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Role of Artificial Intelligence in Enhancing School Digital Twins

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Abstract

A School Digital Twin system powered by AI has been deployed to make educational spaces more responsive and intelligent through real-time monitoring, self-governing decision-making, and decentralized participation. Utilizing cameras, IoT sensors, artificial intelligence, and blockchain-powered smart contracts, the system monitors and interprets real-time data from classrooms to build a dynamic virtual replica of every learning environment. This virtual twin enables timely, data-driven interventions intended to maximize classroom conditions. While AI oversees environmental adaptations, blockchain guarantees transparency and verifiability of decision-making processes. By coupling advanced technological infrastructure with pedagogical goals, the system aims to facilitate more adaptive, resource-effective, and learner-centred education practices. Finally, it aims to enhance learning conditions, promote evidence-informed governance, and increase academic achievement through personalization and intelligent adaptation.

Keywords: School Digital Twin, Artificial Intelligence, IOT sensors, Blockchain.

1. Introduction

Artificial Intelligence (AI) has witnessed remarkable growth in recent decades, driven by advancements across disciplines such as mathematics, computer science, psychology, philosophy, engineering, statistics, and data science. This progress has positioned AI as a transformative force in educational settings, particularly within these proposed systems. These

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systems, which create virtual replicas of classrooms using real-time data from IoT sensors and cameras, can benefit greatly from AI's ability to rapidly process information and make intelligent decisions. For instance, AI can automate tasks such as adjusting classroom temperature and lighting, generating personalized schedules based on student performance, and identifying key focus areas for revision. Furthermore, when integrated with blockchain-based smart contracts, AI enables decentralized, transparent, and unbiased decision-making, especially in handling student and faculty feedback. This eliminates reliance on centralized authorities, fostering fairness and accountability. However, the implementation of such systems at scale faces significant challenges, including infrastructural limitations, privacy concerns, and public acceptance. Considering these factors, this work seeks to explore how AI and blockchain can be effectively leveraged within the proposed system environments to create adaptive, intelligent, and equitable educational ecosystems. The core objectives of this research are to examine the role of AI in real-time classroom adaptation and personalized learning, assess the utility of smart contracts in decentralized governance, and identify the major technical and societal challenges to widespread adoption, ultimately contributing to the design of a more responsive and data-driven educational infrastructure.

2. Related Works

This study elaborates on the ways in which ML (machine learning) enhances the performance of IoT in dynamic environments. It explores how ML strengthens real-time decision-making, connectivity, and service quality in applications including smart cities, smart homes, and smart healthcare, etc. This research study also examines the functions played by the Internet of Things (IoT) in fostering intelligent and context aware automation [1]. This research paper examines the integration of artificial intelligence (AI) into blockchain systems to improve functions such as automation, decision making, and data security. By exploring the intersection of AI and blockchain technologies, it also emphasizes the major applications, cloud-based solutions such as Blockchain-as-a-Service, and the challenges in integrating these two technologies. This digital integration is viewed as promoting improved accuracy and enabling smarter digital ecosystems [2]. This research study examines the challenges and barriers of integrating AI, blockchain, and IoT, while also placing an emphasis on security, scalability, and trust issues. It highlights the need for hybrid models that are necessary to enhance the performance as well as the constraints they face. The results obtained imply that resolving these challenges would facilitate digital transformations across industries as well as new business models [3]. Digital Twin (DT) technology makes an exact, real-time digital copy of physical systems, supporting improved monitoring and analysis. By integrating IoT, AI, and 5G/6G, it creates new opportunities for the evaluation of complex systems. However, challenges in data communication, processing restrictions, and the absence of standardization limit development. This paper examines the supporting technologies, challenges, and uses of Digital Twin across various industries [4]. This research proposes a precise method for the deployment of digital twins, which virtually copy physical entities to reproduce and solve problems. It outlines implementation layers and important technology components to guide development in areas such as energy, transport, and smart cities. The paper further maps the history of digital twin technology and indicates how knowledge of its development can assist in more effective and targeted deployments [5]. This paper surveys the increasing significance of digital twin technology in facilitating intelligent automation in industries. The concept is described, its evolution traced, core technologies, latest trends, issues, and key industrial applications described by a thorough literature review [6].

This paper surveys the notion, emergence, and utilization of Digital Twin (DT) technology, identifying its capacity for adding value to physical systems through transcending barriers of time, space, and cost. A ternary framework based on time, space, and logic is proposed, prominent frameworks and issues are discussed, and directions for the future of DT development are presented [7]. This paper discusses digital twin (DT) applications in building thermal comfort and energy efficiency, with an emphasis on prediction, monitoring, and optimization by AI-based techniques. It identifies research gaps in the utilization of sensors, occupant-centric design, and the need for more collaboration and comparative studies [8]. This article analyzes the ways digital twins (DTs) can address actual city demands through connecting urban functions and DT technology. It presents a back-end/front-end DT model and emphasizes AI-based updates and application-specific views with the purpose of increasing city efficiency while filling current gaps [9]. This review focuses on the application of AI in education, particularly in personalized learning, automated tutoring, and data-driven instruction. It also mentions challenges such as bias, privacy, and ethics, while pointing out the potential of AI to enhance efficiency and student performance [10].

This article discusses state-of-the-art AI systems in education, classifies AIED methods, and investigates their educational assumptions. It also identifies diverse interpretations of the role of AI in learning and formulates major challenges against its widescale adoption [11]. This research assesses the advantages and disadvantages of Integrating AI systems into education, providing observations from various concerned groups points of view. It offers policy recommendations to maximize benefits, reduce ethical issues, and point out the importance of improved AI literacy among educators and learners [12]. This research investigates the way artificial intelligence is being included in digital twin systems across various domains. It emphasizes that although AI components are extensively tested, numerous implementations do not pay attention to careful modeling and do not experience real-time synchronization between the digital and actual worlds [13]. This study looks into how AI enhances digital twin technologies in Industry 4.0, focusing on applications in robotics, advanced manufacturing, and resource efficient. It also outlines future development trends and current challenges [14]. This article highlights the lesser-studied but significant contribution of AI and ML in taking digital twin systems to the next level beyond simulation, highlighting their contributions in health, climate science, and sustainability using major AI methods such as prediction, analytics, and decision-making [15].

