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RESEARCH ARTICLE

The Optimization of Digital Art Teaching Platform Based on Information Technology and Deep Learning

YIYING LIU[1,2] AND YOUNG CHUN KO[3]
[1]College of Fine Arts and Design, Hunan City University, Yiyang, Hunan 413000, China
[2]Department of Education, Graduate School, Sehan University, Chonnam 58447, South Korea
[3]Department of Teaching Profession, Sehan University, Chonnam 58447, South Korea

Corresponding author: Young Chun Ko (ycko@sehan.ac.kr)

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ABSTRACT The study aims to improve the daily teaching level of the school and make students enjoy better teaching methods. Firstly, the Internet of Things (IoT) and deep learning (DL) are deeply studied through information technology (IT). Secondly, the calculation methods based on the IoT and DL are analyzed, through which the research model is constructed. Finally, a digital teaching platform is established through the research model to conduct a real-time statistical survey of students and teachers. The results show that students are leading in the daily teaching process. According to the survey results, most students spend 3 to 4 hours in daily extra-curricular learning; 45% of them acquire knowledge mainly through classroom learning, and 23% through online learning. Their main difficulty in learning is learning ability, accounting for 48%. Moreover, it is an energy problem, accounting for 28%. 64% of students are passive learning, far more than 37% of active learning students. This study combines multiple fields across disciplines, such as IT, IoT, and DL. Digital art teaching platforms usually focus on creativity and performance, and combining IoT and DL can provide art students with a more personalized, real-time teaching experience, and promote the cross-application of digital art and cutting-edge technologies.

INDEX TERMS Information technology, Internet of Things, deep learning, digitization, teaching platform.

I. INTRODUCTION

China's education and teaching have been greatly improved under the background of the new curriculum reform, closely related to information technology (IT) development. IT is constantly applied to education and teaching to optimize classroom teaching and promote classroom teaching efficiency [1]. Thereby, the digital teaching platform is gradually replacing the traditional teaching mode to help schools conduct more effective education and teaching. Recently, the research on digital teaching is also constantly improving. Claro et al. pointed out that in recent decades, technological progress wholly changed all the fields of society, comprising teaching resources and methods used in education. Teachers were adapting to and developing the digital skills needed to adopt information and communication technology, and this process must be permanent [2]. Yuan proposed that the construction of digital teaching resources was a crucial means to adapt to the trend of reform and development of the Internet + education and teaching. It can improve the development and sharing of high-quality teaching resources, and promote the comprehensive application of IT to education and teaching reform and implementation. Moreover, it was also an essential guarantee for strengthening the construction of digital teaching resources and networking teaching [3]. In recent years, Lerma et al. proposed that IT was continuously applied in education to improve teaching quality. The flipped classroom teaching mode and digital teaching resource database were widely implemented in practical teaching, and some results were achieved. On this basis, with the course of

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web page design and production as the starting point, the measures to construct a digital teaching resource database based on flipped classroom teaching mode were analyzed, thus enhancing the quality of classroom teaching and students' IT literacy and lay the foundation for their future career [4]. Robinson et al. believed that the rapid development of digital technology had significantly changed how people obtain information, communicate and interact, and exerted a far-reaching impact on the traditional teaching mode. The network teaching assistant platform was different from the traditional one. It was to use network technology to assist traditional teaching, which was an advanced means of digitally integrating teaching resources and improving teaching efficiency [5].

