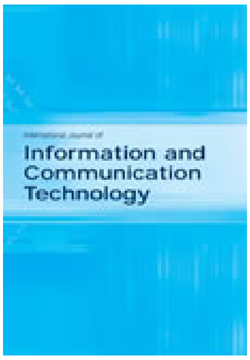

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Design and implementation method of immersive IoT teaching platform based on virtual reality technology

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Design and implementation method of immersive IoT teaching platform based on virtual reality technology

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Abstract: With societal and economic advancements, teaching methods have evolved from traditional single-directional approaches to interactive models utilising diverse online resources. However, certain limitations persist. Addressing these, this paper introduces virtual reality (VR) technology, merging it with internet of things (IoT) teaching platforms to create immersive classroom experiences. By integrating interactive design and learning within surreal VR environments, we establish a novel teaching paradigm. Furthermore, we explore the rationality of interactive design application in teaching. Simulation results demonstrate VR's extensive applicability, offering a broader and more open educational platform. Future endeavours should focus on effectively combining immersive IoT with higher education to enhance educational outcomes.

Keywords: virtual reality; VR; teaching platform; internet of things; IoT; immersive.

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1 Introduction

The internet of things (IoT) technology intertwines with people's daily lives, facilitating data exchange and rapid communication with the environment, driving various industries. Smart cities, for instance, evolve from managing urban traffic flow and addressing social needs. Additionally, the imperative to minimise energy costs propels growth in public infrastructure. Beyond major industries, IoT finds substantial application in diverse fields, fuelling the development of new engineering solutions. Leveraging this backdrop, IoT teaching platforms promote efficient and proactive learning experiences (Zhang, 2021; Heyden et al., 2020; Granjo and Rasteiro, 2018). A prevailing challenge in current professional course instruction is the limited autonomy of students during learning, leading to insufficient flexibility in teaching models and practical content misalignment with industry demands. Practical teaching often prioritises form over instructional objectives, resulting in limited immersion in IoT teaching methods. Typically, practical sessions are scheduled post-theoretical learning and fail to effectively support teaching objectives (Wong et al., 2015; Pembridge and Paretti, 2019). Practical teaching often suffers from high repetition and low efficiency, neglecting individual student growth. Consequently, students lose interest and initiative, becoming disconnected from societal and industrial contexts, hindering the utilisation of their comprehensive capabilities. Traditional education's time constraints limit students' access to teaching resources. However, integrating virtual reality (VR) technology into IoT teaching platforms allows students to optimise their learning time for pre-reading and targeted post-course review, ensuring thorough comprehension. The interactive platform offers cognitive, structural, testing, and training functions. Cognitive functions facilitate resource utilisation through text descriptions and flowcharts. Structural functions demonstrate platform features, while exercise functions support independent knowledge exploration and lectures (Wei et al., 2018; Wang, 2017; Vitayasak and Pongcharoen, 2018). Presently, both IoT and VR technologies are increasingly integrated into teaching, significantly impacting modern education. The internet era's societal shifts have profoundly influenced traditional design education. However, in traditional immersive IoT teaching models, limitations in teaching methods hinder effective student learning enhancement, post-class communication, and skill development. To address current teaching needs, immersive IoT teaching platforms require refinement, leveraging VR technology to optimise resource allocation and enhance teaching quality efficiently. Recent advancements in IoT and VR technologies have revolutionised educational practices, offering immersive and interactive learning experiences. A comprehensive review of the literature reveals a growing trend in integrating IoT with VR to create dynamic educational platforms. However, existing solutions often lack scalability and adaptability to diverse educational needs. This paper addresses these gaps by proposing an innovative platform that leverages the full potential of VR and IoT, providing a more inclusive and effective learning environment.