Digital twins (DTs), empowered by AI, ML, and big data, are revolutionizing sectors. This study identifies their present applications, enabling tools, and the hurdles encountered in designing smart, data-driven DT systems [16]. Data privacy and data security have proven to be major concerns as AI and digital twin technologies continue to develop. This research focuses on the need for proper implementation of necessities such as access control, encryption, classification of data, and continuous monitoring to secure sensitive, data and ensure compliance is maintained [17]. Smart decision making industrial systems is dependent on the availability of accurate data. The data gathered from numerous sensors are verified, and stored on the blockchain for trust. This data is used by the AI driven digital twins to monitor the system, detecting issues, and predict failures. This paper also brings attention to the improvement of digital twins by combining AI and blockchain, along with their benefits, and challenges [18]. Physical systems can be represented through virtual medium with the help of twins. They help visualize forecasts and performance, improve efficiency, and enhance decision-making. They act as a pathway to new possibilities across sectors when coupled with AI and IoT [19]. This research employs blockchain to improve digital twins (DTs) in sustainable production. Decision-making approaches such as neutrosophic theory, OWA, and TOPSIS evaluate the sustainability impact, while Monte Carlo simulations forecast the decision effect [20].

Despite the growing body of research on AI, IoT, blockchain, and digital twin technologies, several key research challenges remain. These include the lack of real-time synchronization between physical and digital systems, difficulties in standardizing digital twin frameworks across domains, and the need for effective integration models that ensure data privacy, security, and ethical compliance. Furthermore, issues related to scalability, system interoperability, and the absence of unified architectures hinder large-scale implementation. In the context of education, additional concerns such as AI bias, limited personalization, and low AI literacy among stakeholders further complicate adoption. Addressing these gaps is essential for realizing the full potential of AI-driven digital twin systems in dynamic and sensitive environments like smart schools.

3. Methodology

The School Digital Twin system, driven by AI, IoT sensors, and blockchain smart contracts, would monitor, analyse, and optimize decision-making to improve classroom environments, student learning, and administrative activities. As opposed to legacy school management systems, which tend to rely on fixed data and manual intervention, or current IoT solutions that have difficulty ensuring data security and centralized control, our solution constructs a dynamic digital twin of the school that refreshes in real time with sensor feeds. This allows for responsive action, such as optimizing the classroom environment or resource allocation, in response to live requirements. With the incorporation of blockchain smart contracts, the system provides secure, transparent, and decentralized data management, resolving privacy and trust issues typical of traditional systems. Unlike independent AI or IoT software, which tends to lack scalability or end-to-end integration, our solution provides an integrated, data-driven framework for a more effective learning environment, informed decisions, and increased administrative efficiency via secure real-time automation.

A modular design was followed in implementing the framework. Modular architecture keeps data acquisition, AI processing, and execution of the blockchain smart contract separate. Scalability was handled by incorporating off-chain processing for demanding AI tasks and combining it with lightweight on-chain contracts. Implementation using standard data formats and Ethereum compatible smart contracts made integration easy with the current learning management systems and digital infrastructure.

3.1 System Architecture and Sensor Deployment

The School Digital Twin is based on gathering real-time data from various sections of classrooms. To achieve this, numerous types of sensors are installed in every classroom. These may range from temperature sensors to detect heat levels, light sensors to measure light levels, humidity sensors to monitor air moisture, oxygen sensors to maintain proper airflow, and sound sensors to monitor noise levels. Additionally, cameras are strategically positioned to provide video that aids in detecting presence and analyzing behavior. Every sensor is selected based on accuracy, durability, and compatibility with the AI system. They are strategically located to ensure they cover every corner and spot so that nothing is left out. The sensors provide continuous data to a central processor that utilizes AI. This is the core component of the digital classroom model. The AI continuously updates the digital twin in real time, displaying every minute or significant change in the classroom. This real-time monitoring allows the system to react promptly and with precision. Real-time measurements, such as the time taken by the sensors to react and initiate the desired action, the success ratio of the action, and the ratio of system uptime, were considered in evaluating the dependability of the autonomous control of the system. Additionally, tracking the error rate by the AI in decision-making, confirmation logs for device actuation, and system override frequency when the result was not as expected were performed to ensure reliable and independent performance by the AI.

3.2 AI-Powered Real-Time Monitoring and Decision-Making

Smart AI systems analyze sensor data in real time, recognizing patterns in the environment, detecting discrepancies, and activating the right reactions. By employing standard IoT protocols, classroom sensor data such as temperature, light, humidity, microphones, and cameras are constantly collected and sent to a central platform for immediate and coherent distribution. Raw data is cleaned before analysis through time-syncing, generalization, and noise filtering to obtain frequent and reliable AI assessments. Over time, such algorithms become better decision-makers because they learn from experiences and adapt to the conditions developed in the classroom. For example, depending on the user's choice and general thermal comfort levels, the AI system automatically compares the current temperature of the environment with an ideal temperature. The AI system adjusts air conditioning settings to increase the system temperature if it is found to be too cool and the video stream indicates a high number of students. In contrast, the system cools down immediately to ensure a comfortable atmosphere if the environment is too warm. This delicate and real-time regulation helps develop a consistent indoor environment that encourages learning and concentration among students. Expert-labeled results were employed to confirm the AI options, along with simulated sensor data and the history of classroom datasets. The predictions of the AI were consistent with approximate behaviors in the actual classroom environment. The accuracy of the system was calculated, and the results showed a good fit with real-world classroom needs.

We deployed a model (Fig. 1) that operates on logistic regression. It makes a prediction about whether any action should be taken based on the input received from the DHT11 temperature sensor. Initially, we had deployed a rule-based method that employed fixed thresholds to trigger heating or cooling. However, this method was too slow in its response and inflexibly rigid. Its responsiveness to temperature changes was suboptimal. To eliminate these weaknesses, we opted to construct a lightweight model that employed historical data of normal classroom temperatures.