The optimization of the digital art teaching platform has become a research hotspot in the field of education. Liu et al. proposed a video self-supervised learning framework, which employed the relational knowledge among video clips to learn global context representation and recalibrate channel features, providing strong support for visual text correspondence in the digital art teaching platform [6]. Zhu et al. combined the Siamese network and a regional proposal network to achieve accurate and stable tracking of targets in video frames, which was of great significance for analyzing students' learning process in digital art teaching [7]. Furthermore, Yang et al. introduced a Dual-level representation enhancement network (DREN) method for local and global matching between image-text pairs through graph correlation inference and weighted adaptive filtering. This method may be able to match and interact with multi-modal information in the digital art teaching platform [8]. Li et al. 's Multi-scale fine-alignments Network (MFA) focused on exploring the correspondence between multi-scale visual texts, which was expected to help solve the cross-modal differences in the digital art teaching platform [9]. In education, the online public opinion crisis rating method proposed by Meng et al. offered a new idea for realizing the crisis early warning of online public opinion. This method may be applied to the digital art teaching platform to survey student and teacher feedback in real-time [10]. The construction of an online learning platform for middle school students by Chen et al. provided a quality-oriented and interactive reference for designing the digital art teaching platform [11]. Moreover, Xiong et al. showed that using new online psychometric tools for students' psychological counseling might have positive effects, which also offered new possibilities for the digital art teaching platform to provide psychological support for students [12]. Lv et al. used machine learning algorithms to improve the research results of deep learning (DL) denoising autoencoders, providing references for data processing and the security and stability of digital art teaching platforms [13]. Finally, although the industrial dangerous gas tracking algorithm proposed by Lv et al. [14] was not entirely related to the theme of the digital art teaching platform, the research results in parallel optimization framework and energy consumption reduction may give specific references for the optimization and continuous improvement of this platform. The above research work has achieved meaningful results in optimizing and improving this platform, covering methods and technologies in many fields. These results will provide a vital reference for developing the proposed platform and enhancing teaching quality.

To sum up, the development of IT significantly affects the traditional teaching mode, forcing the current teaching environment to make continuous changes. First, the Internet of Things (IoT) and DL computing methods are studied through IT, which models the digital education platform. Second, the digital teaching platform investigates and analyzes the school teaching methods and students' daily learning status. This study aims to establish and continuously improve the digital teaching platform based on the IoT and DL in the rapid development of IT, and improve the teaching quality of the school and the motivation of students' learning through the teaching mode of the digital teaching platform.

Through the application of IT, the digital education platform model has been successfully established, which provides a new way for school teaching. Furthermore, the digital teaching platform deeply understands the students' daily learning situation and school teaching methods, offering a solid basis for further teaching optimization. The study successfully combines the IoT and DL, introduces new technical means for the field of education, optimizes the proposed platform, and promotes the teaching quality of schools. The real-time statistical survey offers scientific data support for schools to understand students' learning status, and provides a reference for teachers to formulate more effective teaching strategies. In addition, the study also reveals students' difficulties in optimizing digital teaching platforms, providing a new perspective for educational improvement. In short, this study is of great significance to optimizing the digital art teaching platform and the progress of the school teaching level. It has positively contributed to the development and improvement of the education field.

II. RESEARCH METHOD

A. DATA PREPROCESSING BASED ON IOT

Data preprocessing based on IoT can first fill in missing values. Some data will be lost during data collection. The data integrity can be restored through the algorithm filling of missing data during data processing [15]. The first method is to fill in the mean, median, and mode. This is relatively simple, and the filled results obtained are often more reliable. The second interpolation-filling method serves the missing value with the average value of the two data before and after the missing value. This method is often more accurate. When $n+1$ groups of data are given, such as dataset $\{(x_0, y_0), \cdots, (x_n, y_n)\}$, inserting missing data by interpolation method is to use Lagrange interpolation polynomial to bring the node in the middle that needs to calculate the data into the equation to calculate the missing value [16]. The equation reads.

$$L_n(x) = \sum_{t=0}^{n} \frac{v_{n+1}(x)}{(x - x_t)\, v_{n+1}(x_t)} y_t \tag{1}$$

$$v_{n+1}(x) = (x - x_0)(x - x_1) \cdots (x - x_n) \tag{2}$$

$$v_{n+1}(x_t) = (x_t - x_0)(x_t - x_1) \cdots (x_t - x_n) \tag{3}$$

x_t indicates the time node; y_t represents the value corresponding to the time node. Missing value filling is quite essential in some studies. When the research data are lost, the method of missing value filling can make the research data complete, and the accuracy is relatively high.

