verify instructor privileges, ask for a write password, and save it on the tag and in the LMS database. To write to the tag, the user must enter the write password, authenticate, and upload data to be saved on the tag. Reading from the tag will transfer the stored data to the user's LMS, displaying it as plaintext or a file within the "NFC" section (Endler, 2024).

17. Big Data Storage in the Cloud for Smart Educational Environments

The proliferation of smart environments and audio/video streams generates massive amounts of complex digital data. Sensing equipment and sensor networks monitor various phenomena, providing heterogeneous measurements and multimedia data, which are then stored, shared, and processed for applications like healthcare, air quality monitoring, and risk management.

Enterprise organizations have long stored growing data sets, running analytics to derive value and manage data. However, a new trend decouples data production, information management, and application development, necessitating flexible solutions to merge activities of vendors, manufacturers, service providers, and retailers.

This paper focuses on data storage services, presenting a new architecture aimed at monitoring activities in smart environments. Efforts in industry and research have focused on balancing costs and performance for IoT data maintenance and analysis. Cloud computing plays a significant role in handling big data, offering scalable storage and processing capabilities (Liu, 2022).

We designed a monitoring-oriented Cloud architecture for storing big data, supporting the development of applications and services in smart environments. "Big Data" today refers to very large unstructured data sets requiring rapid analytics. Managing big data depends on data type, with observations generating significant amounts of data over long periods. These observations are stored and structured, making them available through standardized internal formats (Awotunde et al., 2021; Guo et al., 2023).

18. Results and Conclusion

Our vision of a future LMS utilizes IoT applications and tools to enhance learning and teaching processes, transforming education into a dynamic and flexible experience. We presented eight LMS applications benefiting from IoT integration. Some applications, such as experimentation and remote lectures, exist in current LMSs but do not utilize IoT functionalities. New applications, like virtual reality and classroom monitoring, add significant value to future LMSs, opening new domains and practices.

IoT will influence instructional classrooms and their physical conditions, transforming various community aspects. Universities can lead the development of IoT technologies, market models, standards, and future economies. For example, computer science and engineering departments can develop IoT technologies, while information colleges can manage IoT data. Business colleges can create new business models, and medical and law schools can explore IoT's impact on healthcare and policy.

Advanced technology, including IoT, has addressed many university challenges, such as resource tracking, smarter planning, and information access. IoT offers significant educational benefits by motivating and engaging staff and students, facilitating fast learning. This research concludes that IoT improves and develops education, particularly in universities, through smart classrooms and laboratories, enhancing student-teacher communication and scientific material access.

19. Challenges of Using IoT in Education

JAYPS Adolescent and Youth Psychological Studies E-ISSN: 2981-2526

High Implementation Cost

IoT solutions require significant hardware and software investment. Deploying custom platforms or connected devices necessitates a robust tech team, incurring hardware license fees and maintenance costs. Not all publicly funded schools can afford such innovations.

- In-Class Ethics
- IoT-based tools must prevent academic dishonesty, such as cheating and plagiarism. A framework for tamper-proof data sharing is essential before implementing global IoT-based systems.
- Lack of Data Processing Infrastructure
- Choosing a reliable computing platform and data tools is crucial. Outdated on-premises infrastructure may not support connected IoT solutions.
- Security and Privacy Concerns
- Educational institutions must address hacking threats, with contingency plans for data breaches and security attacks. Increasing student awareness about data security is also vital.

By overcoming these challenges, IoT can be fully integrated into education, offering immense benefits and transforming the learning experience.

Acknowledgments

We would like to express our appreciation and gratitude to all those who cooperated in carrying out this study.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethics Considerations

Not applicable.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

Funding

This research was carried out independently with personal funding and without the financial support of any governmental or private institution or organization.

Authors' Contributions

All authors contributed equally.