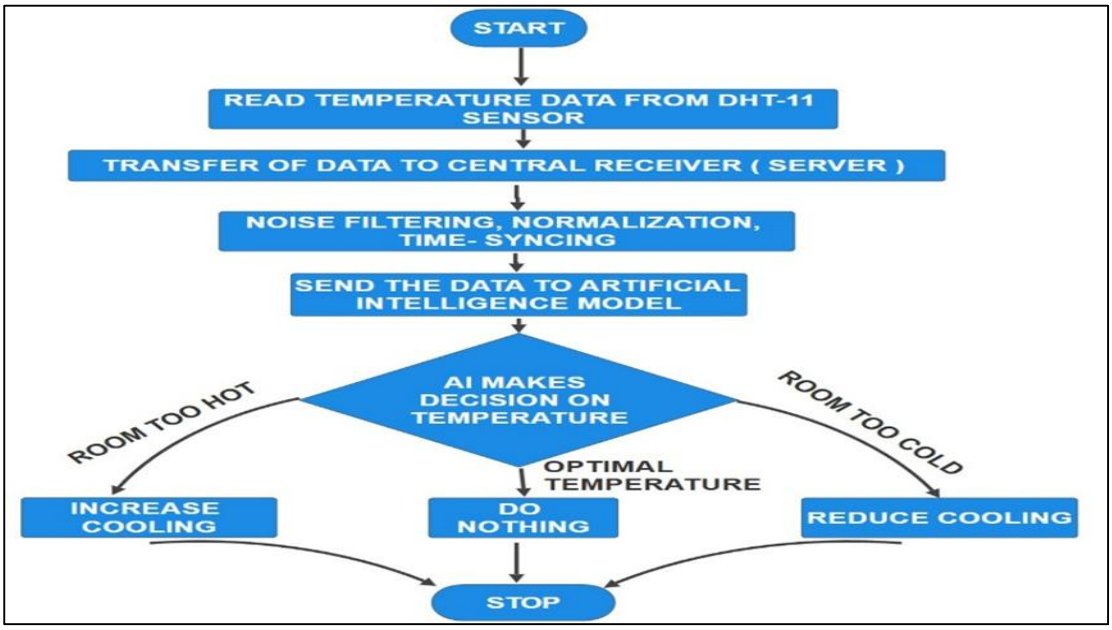


Figure 1. Classroom Temperature Analysis Model

This model can continuously accept temperature values from the sensor (DHT11) and determine whether any action should be taken. It can detect unwanted temperatures and respond accordingly. Its adaptability is useful for the precision of the system, which aids in enhancing the comfort of students as well as conserving energy. It applies data from ambient light sensors to find a balance between energy efficiency and visual comfort. When natural light is poor, it activates artificial lights to maintain good visibility. However, when there is sufficient daylight, it shuts off unnecessary lights in order to conserve energy, making the classroom comfortable and sustainable.

We created an intelligent lighting system (Fig. 2), which decides whether to switch on or off artificial lighting, using a logistic regression algorithm based on light readings from the BH1750 sensor. We started with a steady threshold-based system, where the lights would turn on or off according to a predetermined Lux value. However, this approach was not very flexible and reacted improperly to fine changes in light, especially on cloudy days or in areas near windows. To combat this deficiency, we trained a light-wisdom machine learning model with synthetic data covering a range of lighting conditions throughout the day. This model now accepts continuous lux input from the sensor and makes smart decisions in real time. Not only does it react rapidly and more accurately, but it also adjusts to slight changes in natural light, illuminating the classrooms efficiently without excessive energy use. It helps create a more dynamic and energy-efficient learning space.

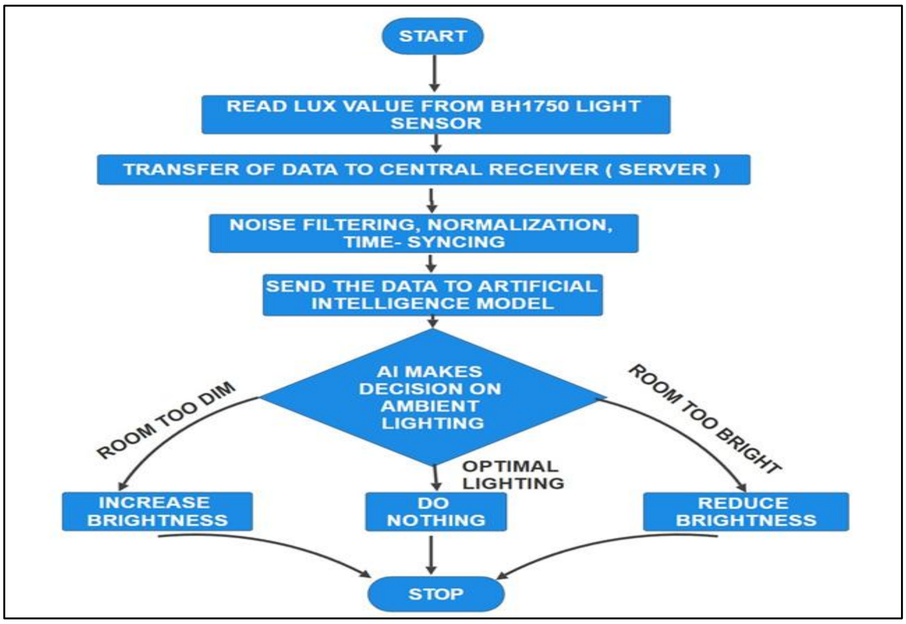


Figure 2. Smart Lighting Model

The system also controls humidity to maintain classrooms in a healthy and comfortable state. When humidity levels rise too high, which can be uncomfortable or unhealthy, the AI sends an immediate alert to the teacher's dashboard to trigger responses such as dehumidifier operation or increased ventilation. Early warning maintains indoor air quality at optimum levels. To effectively control classroom humidity levels, we employed a predictive model (Fig 3) based on logistic regression, which decides if humidity-controlling measures are required from live input taken from the DHT11 sensor. We initially employed a simple threshold approach wherein predefined values of humidity would cause a humidifier or dehumidifier to turn on. This was an inconsistent method that failed to deal with slight variations typically found in naturally ventilated classrooms. It frequently did not respond in a timely manner or overcorrected and caused discomfort. To address this, we trained a smaller machine learning model on synthetic data created from representative indoor humidity conditions. This model now continuously processes incoming sensor data and forecasts the requirement for environmental correction more reliably. Through more intelligent adaptation to changes, it maintains a consistent and comfortable environment while avoiding wasteful energy consumption from unnecessary activations.