Moreover, some noise data may exist due to lax operation in data collection. Leveraging the capabilities of IoT for data processing can, to a certain degree, mitigate the presence of noise and reinstate the intrinsic regularity of the dataset [17]. One method is to conduct data rule constraints, which can accurately remove the existing abnormal data during data processing. The specific principle is to specify a range of abnormal data according to its nature and then select appropriate values to fill in this range. Thus, the abnormal data can return to normal to the greatest extent [18]. The other method is to fill the missing value through the 3σ principle. Namely, the data are calculated according to the Gaussian distribution, and then the missing value is supplied through the interval distribution [19].

In addition to filling in missing data values, data processing with IoT can also transform data. The first data transformation method is to reduce the data dimension. In other words, a standardization operation after the original data collection, involves data component analysis and down-sampling. The former is the linear computation of high-dimension data to transform them to a low-dimension value [20]. During processing, the data's inherent features undergo decentralization, with subsequent phases involving removing irrelevant data through standard deviation, variance, and diagonalization. Then, the data are processed by orthogonal vectorization. Lastly, the processed low-dimensional data can be obtained by taking the eigenvectors of the first n data groups [21]. The second method is down-sampling, which processes the original high-frequency data to get a smooth dataset [22].

IoT-facilitated data transformation also encompasses the standardization or normalization of data to establish uniformity across distinct variable levels within the dataset, thereby augmenting the velocity of data processing [23]. The first method is to normalize the data to the maximum or minimum. In other words, the original data are linearly calculated and transformed into standard data. This operation is mathematically expressed as:

$$x_a = \frac{x - min}{max - min} \tag{4}$$

$$x_b = \frac{x_a}{a - b} + b \tag{5}$$

max and *min* express the maximum value and minimum value in the dataset. x_a refers to the value obtained through linear change; x_b represents the value of the standard value in the [a, b] interval after mapping. The second is to standardize the 0-means. In other words, it is necessary to subtract the average of the column in which the data is located from the value in the original data, and then divide it by the standard deviation of the column to get the desired standardized value. This method requires the data to obey Gaussian distribution [24]. Its expression is:

$$x = \frac{x - \mu}{\sigma} \tag{6}$$

μ refers to the average value of the column of data to be processed; σ represents the standard deviation of the column to be processed in the original data; x indicates the processed value.

IoT refers to a network system that connects various physical devices and objects via the Internet. It connects and interacts with the physical and digital worlds through sensors, communication devices, and data processing technologies. IoT can offer many beneficial applications in digital art teaching. For example, (1) Visitors can interact with artworks by embedding IoT devices in artworks or exhibitions. For instance, visitors can interact with digital artworks in the exhibition via mobile devices, changing the work's color, shape, or sound. (2) IoT can provide artists with intelligent, creative tools. For instance, a smart paintbrush or drawing pad can capture an artist's movements and gestures through sensors and turn them into digital images. In this manner, artists can create digital art more intuitively and naturally. (3) IoT devices can be utilized to protect and monitor the security of artworks. For example, the artwork's position, environmental conditions (such as temperature, humidity), and vibrations can be monitored in real-time using sensors and cameras. If an anomaly is detected, the system can immediately issue an alert and take appropriate measures to protect the artwork. (4) IoT can connect students and artists in different geographical locations, facilitating remote collaboration and presentation. Through IoT devices and Internet connectivity, students can have real-time digital art creation instruction and communication with remote artists. Simultaneously, the IoT platform can display students' works online to a global audience. A richer, interactive, and innovative digital art teaching experience can be provided through IoT technology to stimulate students' creativity and engagement. IoT can offer intelligent, automated services and functions by connecting and controlling physical devices. IoT can provide students and teachers with a more convenient and personalized learning environment and teaching methods in the education field. The basic architecture of IoT includes four layers, the data sensing layer, network layer, integrated service layer, and interface layer. The data sensing layer is the device of the user end. These devices include mobile phones, wireless sensors, and Bluetooth devices, through which the state of things can be perceived [25]. The network layer is the facilities connected to the network. These facilities share data through which the condition of all items can be perceived. The service layer processes data in the cloud and feeds them to the user's software program. The interface layer allows users to connect with different applications [26]. Figure 1 reflects the basic process of IoT application.