As technology advances and immersive IoT technology evolves, its applications span various fields, including immersive IoT teaching platforms. However, the need for enhanced security and data protection in these platforms has become increasingly evident (Lin, 2020; Wen and Zhang, 2015). However, the effectiveness of immersive IoT teaching is vulnerable due to potential security risks. Despite the availability of robust hardware for data protection, any software or methodological flaws can expose significant security vulnerabilities. Exploiting these vulnerabilities illegally poses a high risk to the immersive IoT teaching experience. Consequently, research on enhancing the effectiveness of immersive IoT teaching has garnered significant attention globally. Traditional data encryption methods often fall short in addressing these challenges adequately. In contrast, employing bionic intelligent algorithms offers a more comprehensive approach, improving overall performance. Integrated design styles facilitate the creation of user-friendly interfaces, leveraging visual space configurations, colours, design principles, and cognitive styles specific to IoT teaching. This diversified approach to information delivery enhances real-time expression and fosters a more intelligent immersive IoT teaching experience, ultimately enhancing user satisfaction (Zhe et al., 2016; Riera et al., 2015). The integration of IoT teaching inspiration and VR technology within immersive IoT teaching platforms offers a promising approach to enhance IoT teaching quality. This integration leverages the strengths of both technologies, effectively combining them to improve the overall teaching experience. The internet era's societal shifts have deeply influenced traditional online education platforms. In conventional teaching models, limitations in teaching methods hinder effective student learning enhancement and post-class communication, impeding skill development. To address current teaching needs, teaching platforms must be refined, incorporating VR technology. By utilising VR, teaching resources can be distributed optimally, thereby enhancing immersive IoT teaching quality. Moreover, network technology and sensors enable efficient access to business data and information, further enriching the teaching experience.

In recent years, the widespread availability of college education has led to an increase in enrolment, straining teaching resources. Many students lack access to suitable teaching platforms or experimental samples for analysis. Consequently, there's a pressing need for pedagogical and practical solutions to address these challenges. Collaborative innovation emerges as a response to these demands and shortcomings. This paper explores the integration of immersive learning with specific virtual environment teaching, analysing design concepts and implementation methods of IoT teaching platforms using VR technology. Additionally, it delves into the rationality of interactive design in the teaching process to enhance teaching quality, effectiveness, and student engagement, fostering improved performance. To address the concern of high-end hardware requirements for VR technology, the revised platform will incorporate cloud-based VR solutions. Cloud VR allows for the processing power and data storage to be managed remotely, reducing the need for expensive local hardware. This approach enables the use of more affordable VR headsets that can connect to the cloud service, significantly lowering the entry barrier for educational institutions.

2 VR technology

Utilising VR technology within the IoT framework, immersive classroom teaching creates an intellectualised learning environment where teachers and students engage interactively with course materials. By integrating VR, traditional graphics and audio are transformed into immersive content, enabling students to engage with course materials using all their senses. This immersive approach allows students to explore course content from various perspectives, fostering a sense of immersion that enhances motivation and improves teaching quality. To simplify the integration process and ensure seamless communication between IoT devices and VR environments, the platform will adopt a modular plug-and-play architecture. This design allows for easy addition or removal of IoT devices without complex setup procedures. Furthermore, the platform will provide a user-friendly interface and automated tools for handling data streams and synchronising interactions, minimising the technical expertise required for setup and operation. The modular plug-and-play architecture is a game-changer in reducing the technical complexity associated with integrating IoT devices into VR environments. This design philosophy simplifies the process of adding new devices and ensures compatibility with a wide range of IoT hardware. The inclusion of user-friendly interfaces and automated tools further abstracts the underlying complexity, allowing educators and students to focus on the learning experience rather than the technology itself. This approach not only lowers the barrier to entry for institutions but also enhances the platform's flexibility and scalability.

VR technology primarily enhances system stability through the implementation of multiple constraints. The system essentially utilises various functional modules and effectively integrates the structures obtained from each module (Dan et al., 2017; Kaveh et al., 2020). Through the use of the original data samples, the obtained data is fed back to the sample dataset. It is assumed that the individual sample probabilities within the use group can be extracted, which is described as the following:

$$p = (1 - 1/N)^N \tag{1}$$

This paper utilises VR technology in developing an immersive IoT teaching platform, enhancing functional module design through overlay optimisation techniques. This optimisation enhances the accuracy of knowledge identification within the constraint system. Furthermore, the decision tree generation process benefits from parallel processing of individual decision trees, enhancing system efficiency. Evaluation analysis factors relevant to the subject under evaluation are considered as elements, forming an evaluation analysis factor set. This approach facilitates the implementation of an immersive IoT teaching platform design based on VR technology.