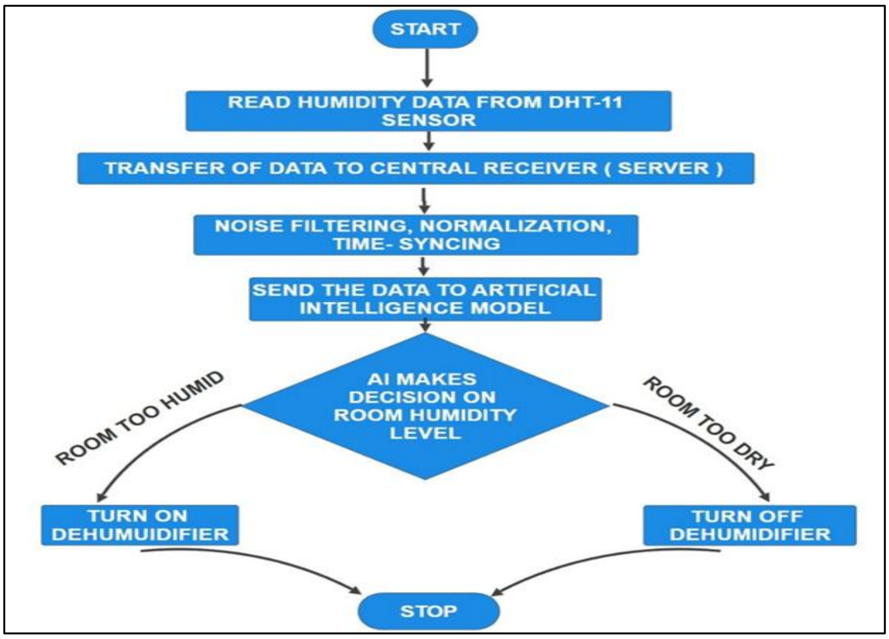


Figure 3. Smart Humidity Model

The AI also integrates audio monitoring with real-time video analysis. When it detects high levels of noise that could suggest a disruption, it analyzes the video to determine if a supervisor is on the scene. If no supervisor is identified, the system indicates a possible behavioral problem and reports it to the teachers' dashboard for immediate response. The integrated strategy assists the system in identifying issues correctly and enabling fast decision-making.

3.3 Classroom Dashboard and Alerts

The classroom dashboard is the focal point of interaction through which the system is accessed by teachers and administrators. It provides an overall, real-time snapshot of the status of each classroom, allowing users to view environmental conditions including temperature, light, humidity, sound level, and occupancy level. Logging and archiving are also facilitated by the dashboard, enabling the review of previous trends and conditions based on historical data. The dashboard for teachers reveals AI recommendations, teacher attendance verifications, and outcomes of decisions made. These functionalities render school management clearer and easier to navigate. Teachers can make informed decisions, while the system continues to function in the background to provide excellent classroom environments.

3.4 Integration of Blockchain Smart Contracts for Decision-Making

To offer decentralization, transparency, and accountability, blockchain-based smart contracts are utilized in the School Digital Twin system (Fig. 4). Smart contracts refer to computerized digital contracts that perform actions upon fulfilling certain conditions. Here, they are primarily used to facilitate group decision-making and policy-making in a trustless environment. When an important decision needs to be made, e.g., during the modification of infrastructure, changes to class timetables, or implementation of new rules, a smart contract is deployed that collects opinions and comments from concerned parties, i.e., faculty, students, and administrators. These inputs are recorded in the blockchain as unalterable and recoverable, making it impossible to manipulate data or introduce bias for the purpose of making a judgment. Once it has collected the feedback, the AI system analyzes the content in terms of sentiment, frequency of suggestions, and common themes. Subsequently, it aggregates the feedback and suggests a final option along with a justification derived from the input data. The reply is encrypted on the blockchain so that it cannot be altered or traced, thereby avoiding data tampering or bias in decision-making.

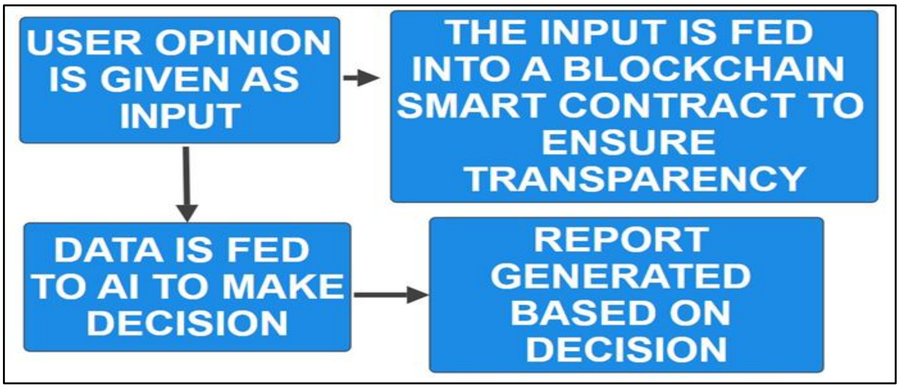


Figure 4. Operational flow of Decision-Making by Integration of Blockchain Smart Contracts

This integration of blockchain technology assures that every opinion and voice heard equally. Decisions are made in a transparent manner supported by data. Faith in the system can be seen as a verification record of participation and decision logic is available.

3.5 Feedback Handling Through Smart Contracts

This blend of blockchain technology guarantees that each opinion has an equal value. Decisions are made openly and backed with data, instilling confidence in the system with a verifiable record of participation and shareable decision logic. Smart contracts are used to gather and review comments on different facets of college operations such as classrooms, coaching practices, school policies, and sports administration. Adaptability and constant improvement in line with new standards are a priority. Feedback process starts with participants who are able to make comments anonymously or publicly on a secure blockchain-based platform. This method protects data, guarantees its immutability, and makes it easily accessible for future use. The submission is verified automatically by the smart contract for suitability and stored without any intervention. After gathering feedback, AI steps in to process it. Using natural language processing (NLP), AI detects keywords, major themes, and repeating concerns. It then creates an executive summary report that summarizes problems and provides actionable suggestions. This report is made available on the dashboard for teachers and sent to concerned stakeholders to enable informed decision-making. The integration of blockchain and AI in managing feedback ensures data protection while appropriately utilizing feedback. This forms a systematic process of listening, assessment, and response, promoting school culture geared towards timely responses and responsiveness.