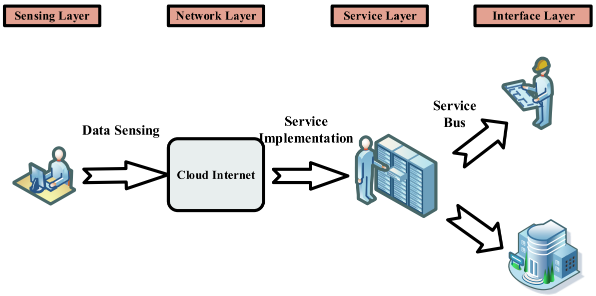

FIGURE 1. The basic workflow of IoT.

In Figure 1, after the user inputs the data, the cloud network processes the data, and then the integrated service outputs and stores the data.

Real-time data on students and teachers is collected, and statistical analysis is performed. For digital teaching platforms, data processing involves multiple data formats. Firstly, data such as students' personal information, academic performance, number of classroom interactions, etc., are stored and processed in a structured format. Secondly, structured data about teachers' instructional chronicles, assessment outcomes, and utilization of pedagogical resources undergo analogous processing modalities. Finally, data fostered through the interaction between students and the platform, encompassing outcomes from online assessments and records detailing students' platform-related behaviors (clicking, browsing, submitting, etc.), are processed as event streams and log files. In addition, the DL algorithm is used to analyze and explore the collected data, facilitating the discernment of distinctive student attributes, behavioral tendencies, and challenges encountered during the course of the learning journey.

B. DEEP NEURAL NETWORK

The Deep Neural Network (DNN)'s basic function is data input, perception, and output. When the neural network processes data, it perceives the input data, divides it into binary for processing, and then outputs the results according to the binary processing [27]. The basic equation reads:

$$\text{output} = \begin{cases} 0 & \text{if } \sum_j \leq w_j x_j \leq \text{threshold} \\ 1 & \text{if } \sum_j > w_j x_j > \text{threshold} \end{cases} \tag{7}$$

$$z = w * x + b \tag{8}$$

$$\sigma = \frac{1}{1 + e^{-x}} \tag{9}$$

w represents a matrix, which refers to all neurons in the output layer; b and σ are the offset and the activation function. The basic architecture of a neural network covers an input layer, a hidden layer, and an output layer. The input layer contains multiple neurons, which can input massive data into the hidden layer simultaneously. The hidden layer is the most complex in the neural network, which includes multiple layers, and each layer contains multiple neurons so that the neural network can process data quickly. The output layer covers only one neuron for data output from the client [28]. The basic architecture of DNN is signified in Figure 2.

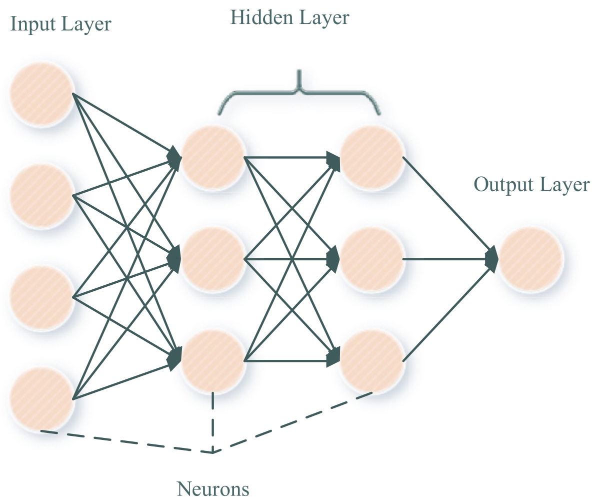

FIGURE 2. The basic architecture of DNN.