The design steps of the immersive IoT teaching platform are divided to obtain the set of evaluation and analysis factors as the following:

$$\begin{cases} U_1 = \{U_{11}, U_{12}, \ldots, U_{1n}\} \\ U_2 = \{U_{21}, U_{22}, \ldots, U_{2n}\} \\ \vdots \\ U_m = \{U_{m1}, U_{m2}, \ldots, U_{mn}\} \end{cases} \tag{2}$$

The method employed in the immersive IoT teaching platform, utilising VR technology, calculates the weights of platform elements using a hierarchical analysis approach (Jamieson and Shaw, 2020; Gadola et al., 2019). The assessment and analysis elements are categorised into multiple levels using a top-down approach. Assessment and analysis criteria are graded based on varying levels and systems, considering the attributes of the objects under evaluation. Comparison of indexes at the same level is conducted, and the results are standardised and quantified according to their relative importance, determining the weights of evaluation criteria for immersive IoT teaching and learning. The specific process is outlined as follows.

Compared with the indexes present in this layer, a determination matrix A is built, and its expression is shown as the following:

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} \tag{3}$$

Normalisation is carried out on the judgment matrix by column as the following:

$$b_{ij} = a_{nn} \Big/ \sum_{i=1}^{n} a_{nn} \tag{4}$$

Normalisation is carried out on the judgment matrix by row as the following:

$$v_{ij} = \sum_{h=1}^{n} b_{ij} \tag{5}$$

As the weights corresponding to the evaluation metrics of immersive IoT teaching, it can be calculated in accordance with the equation as the following.

$$w_i = b_{ij} \cdot v_i \Big/ \sum_{i=1}^{n} v_i \tag{6}$$

The weight vector matrix W is established on the basis of the calculated weights of the immersive IoT teaching platform design indexes.

Based on the collected evaluation and analysis data, the subordination degree corresponding to the evaluation and analysis indexes present in the evaluation and analysis element set can be calculated, and the fuzzy matrix U_{mn} is constructed accordingly.

$$U_{mn} = \begin{bmatrix} U_{11}, U_{12}, U_{13}, U_{14}, U_{15} \\ U_{21}, U_{22}, U_{23}, U_{24}, U_{25} \\ \vdots \\ U_{m1}, U_{m2}, U_{m3}, U_{m4}, U_{m5} \end{bmatrix} W \tag{7}$$

The process of designing an immersive IoT teaching platform based on VR technology is described as the following: it is assumed that S is a collection of $|S|$ student performance data samples. The 'class number' attribute is defined to have n different values, and its n different classes are defined as C_i (i = 1, 2, …, n). Assuming that there are $|C_i|$ samples in the class C_i, and the expected information required to classify a given sample is given in equation (10) as the following:

$$I\left(S_1, S_2, \ldots, S_n\right) = \sum_{i=1}^{n} -p \log_2\left(p_i\right) \tag{8}$$

In the above equation, $p_i = |C_i|/|S|$ stands for the probability of each sample in the class i.

It is assumed that $\overline{\alpha_i} = (a_{i1}, a_{i2}, a_{i3})$, i = 1, 2, …, m stands for the virtual realisation technique. Thus, the non-negative linear combination with the virtual realisation technique planning of $\overline{\alpha_i}$ can be obtained as the following:

$$p_{ij}^{k}(t) = \begin{cases} a \times \dfrac{\tau_{ij}(t)^{\alpha} \times \eta_{ij}(t)^{\beta}}{\sum_{h \in Q}()} \end{cases} \tag{9}$$

In addition, the following can be obtained

$$\sum_{i=1}^{m} \lambda_i \overline{\alpha_i} = \left(\sum_{i=1}^{m} \lambda_i a_{i1}, \sum_{i=1}^{m} \lambda_i a_{i3} \right) \tag{10}$$

The virtual realisation techniques are essentially stochastic plans and the constraints include stochastic parameters. The problem of planning with stochastic parameters and technical parameters of virtual realisation is solved accordingly. This model is in a general form, as shown in the following.

$$\begin{cases} \max_{x} f(x, \xi, \eta) \\ \text{s.t. } g_j(x, \xi, \eta) \le 0,\ j = 1, 2, \ldots, m \end{cases} \tag{11}$$

In the above equation, x stands for the decision vector, ξ stands for the random vector parameter, η stands for the virtual implementation technology vector parameter, $f(x, \xi, n)$ stands for the objective function, and $g_j(x, \xi, n)$ stands for the constraint function.