3.6 Student Performance Analytics and AI-Based Study Plans

One of the strongest uses of AI in the School Digital Twin is creating tailored study plans according to student performance analytics. The system converts study rankings into actionable recommendations and adaptive learning plans, ultimately improving academic performance. The process is demonstrated in Fig. 5. We begin by compiling college students' check rankings, either by topic or by issue. Students' test score statistics are fed into an artificial intelligence system, which uses the information to determine the students' strengths, weaknesses, and trends. For example, if students are performing poorly in math, the system would draw attention to this issue and encourage both students and teachers to work on it.With the assistance of this data, it proposes a class timetable where students are found to be underperforming and less emphasis is positioned at the topics in which the students are perform well. This balances the curriculum to the desires of the students and allows greater effective use of time.

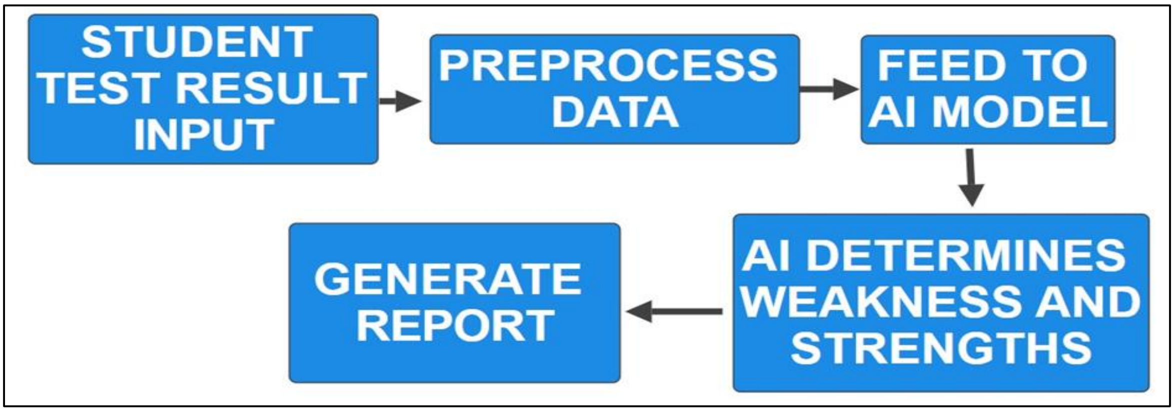


Figure 5. Operational flow of Student Performance Analytics and AI-Based Study Plans

We employed a model that helps in the study of student academic performance. The model is capable of processing subject scores and classifying them based on students' performance. It performs the application of the K-Means clustering algorithm to group subjects into three clusters: Vulnerable, Mild, and Strong. We first employed synthetic data simulating students' ratings for various subjects given to the system. The model then determines patterns in the ratings and clusters the topics accordingly. Once the clusters have been formed, the clusters are labeled according to the levels of rating on which AI recommendations are cast. For instance, struggling subject's prompt suggestions like "More Classes" or "Extra Practice." When subject data from the test results is entered, the AI can suggest revision plans, extra classes, additional practice exercises, and recommend resource materials to concentrate on the weaker topics. These suggestions are communicated to the teachers and students through the dashboard, enabling them to derive insights and make informed choices. This AI-powered academic system facilitates that the required help reaches students, which supports individualized learning and assists teachers in adapting their teaching methods to become more efficient.

4. Results

The installation of the School Digital Twin device, powered by AI, with its safe login page presented fantastic improvements in environmental control, decision-making, feedback processing, and planning for school sports. The login page (Fig. 6), implemented using HTML, CSS, and JavaScript to achieve a responsive and user-friendly layout, secures that only users who have permission to utilize the digital twin platform, such as teachers, administrators, and facility managers, can log in. By integrating blockchain smart contracts for secure verification, the login page secures sensitive information, such as IoT sensor data and student records, promoting trust and privacy in school operations. The managed access enables authorized users to utilize the device's real-time data and AI-driven insights, advancing optimized classroom environments, data-driven administrative decisions, streamlined feedback integration, and strategic education planning. Compared to traditional systems with lower security or manually controlled access, the login page provides a solid basis for the digital twin's smooth and secure performance, which has a direct impact on school management innovation.

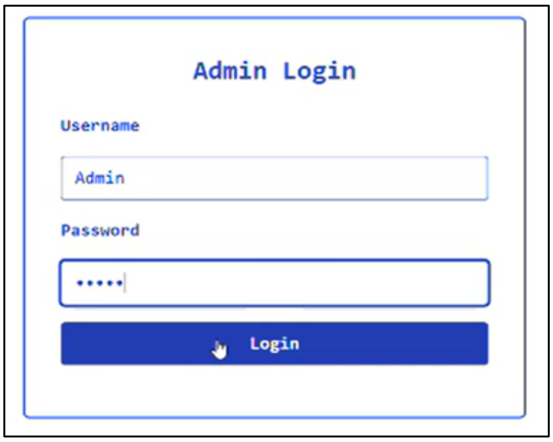


Figure 6. Login Page

Based on this premise, an admin panel (fig 7) has been designed to enable permitted users to select which functionality of the digital twin they would like to engage with, further optimizing the system's usefulness. Built with React for a dynamic, intuitive front-end and Node.js and MongoDB for solid back-end data handling, the admin panel is an integrated hub from which users may choose from activities like monitoring real-time IoT sensor readings (e.g., room temperature or capacity), analysing AI-generated results for resource allocation, handling stakeholder feedback, or scheduling academically. Protected by blockchain smart contracts, the panel provides transparent and tamper-resistant interactions, upholding the system's promise of data integrity. In contrast to standard school management software that tends to be inflexible or not integrated, this admin panel provides a unified, easy-to-use platform that allows users to customize their interaction with the digital twin, significantly improving environmental management, decision-making effectiveness, feedback processing, and academic planning within a comprehensive, secure system.

Figure 7. Admin Panel

The AI with an integrated sensor ensured real-time adjustment of conditions in classrooms, such as temperature, lighting, and humidity, to deliver the best and most energy-efficient environment (fig 8).