Figure 2 reveals that DNN architecture encompasses the middle's input, output, and hidden layers. Multiple neurons are in the hidden and input layers; the neurons in the same layer are not connected, but all neurons in different layers will be connected [29]. The calculation of neural networks follows the binary calculation method. If n groups of data are input, the first calculation can be written as equations (10) and (11):

$$z_i^t = \Sigma_k u_{ik}^t a_i^{t-1} + b_i^t \tag{10}$$

$$a_j^l = \sigma\left(z_j^l\right) \tag{11}$$

u_{ik}^t and z refer to the weight and state of the data; σ means the activation function; a and b indicate the activity value and offset of the data; The second calculation method is to calculate the data cost function. The basic equations are:

$$L(Y, f(X)) = \begin{cases} 1, & Y \neq f(X) \\ 0, & Y = f(X) \end{cases} \tag{12}$$

$$L(Y, f(X)) = (Y - f(X))^2 \tag{13}$$

$$L(Y, f(X)) = |Y - f(X)| \tag{14}$$

$$L(Y, Q(Y \mid X)) = -\log|Q(Y \mid X)) \tag{15}$$

Y and $f(X)$ represent the data's authenticity and decision function; X is the result of the data output. The cost function is extensively used, and its accuracy is also high. Equation (13) is the most widely used, generally regarded as the loss calculation function of data. In calculating the dataset $\{(x_1, y_1), (x_2, y_2), \ldots, (x_n, y_n)\}$, if $\{\hat{y}_1, \hat{y}_2, \ldots, \hat{y}_n\}$ is known, the loss function of the dataset can be calculated [30], as illustrated in equations (16) and (17):

$$F_1(y, \hat{y}) = \frac{1}{2n}\sum_{i}^{n}\left(y_i - \hat{y}_i\right)^2 \tag{16}$$

$$F_2(y, \hat{y}) = \frac{1}{2n}\sum_{i}^{n}\left(y_i - \hat{y}_i\right)^2 + \lambda\frac{1}{2n}\sum_{i} u_i^2 \tag{17}$$

n refers to the number of data in the dataset. This extreme cost loss equation can minimize the empirical risk, which is stable in calculating the loss. Neural network calculation can also feedback the front-end data through the back-end data, and then adjust it to make the final result close to the real value [31]. The calculation is shown in equation (18):

$$\delta_i^T = \frac{\partial c}{\partial a_i^T}\sigma'\left(z_i^T\right) \tag{18}$$

i represents neurons; T indicates the total number of layers of the neural network. δ_i^T refers to the error of data at i neuron, and z is the state of data. The data activity value and weight sum can be acquired after the data error is calculated [32], as indicated in equation (19):

$$\delta^{T-1} = \left(\left(u^T\right)^D \delta^T\right) * \sigma'\left(z^{T-1}\right) \tag{19}$$

δ^{T-1} and u^T represent the error and weight matrix of layer $T-1$ neuron data; z is the data state. The equations for calculating the weight and offset are as follows:

$$\frac{\partial D}{\partial w_{ik}^t} = a_k^{t-1} \tag{20}$$

$$\frac{\partial D}{\partial b_i^t} = \delta_i^t \tag{21}$$

The meanings of specific parameters are the same as those above. The minimum value of the final loss function value will be obtained by calculating weight and offset after several cycles. The recurrent neural network (RNN) calculation method is not much different from that of DNN. The forward calculation equation reads:

$$h_t = f\left(Wh_{t-1} + Vx_t + b\right) \tag{22}$$

W represents the weight matrix of data between hidden layers; V refers to the weight matrix of data between input layers and hidden layers; h_t, f, and b stand for the activation value, activation function, and offset of the data. After the forward calculation, the backpropagation algorithm can also calculate the data loss. Their calculations are expressed in equations (23)–(25):

$$\delta_1 = \frac{\partial L}{\partial o_t}\frac{\partial o_t}{\partial h_t} = U^T\left(\hat{y}_t - y_t\right) \tag{23}$$

$$\delta_2 = \frac{\partial L}{\partial h_{t+1}}\frac{\partial h_{t+1}}{\partial h_t} = W^T\delta_t \text{diag}\left(1 - (h_t)^2\right) \tag{24}$$

$$\delta_t = \delta_1 + \delta_2 \tag{25}$$

$\hat{y}_t$ and y_t are the output and true values of the data; h_t is the active value of data in the hidden layer. U^T means the transposition of data between the output and hidden layers, which refers to the transposition of the weight matrix. W^T represents the transposition of data between the hidden layers.