References

Abomhara, M., & Køien, G. M. (2014). Security and Privacy in the Internet of Things: Current Status and Open Issues. https://doi.org/10.1109/prisms.2014.6970594

Ahmad, S., Umirzakova, S., Jamil, F., & Whangbo, T. K. (2022). Internet-of-things-enabled serious games: A comprehensive survey. *Future Generation Computer Systems*, *136*, 67-83. https://www.sciencedirect.com/science/article/pii/S0167739X22001972

Awotunde, J. B., Adeniyi, E. A., Ogundokun, R. O., & Ayo, F. E. (2021). Application of Big Data with Fintech in Financial Services. In P. M. S. Choi & S. H. Huang (Eds.), *Fintech with Artificial Intelligence, Big Data, and Blockchain* (pp. 107-132). Springer Singapore. https://doi.org/10.1007/978-981-33-6137-9_3

Awotunde, J. B., Imoize, A. L., Jimoh, R. G., Adeniyi, E. A., Abdulraheem, M., Oladipo, I. D., & Falola, P. B. (2024). AIoMT Enabling Real-Time Monitoring of Healthcare Systems: Security and Privacy Considerations. *Handbook of Security and Privacy of AI-Enabled Healthcare Systems and Internet of Medical Things*, 97-133. https://www.taylorfrancis.com/chapters/edit/10.1201/9781003370321-5/aiomt-enabling-real-time-monitoring-healthcare-systems-joseph-bamidele-awotunde-agbotiname-lucky-imoize-rasheed-gbenga-jimoh-emmanuel-abidemi-adeniyi-muyideen-abdulraheem-idowu-dauda-oladipo-peace-busola-falola

Barron, L. (2022). Smart cities, connected cars and autonomous vehicles: Design fiction and visions of smarter future urban mobility. *Technoetic Arts*, *20*(Themed Issue: Projected Interiorities), 225-240. https://doi.org/10.1386/tear_00092_1

Burd, B., Barker, L., Divitini, M., Fermin Perez, F. A., Russell, I., Siever, B., & Tudor, N. (2017). *Courses, Content, and Tools for Internet of Things in Computer Science Education*. https://doi.org/10.1145/3174781.3174788

Cheng, H., Shi, Y., Wu, L., Guo, Y., & Xiong, N. (2021). An intelligent scheme for big data recovery in Internet of Things based on Multi-Attribute assistance and Extremely randomized trees. *Information Sciences*, *557*, 66-83. https://doi.org/10.1016/j.ins.2020.12.041

Endler, M. (2024). *Easy reading and writing NFC tags and cards in Node.js*. https://github.com/pokusew/nfc-pcsc

Gul, S., Asif, M., Ahmad, S., Yasir, M., Majid, M., Sheraz, M., & Malik, A. (2017). A Survey on Role of Internet of Things in Education. https://www.researchgate.net/publication/345896193_A_Survey_on_Role_of_Internet_of_Things_in_Education

Gunawan, T., Yaldi, I., Kartiwi, M., Ismail, N., Za'bah, N., Mansor, H., & Nordin, A. (2017). Prototype Design of Smart Home System using Internet of Things. *Indonesian Journal of Electrical Engineering and Computer Science*, *7*, 107-115. https://doi.org/10.11591/ijeecs.v7.i1.pp107-115

Guo, B., Wang, Y., Zhang, H., Liang, C., Feng, Y., & Hu, F. (2023). Impact of the digital economy on high-quality urban economic development: Evidence from Chinese cities. *Economic Modelling*, *120*, 106194. https://doi.org/10.1016/j.econmod.2023.106194

Hawari, H. F., Zainal, A. A., & Ahmad, M. R. (2019). Development of real time internet of things (IoT) based air quality monitoring system. *Indonesian Journal of Electrical Engineering and Computer Science (IJEECS)*, *13*(3), 1039-1047. http://doi.org/10.11591/ijeecs.v13.i3.pp1039-1047

He, J., Lo, C.-T., Xie, Y., & Lartigue, J. (2016). *Integrating Internet of Things (IoT) into STEM undergraduate education: Case study of a modern technology infused courseware for embedded system course*. https://doi.org/10.1109/FIE.2016.7757458

Khedmatgozar, H. R. (2015). The role of internet of things (IOT) in knowledge management systems (Case study: Performance management of Yazd municipality staff). *Journal of Information Technology Management*, *7*(3), 553-572. https://doi.org/10.22059/jitm.2015.53916