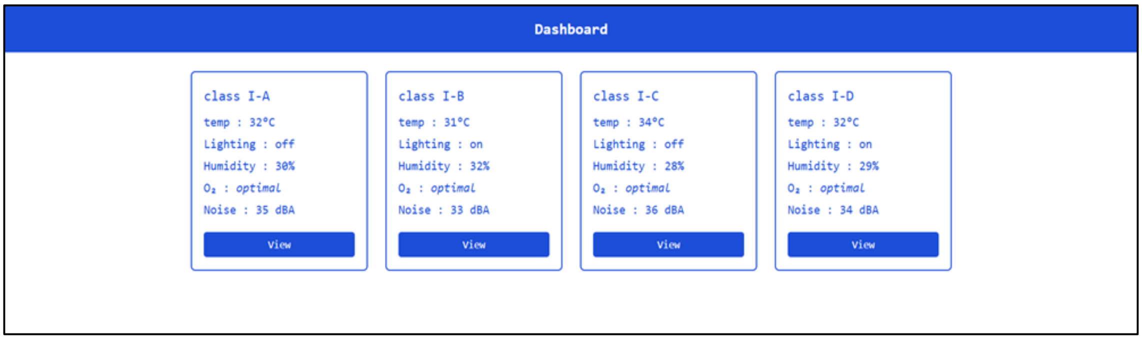


Figure 8. Classroom Dashboard

The dashboard would prompt immediate warnings when abnormal noise levels were recorded in the faculty's absence to improve discipline control and classroom observation. The use of blockchain smart contracts provided accountability in decision-making through the secure collection and recording of inputs by stakeholders (Fig 9), which were then processed by the AI to provide fair and summarized outputs. Inputs obtained via various school activities were effectively dealt with AI to introduce key issues and suggest credible modifications.

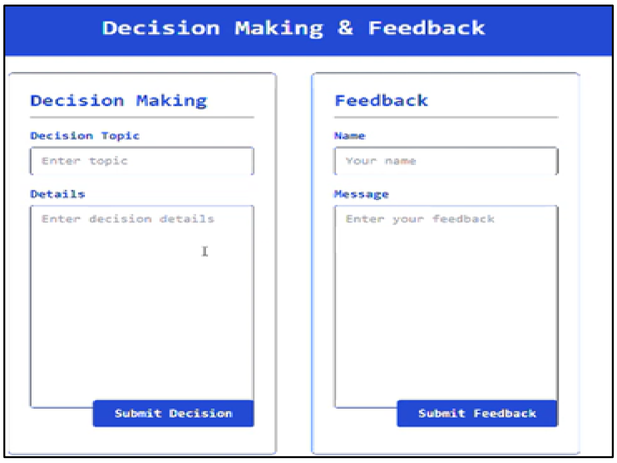
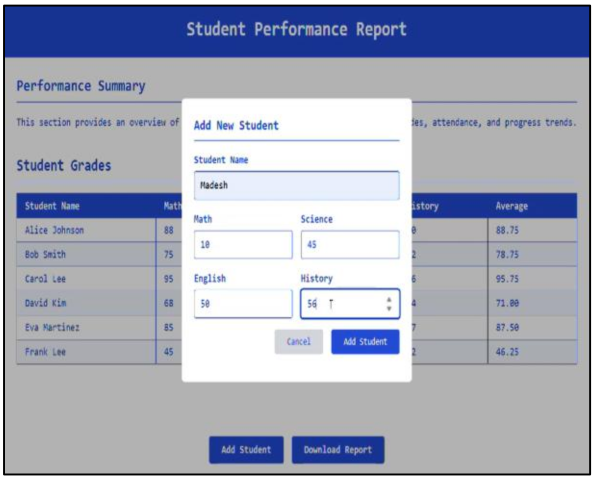


Figure 9. Decision Making and Feedback Page

Further, the information an academic results entered into the system (fig 10a, fig 10b) permitted the AI to generate individualized study plans, identifying areas or subjects requiring increased focus and then adjusting class schedules accordingly (fig 11).



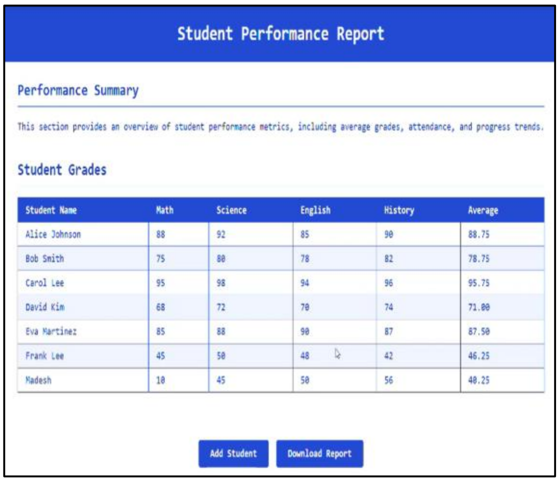


Figure 10a. Student Marks Input **Figure 10b.** Student Marks Input Summary

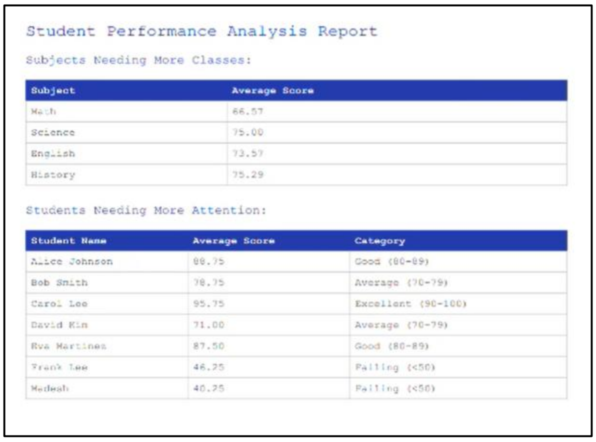


Figure 11. Student Performance Analysis Report

The system proved to work well in automating routine workloads, enhancing responsiveness, and facilitating a more intelligent and data-driven process of school administration. The prototype hardware module (Fig 12) that we implemented was designed with the requirement of it being compact and also robust. The hardware module was equipped with an ESP32-CAM, a mic, a DHT11 temperature sensor, an LCD display to indicate the present humidity and temperature, a DFRobot oxygen sensor, a BH1750 light sensor, an ESP8266 Wi-Fi module, and an Arduino UNO.