In the solution of the problem of immersive IoT teaching approach in the application of teaching platform, it is necessary to consider the length of the web platform approach and the concentration of pheromones on the web platform approach for the following client points for the transfer probability of immersive IoT teaching effect k from client i to client j. Among them, j stands for the accessible customer points, and O stands for the immersive IoT teaching effect centre (Adriana et al., 2017; Darya et al., 2015; Rabhi et al., 2021). The probability of choosing the immersive IoT teaching effect k to be transferred from client i to j can be calculated according to the equation in the following:

$$p_{ij}^{k}(t) = \begin{cases} a \times \dfrac{\tau_{ij}(t)^{\alpha} \times \eta_{ij}(t)^{\beta}}{\sum_{h \in Q} \left(\tau_{ij}(t)^{\alpha} \times \eta_{ij}(t)^{\beta} \right)} + \dfrac{\dfrac{b}{|t_{ij} - e_h| + |t_{ij} + l_h|}}{\sum_{h \in Q} \dfrac{1}{|t_{ij} - e_h| + |t_{ij} + l_h|}}, & j \in Q \\ 0, & \text{otherwise} \end{cases} \tag{12}$$

In the above equation, a and b stand for the weighting factors, t_{ij} stands for the time from client i to client j, α stands for the message sending factor. β stands for the expectation departure factor. $\eta_{ij}(t)$ identifies the network platform method (i, j) related to the initiation message value, which is defined as the following.

$$\eta_{ij}(t) = \frac{1}{d_{ij}} \tag{13}$$

In the above equation, d_{ij} stands for the distance between client i and client j.

In the virtual implementation technique, for the purpose of making full use of the cyclic optimal solution and the optimal solution found so far, the pheromone of each immersive IoT teaching effect is updated in each cycle. The rules for pheromone updating are described as the following.

$$\begin{aligned} &\tau_{ij}(t+n) = (1-\rho) \times \tau_{ij}(t) + \Delta\tau_{ij}(t) \\ &\Delta\tau_{ij}(t) = \sum_{k=1}^{m} \Delta\tau_{ij}^{k}(t) \end{aligned} \tag{14}$$

In the above equation, ρ pheromone susceptibility factor stands for a random number between [0, 1], and $1 - \rho$ stands for the residual factor of the pheromone. $\Delta\tau_{ij}(t)$ stands for the network platform method in this cycle (Kaveh et al., 2020; Romero et al., 2020). The increment of the information element above (i, j) has the initial value stands for that the k^{th} immersive IoT teaching effect stays on the web platform method in the loop described above. $\Delta\tau_{ij}(0) = 0\ \Delta\tau_{ij}^{k}(t)(i, j)$ indicates the total amount of the above pheromone.

3 Establishment of immersive IoT teaching platform

The utilisation of an immersive IoT teaching platform allows for a thorough analysis of user demands prior to designing a suitable platform. Currently, many domestic universities face limitations with their network teaching platforms, with students and teachers being the primary focus for improvement. From a teacher's perspective, there's a need for increased time and effort on equipment management and assignment control to ensure practical teaching efficacy. Conversely, from a student's viewpoint, existing teaching platforms often rely solely on textbook content for knowledge dissemination, resulting in a disjointed learning experience with minimal correlation between pre- and post-application scenarios. Such disconnection can dampen students' interest in learning (Wen and Zhang, 2015; Darya et al., 2015). The platform will introduce a tiered subscription model that offers different levels of service based on the institution's budget. This model will include a basic tier with essential VR functionalities that can operate on lower-end hardware, making it more affordable for institutions with budget constraints. Additionally, partnerships with hardware manufacturers can be established to provide educational discounts or leasing options for the necessary VR equipment. Furthermore, traditional teaching platforms typically offer limited functionality, impeding students' innovation and personalisation. Building upon these shortcomings, this paper proposes the design of an immersive IoT development teaching management system. Addressing practical needs, the architecture of the immersive IoT teaching platform is outlined based on VR technology, as depicted in Figure 1. The architectural design of our immersive IoT teaching platform is meticulously crafted to support seamless integration of VR and IoT technologies. The updated architecture diagram (Figure 1) illustrates the interplay between the data information perception layer, the network layer, the platform layer, and the application layer. Each layer is designed with specific functionalities in mind, ensuring efficient data flow and interactive mechanisms that cater to the needs of educators and learners alike.