Kim, H. (2019). Research Issues on Data Centric Security and Privacy Model for Intelligent Internet of Things Based Healthcare. *Biomedical Journal of Scientific & Technical Research*. https://doi.org/10.26717/bjstr.2019.16.002856

Liu, G. (2022). Physical Education Resource Information Management System Based on Big Data Artificial Intelligence. *Mobile Information Systems*. https://doi.org/10.1155/2022/3719870

Maksimović, M. (2017a). *Green Internet of Things (G-IoT) at engineering education institution: the classroom of tomorrow*. https://www.researchgate.net/publication/315496881_Green_Internet_of_Things_G-IoT_at_engineering_education_institution_the_classroom_of_tomorrow

Maksimović, M. (2017b). IOT CONCEPT APPLICATION IN EDUCATIONAL SECTOR USING COLLABORATION. *Facta Universitatis- Series Teaching, Learning and Teacher Education*, *1*. https://doi.org/10.22190/FUTLTE1702137M

Maksimović, M. (2017c). *Transforming educational environment through Green Internet of Things (G-IoT)*. https://www.researchgate.net/publication/313904352_TRANSFORMING_EDUCATIONAL_ENVIRONMENT_THROUGH_GREEN_INTERNET_OF_THINGS_G-IOT?__cf_chl_tk=fpJoq3sLcM02_mZxJrn3JOARoMywGbqq0HPzGr3zXyM-1715698475-0.0.1.1-1855

Mohammadian, M., Sedighi, M., & Serkani, M. (2022). Selection of Internet of things (IOT) applications in education industry using the Best-Worst Multi-Criteria Decision-Making Method. *Technology of Education Journal (TEJ)*, *16*(2), 363-386. https://doi.org/10.22061/tej.2022.7414.2533

Moradi, M., & Fard, K. (2019). An English-language teaching plan for children in the internet of things environment. *Indonesian Journal of Electrical Engineering and Computer Science*, *13*, 927-932. https://doi.org/10.11591/ijeecs.v13.i3.pp927-932

Moreira, F. T., Magalhães, A., Ramos, F., & Vairinhos, M. (2018, 2018//). The Power of the Internet of Things in Education: An Overview of Current Status and Potential. Citizen, Territory and Technologies: Smart Learning Contexts and Practices, Cham.

Ralhan, B. (2017). *How IoT Is Transforming The Education Sector*. https://inc42.com/resources/io-transforming-education/

Taajamaa, V., Rwegasira, D., Kelati, A., Kondoro, A., Mvungi, N., Tenhunen, H., Ben Dhaou, I., & Naiman, S. (2017). *Challenge Driven Education in the Context of Internet of Things*. https://doi.org/10.21125/edulearn.2017.1521

Tu, J.-C., Chen, Y.-Y., & Chen, S.-C. (2017). The Study of Consumer Green Education via the Internet of Things with Green Marketing. *Eurasia Journal of Mathematics, science and technology education*, *13*, 6133-6145. https://doi.org/10.12973/eurasia.2017.01054a

Veeramanickam, M. R. M., & Mohanapriya, M. (2016). IOT enabled Futurus Smart Campus with effective E-Learning : i-Campus. *GSTF Journal of Engineering Technology*, *3*. https://www.semanticscholar.org/paper/IOT-enabled-Futurus-Smart-Campus-with-effective-%3A-Veeramanickam-Mohanapriya/ef5da388a254c17744aefb45f0b3053063059756

Virat, M. S., Bindu, S. M., Aishwarya, B., Dhanush, B. N., & Kounte, M. R. (2018, 11-12 May 2018). Security and Privacy Challenges in Internet of Things. 2018 2nd International Conference on Trends in Electronics and Informatics (ICOEI),

Zargar, S. M. (2019). Assessment of barriers to establishing the Internet of things in libraries in Iran based on a combined approach. *Iranian Journal of Information Processing and Management*, *34*(3), 1371-1398. https://jipm.irandoc.ac.ir/article_699551_en.html

JAYPS Adolescent and Youth Psychological Studies
E-ISSN: 2981-2526