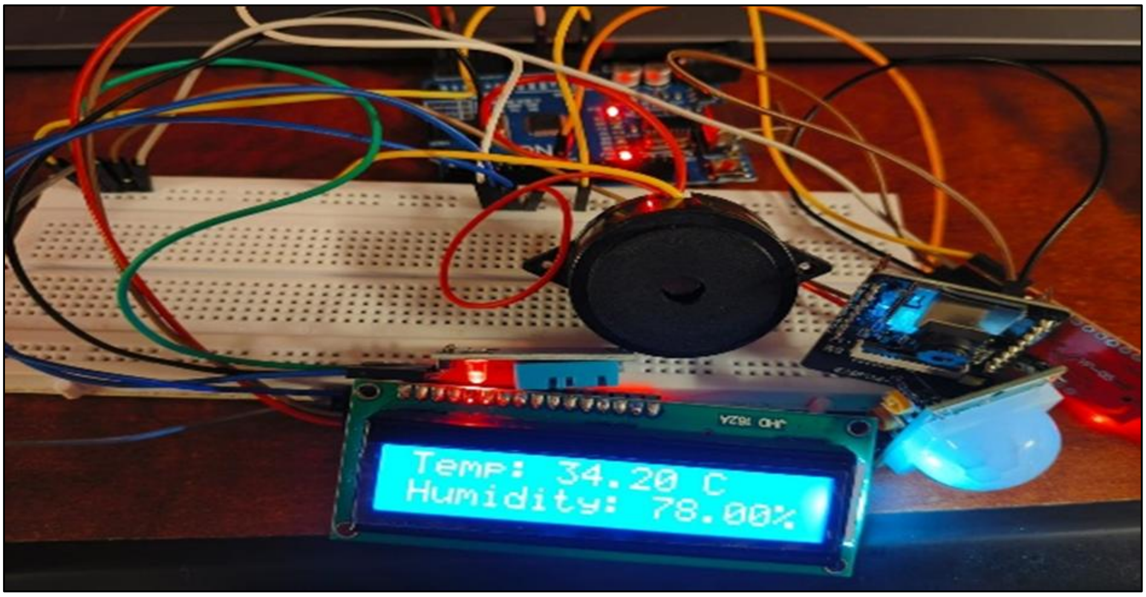


Figure 12. Hardware Module

When we actually deployed and tested this prototype module, we saw that the real-time monitoring of environmental conditions enhances the learning experience in the classroom. The data has also been discovered to propagate smoothly to the digital twin without any lag. The teachers find that the digital twin interface is simpler to work with and enjoy the capabilities enhanced by AI. They also appreciate the fact that the use of blockchain smart contracts assists them in making transparent classroom decisions. The AI's help in monitoring and analyzing the students' performance improves the teachers' understanding of where the students are deficient and where they need to concentrate their efforts. The digital twin dashboard also proves to be useful in observing multiple classrooms simultaneously.

The sensors adopted by the physical module were determined after extensive comparison with several alternatives: the DFRobot Oxygen Sensor (90% accuracy/compatibility) and the BH1750 Light Sensor (87% accuracy/compatibility), as seen in Figures 13 and 14, were selected based on their effectiveness in minimizing energy consumption. These precision sensors allow the AI to adjust lighting and ventilation in response to real-time air quality and occupancy levels, surpassing less accurate options like the MQ-135 Gas Sensor (36%) and LDR (36%).

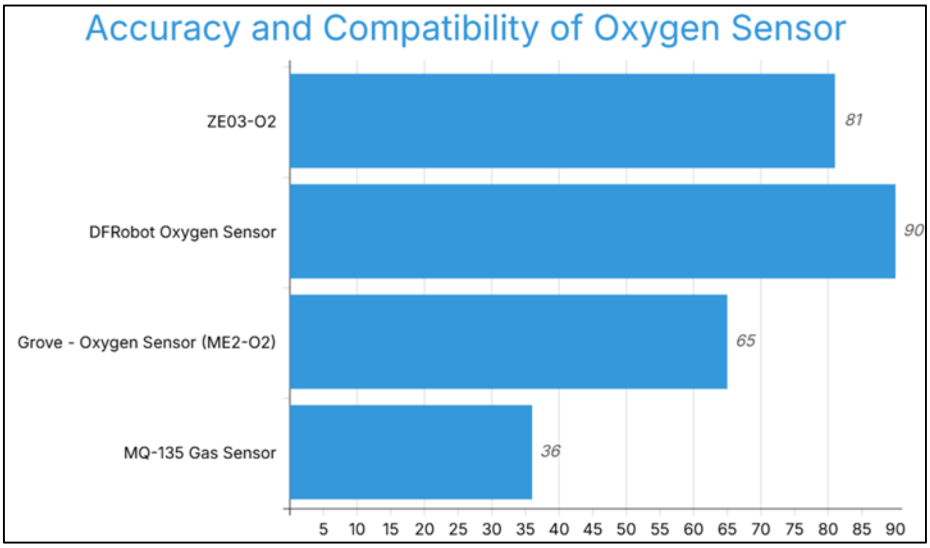


Figure 13. Accuracy and Compatibility of Oxygen Sensor

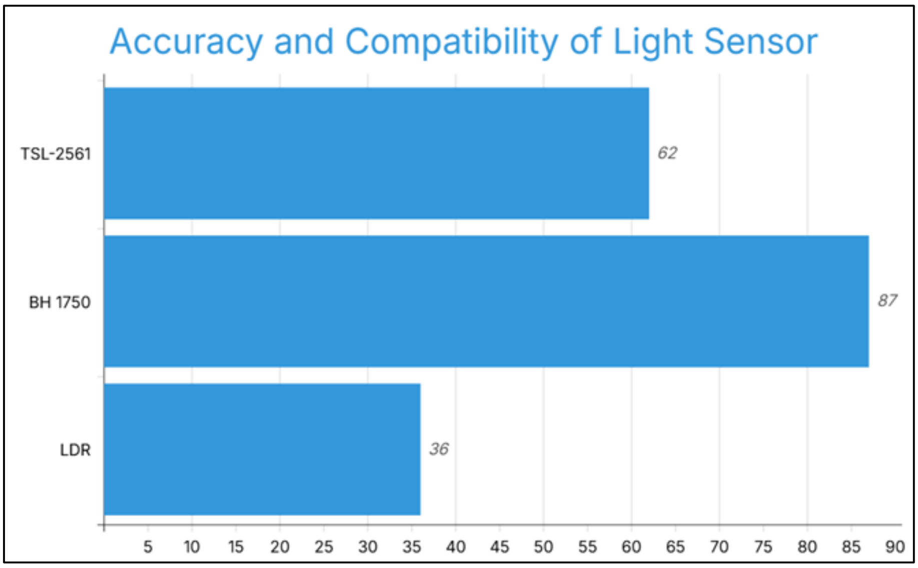


Figure 14. Accuracy and Compatibility of Light Sensor

The effects of the system on learning performance were tested via a controlled pilot with two groups of students. One group used the AI-augmented digital twin, and the other did not. Measurements such as test scores and engagement were monitored. The group assisted by AI showed significant improvement and was more uniform in learning, resulting in heightened understanding of the topic, which was confirmed through the use of pre- and post-experiment assessment data and the teacher's comments.