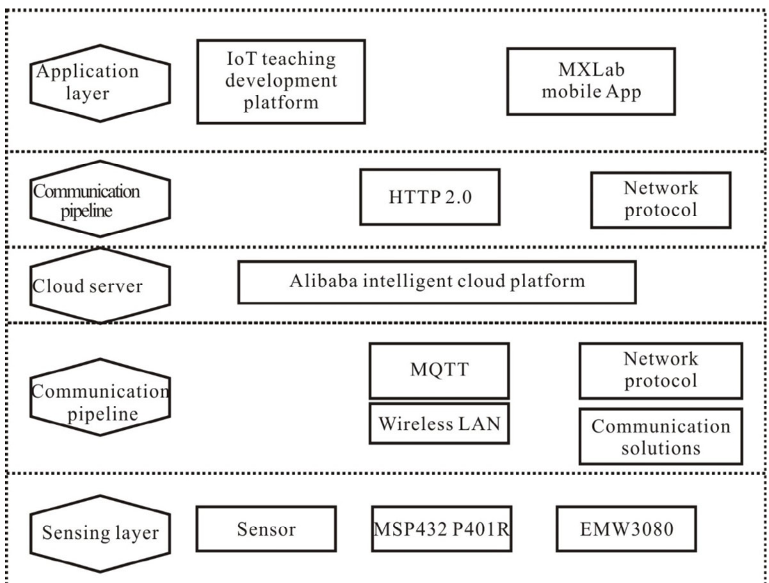
1 The data information perception layer serves to collect data information, allowing students to choose suitable sensors based on their learning needs. Using the main control chip and EMW3080 Wi-Fi module, terminal devices connect to the network. The teaching platform is adaptable to various common teaching controller tool boards such as Arduino and MSP432 P401R, ensuring versatility. During experimental testing, MSP432 P401R serves as the development tool board, with device terminals in the sensory layer employing the MQTT protocol for wireless LAN communication with the teaching platform.

2 The network layer utilises an IoT gateway to transmit data from the perception layer to the cloud, ensuring seamless data transmission. Additionally, it enables the application layer to indirectly control operation status with the perception layer through the gateway, facilitating real-time display of relevant data information based on network management protocols.

3 The platform layer optimises the traditional Internet network structure into a three-layer network structure, primarily based on the HTTP2.0 network protocol. This allows communication with the Alibaba cloud platform and mobile terminals. Implemented through a microservice network structure, the platform offers unified and standardised ports outside the server, facilitating secondary development of the teaching system.

4 The application layer serves to offer interface services to external entities through the teaching platform, while also providing teaching management functionality.

Figure 1 Architecture diagram of the immersive IoT teaching platform



It supports the application of MXLab on mobile devices, creating distinct functional modules tailored to students, teachers, and backend administrators. These modules are customised based on different roles, including corresponding accounts, devices, and data models.

The design of this teaching platform involves different directions of data transmission: data uplink and data download. Data sensors, connected via UART and I2C serial ports, transmit data in JSON format to the EMW3080 module. Using the MQTT protocol, acquired data is sent to the teaching platform. Subsequently, the platform delivers data to user terminals, enabling mobile users to develop personalised learning interfaces tailored to their specific learning needs. Upon receiving data at the user end, the mobile app transmits it to the device in JSON format, facilitating corresponding adjustments.

Upon logging into the teaching platform, users input their account and password on the home page for verification. Different security levels correspond to various operational restrictions on the education teaching platform. Teachers can access teaching data and review students' homework completion post-registration. Students, once registered, can submit assignments and download learning materials multiple times. Teaching platform administrators have access to background data management, including user account information, student post-class message reviews, and other operational functions. The user login verification process is depicted in Figure 2.