Teachers also discovered that the system helped maintain discipline in class, as it aided in avoiding misbehavior in classes in the absence of faculty by alerting teachers to the absence of faculty in the classroom through the digital twin dashboard. Henceforth, we have created a school digital twin powered by AI and blockchain technology that is advancing school education with different features, including class environment control, transparent and equitable decision-making, and improving student academic performance by analyzing their exam scores and providing feedback to instructors on areas of concern.

5. Discussion

The integration of AI, IoT, sensors, and blockchain smart contracts into school digital twins is a perceivable leap in the development of the education system. The system, presented and argued in this research work, proves its technical applicability as well as its pedagogical and administrative benefit. It facilitates a responsive and smart school ecosystem that evolves at the same time against physical environments and human inputs. This part discusses the broader implications of the system, examines whether it is effective in realizing its goals, and suggests potential areas for development and further research. This AI-powered continuous monitoring system is the key to this project. The system maintains a comfortable and distraction-free learning environment for the students by constantly monitoring and controlling temperature, humidity, lighting, oxygen levels, and sound. The camera feed, conveyed to the AI, enhances context awareness, allowing the system to make smart decisions, like adjusting air conditions on the basis of class occupancy and sending alerts if faculty is absent. The prepped management of learning spaces directly helps enhance student focus, keeping them more engaged in class, and lowering administrative overhead.

Furthermore, the computerized automation system displays how AI can reduce the workload for human personnel as well as increase performance. The system runs unmanned and makes adjustments minute by minute to ensure optimal conditions instead of relying on human observation and tuning. The AI decisions are derived from real-time information, which minimizes slippages and ensures consistency in the classroom conditions throughout the school. This creates a better learning environment, where every classroom is guaranteed to get the same environmental support as any other class.

The use of a centralized dashboard serves to drive the system's practical usefulness further. The faculty and administrators have an easy-to-access and transparent overview of the status of each classroom. The insights generated by these visualizations inform the decision-making process, and alerts ensure that key problems are being dealt with immediately. The dashboard serves an important role by being a bridge between human operators and the AI system, allowing both monitoring and technological assistance when required. It illustrates the human-in-the-loop AI principle, where technology assists but never replaces human judgment.

Blockchain smart contracts are one of the most innovative components of this system as they aid in decision-making and feedback management. Traditional school systems face problems of lack of transparency, manipulation, and difficulty in summarizing data when input is collected from multiple sources. Smart contracts provide a secure and tamper-proof platform for gathering and storing data (feedback and votes). This promotes fairness, as no single authority can manipulate the data or influence the outcome in an unfair manner. A participatory government model is introduced that empowers all stakeholders (faculty, students, administrators) to be active contributors in school decision-making. The feedback analysis driven by AI operates by summarizing the data collected via the blockchain and converting it into actionable insights. This greatly reduces the cognitive load on human decision-makers. It provides significant relief in large school settings where manual review of individual feedback would be impractical. The output that is summarized by the AI is efficient as well as inclusive, gathering collective sentiments while offering recommendations backed by data. There are various challenges faced by this system. The reliability of sensors and the integrity of the data determine the reliability of the system's responses. Faulty readings can lead to inappropriate AI responses. Frequent calibration and sensor drift prevention would help in preventing faulty readings. The AI model should be robust enough to handle scenarios like unexpected inputs and edge cases. There must also be continuous learning; without it, there could be an over-dependency on statistical data. Another important concern is privacy. Stricter guidelines on data usage, storage, and access must be implemented to promote classroom monitoring and transparency. Identities of students and their behaviors must not be misused to ensure trust in the system. Characteristics such as data rectification or deletion, especially under regulations like GDPR, ensure privacy. The AI-based study planning mechanism offers enormous potential to personalize learning from an educational point of view. The system can tailor academic schedules and resource recommendations based on student test scores and performance trends. Weaker students benefit from receiving a better quality of education, and teachers can focus their efforts more on areas that require attention. The quality of the data provided dictates the success of this approach. The recommendations can be less effective if the input data is not accurate. Moreover, logistical constraints such as the availability of faculty and the institutional timetable must be taken into consideration by the system's integration of performance analytics with class schedules. Negotiations are required when the AI suggests optimal subject allocations, as this involves real-world implementation. It is important for a human staff member to finalize the plan while the AI acts as a semi-automated scheduling system to ensure the best balance between adaptability and feasibility. To sum up, the AI-driven school digital twin showcases a promising model for the future of education systems. The strengths of real-time sensing, machine learning, personalized learning, and decentralized governance are combined to implement a single system. The benefits provided by the system, such as improved student outcomes, operational efficiency, and stakeholder engagement, outweigh the challenges, including technical, logistical, and ethical issues. This system can become a cornerstone of smart education ecosystems in the digital age with some refinement. Student classroom movement can also be detected via tools like YOLO object detection.

6. Conclusions and Future Research Scope

The alignment of Artificial Intelligence with school digital twins and blockchain technology yields a turning point in the education system. The efficiency of school functions is boosted with the help of AI through quick and insight-driven decisions such as generating personalized student schedules, adjusting classroom conditions, and analyzing test performances for better learning. The merging of smart contracts allows for fair, decentralized, and transparent feedback handling and decision-making processes. A more intelligent, adaptive, and equitable education environment can be observed as a result. The long-term gains convince us to overlook the challenges faced by this system, such as technological barriers, implementation costs, and public acceptance. An AI-powered school digital twin system can redefine the way schools function through thoughtful planning and strategic execution, which ultimately leads to making it more responsive, personalized, and future-ready in satisfying the changing needs of both students and educators. As AI and blockchain technologies continue to integrate into educational landscapes, it is reasonable to expect that the next round of improvements will center around accessibility, mobility, and security. Ensuring that schools, particularly in low-resource settings, have access to this technology is critical to maintaining an equitable process. Offering teacher and administrator education or training on the use of these tools will be an important step in alleviating learning curve issues that extend beyond simple access. The security of the digital twin must also be improved. Student behavioral patterns and individual monitoring can be introduced to make the digital twin system more effective.

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