Figure 2 Login verification process for users of the teaching platform

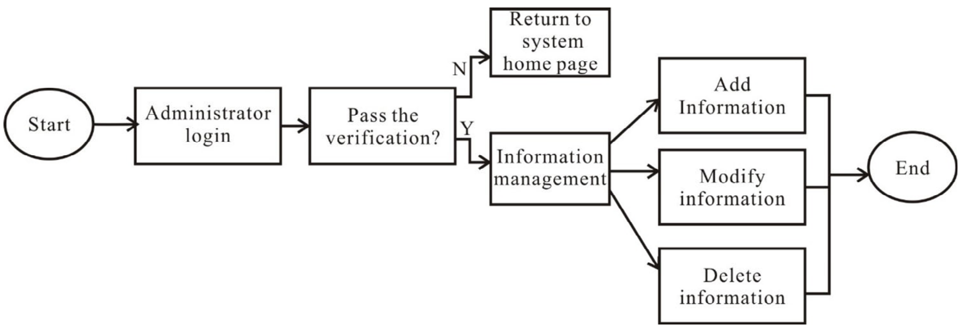
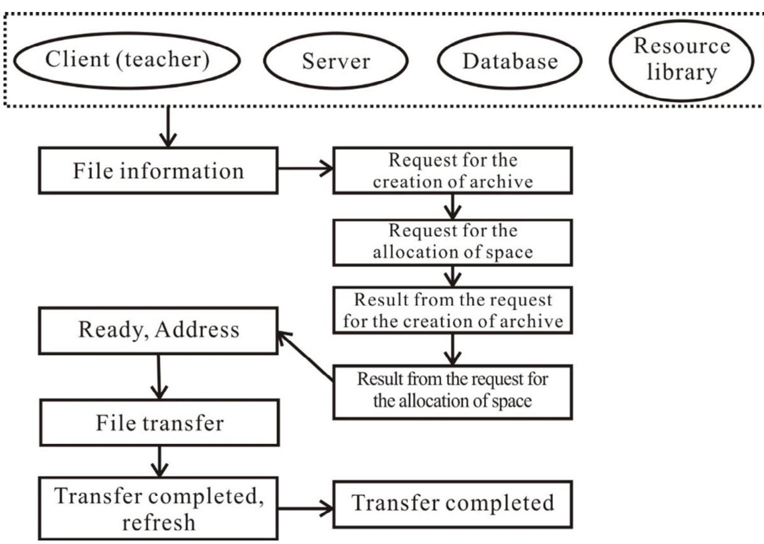


Figure 3 Data resource transfer process



If it is necessary to upload teaching materials, the teachers can click the upload button and select the educational resources to be used in the classroom. The effective transfer and sharing of educational resources can be quickly accomplished. Subsequently, the teaching platform administrator will transfer the data in accordance with the user who uploads the resources, as shown in Figure 3, which illustrates the process of transferring educational resources such as data storage location and data transmission line.

The VR technology applies the experience, information dissemination, and a central title on the basis of various platforms that can significantly reduce computing costs and increase efficiency. Cloud computing can calculate a sorry result. It carries more forms of data information, and such information can be obtained by using VR technology way of information (Martinho et al., 2016; Zolfagharian et al., 2017; Zhe et al., 2016). It can also effectively participate in the operation and calculation of the VR technology approach and share resources. In this way, it allows learners to know the information they want anytime and anywhere. The significance of the VR technology approach is through the rational use of platforms. The application of various network platform companies teaching platform, the user's teaching platform and the intelligent platform of the communication tool build the network platform's use platform jointly. The cloud platform uses sensor information to work, organise, categorise and develop, giving the whole network platform industry and network platform sector favourable and effective scientific data resources to create a comprehensive information platform.

4 Simulation experiment

In this study, three PCs were utilised for testing purposes, with Apache JMeterVersion serving as the testing tool to evaluate the performance of the immersive IoT teaching platform designed in this paper. The polling algorithm, weighted polling algorithm, and virtual implementation technology were compared and analysed. The experiment consisted of two main parts. In the first part, three sets of comparison tests were conducted. The first set involved constructing three thread groups with ten threads each. These tests aimed to assess the platform's performance under varying degrees of system load. The thread groups were assigned different loads corresponding to HTTP requests: 1, 5, and 10. The mean response time and throughput of the platform were then tested. For the second and third groups of tests, the number of threads was set to 100 and 500, respectively, while other settings remained unchanged. The concurrency levels for the three groups of experimental tests were set to 150, 1,500, and 9,000. The experimental results indicated that, under a concurrency of 9,000, the weighted polling algorithm did not demonstrate a competitive advantage over the polling algorithm at lower concurrency levels of 150 and 1,500. However, as the weighted approach aimed for longer computation times, it yielded a better working result when the concurrency reached 9,000. Moreover, dynamic computation, polling computation, and smoothing weighting computation resulted in higher mean corresponding times and throughputs compared to previous results. The proposed VR technique in this study demonstrated higher efficiency and throughput, indicating its ability to achieve desired results in the context of a complex network.

The second part of the experiment involved constructing three thread groups with 2,000 threads each. Different load amounts were applied to HTTP requests, with thread loads set to 1, 5, and 10, respectively. The platform's response time and throughput were separately tested, with concurrency set to 15,000. The test results are summarised in Table 2. Analysis of the experimental results reveals that the application of VR technology to the immersive IoT teaching platform significantly reduces the likelihood of errors in this scenario. Moreover, errors can lead to increased mean response times.

Table 1 Comparison of the experimental results in the three groups

Algorithm	*Number of threads*	*Number of concurrent connections*	*Mean response time/ms*	*Throughput*	*Error rate*
Polling algorithm	10	150	5.67	56.50	0
	100	1,500	110.33	278.87	0
	500	9,000	767.00	320.69	0
Weighted polling algorithm	10	150	7.00	56.99	0
	100	1,500	180.33	167.93	0
	500	9,000	533.00	323.77	0
Algorithm proposed in this paper	10	150	3.00	57.95	0
	100	1,500	74.00	326.17	0
	500	9,000	357.33	468.78	0

Table 2 Comparison of the experimental results in one group

Algorithm	*Number of threads*	*Number of concurrent connections*	*Mean response time/ms*	*Throughput*	*Error rate*
Polling algorithm	2,000	15,000	1,714.33	10,391	0.10
Weighted polling algorithm	2,000	15,000	1,812.00	10,575	0.07
Algorithm proposed in this paper	2,000	15,000	1,654.00	22,552	0.03

In comparison with the traditional teaching platforms, VR teaching platforms can provide learning resources for teachers and students, and schools thus do not need to provide specific experimental specific equipment, resources for teaching, and specific teaching platforms. In this way, teachers and students can implement VR teaching analysis through the network. For the VR technology under the network can make the specific teaching content intelligent and virtualised, so that teachers and students can analyse the course content and realise the interaction between teachers and students. At the same time, on the basis of VR, the traditional perspective of immersive course content analysis can be realised, allowing students to experience specific course content, fully mobilising the students' motivation and improving the specific quality and effectiveness of teaching. The teaching resources of immersive classroom teaching on the basis of VR technology under immersive IoT are very rich, and teachers can use different terminal devices to upload teaching resources to the background of VR classroom. The students can quickly access the teaching resources of the VR classroom through the immersive IoT and can learn independently anytime and anywhere.

To address data privacy and security concerns, the platform will implement robust end-to-end encryption for all data transmitted between IoT devices and the VR environment. Additionally, a clear data usage policy will be established, outlining how data is collected, stored, and utilised. Regular security audits and compliance checks will be conducted to ensure adherence to best practices and regulatory standards. Data privacy and security are paramount, especially when dealing with the vast amounts of data collected by IoT devices. The implementation of end-to-end encryption ensures that data remains secure throughout its lifecycle, from collection to storage and analysis. The establishment of a transparent data usage policy builds trust with users by clearly communicating how their data will be used. Regular security audits and compliance checks further reinforce the platform's commitment to data protection, ensuring that it meets or exceeds industry standards and regulatory requirements. These measures collectively create a secure environment where educational institutions can confidently utilise the platform for immersive learning experiences.

5 Conclusions

With the ongoing advancement of IoT technology, there's a growing recognition of the significance of teaching resources available within educational platforms. However, traditional teaching platforms often fall short in meeting the practical needs of students. Consequently, VR technology has emerged as a solution, extensively integrated into the teaching process to facilitate immersive classroom instruction. By analysing the business logic of IoT teaching platforms, immersive IoT connects with students, transcending traditional spatial and temporal teaching constraints, enabling students to access course content anytime, anywhere. This integration of interactive design and VR technology allows for specific application and interaction design analysis during teaching. Simulation results demonstrate that the immersive IoT teaching platform serves as a VR teaching experience tool, allowing teachers to tailor instruction to students' actual learning situations. This fosters active student engagement and mastery of course content, underscoring the effectiveness of VR technology in enhancing student interest and performance within the immersive IoT teaching platform. As we look to the future, there are numerous opportunities for enhancing our immersive IoT teaching platform. Future research directions include expanding our content library to cover a wider range of subjects, integrating additional IoT devices to enrich the learning environment, and exploring new VR interactions that promote deeper engagement. We also aim to investigate the long-term impact of our platform on educational outcomes and continuously refine our approach based on feedback from educators and learners.

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