III. MODELING BASED ON DNN AND IOT

A. MODELING BASED ON DNN

In optimizing the digital art teaching platform, DNN has specific effects such as personalized learning recommendation, learning behavior analysis and prediction, real-time learning assessment, and automated teaching process. These contributions collectively enhance both students' learning experiences and the caliber of instructional delivery. Leveraging DNNs for analyzing and modeling students' learning data facilitates the realization of personalized learning recommendations. Through the DL algorithm, the platform can provide learning content and resources suitable for students' individual needs according to their learning habits, interests, and abilities, thereby augmenting their learning efficacy and contentment. By analyzing students' learning behavior on the platform through DNN, students' learning patterns, preferences, and difficulties can be revealed. These analysis results, in turn, facilitate the delivery of targeted supplementary interventions and personalized learning advisories. Additionally, the DL-based predictive model can predict students' learning progress and forthcoming educational demands, thus enabling timely recalibration of pedagogical plans and allocation of resources. DNNs are instrumental in effectuating real-time learning assessment through the platform. Based on the DL model, the platform can accurately evaluate students' learning advancement and knowledge mastery, and give timely feedback to students and teachers. In this way, students can get timely feedback and guidance, while teachers glean insights into students' learning status, to carry out targeted teaching adjustments and guidance. DNNs can automate some of the tedious tasks and decisions in the teaching process, thus reducing the work burden of teachers. For instance, the platform can leverage the DL model to automatically analyze student assignments and answers and generate automated grades and feedback. Moreover, DNN can automatically create teaching materials and learning resources that adapt to students' levels, improving teaching efficiency and quality. Modeling with DNN includes four steps. The first is the modeling of forget gate. The modeling equation is:

$$f_t^{(l)} = \sigma\left(U_{fx}^{(l)} n_t^{(l-1)} + U_{fh}^{(l)} n_{t-1}^{(l)} + b_f^{(l)}\right) \tag{26}$$

$f_t^{(l)}$ means the data's value in the hidden layer's forget gate; $n_t^{(l-1)}$ represents the output of data in the hidden layer; $U_{fx}^{(l)}$ represents the weight matrix between the forget ate and the previous step; $U_{fh}^{(l)}$ indicates the weight matrix between the forget gate and the previously hidden layer. b and σ refer to the offset and activation function of the data.

The expression of the input gate is:

$$i_t^{(l)} = \sigma\left(U_{ix}^{(l)} n_t^{(l-1)} + U_{ih}^{(l)} n_{t-1}^{(l)} + b_i^{(l)}\right) \tag{27}$$

$i_t^{(l)}$ indicates the value of the data in the input gate of the hidden layer; $U_{ix}^{(l)}$ means the weight matrix between the input gate and the calculation in the previous step; $U_{ih}^{(l)}$ refers to the weight matrix between the input gate and the previously hidden layer. Then, the data status is updated. The specific equation reads:

$$g_t^{(l)} \& = \phi\left(U_{gx}^{(l)} n_t^{(l-1)} + U_{gh}^{(l)} n_{t-1}^{(l)} + b_g^{(l)}\right) \tag{28}$$

$$r_t^{(l)} \& = h_t^{(l)} * i_t^{(l)} + r_{t-1}^{(l)} * d_t^{(l)} \tag{29}$$

$r_{t-1}^{(l)}$ represents the state value of data in the hidden layer, $U_{gx}^{(l)}$ is the weight matrix between the data in the hidden layer and the previous step; $U_{gh}^{(l)}$ signifies the weight matrix between the data in the hidden layer and the previously hidden layer; ϕ is the activation function. Finally, the output gate is calculated as follows:

$$s_t^{(l)} = \sigma\left(U_{sx}^{(l)} n_t^{(l-1)} + U_{sh}^{(l)} n_{t-1}^{(l)} + b_s^{(l)}\right) \tag{30}$$

$$h_t^{(l)} = \phi\left(r_t^{(l)}\right) * s_t^{(l)} \tag{31}$$

$s_t^{(l)}$ means the value of the data in the output gate of the hidden layer; $U_{sx}^{(l)}$ denotes the weight matrix between the data of the output gate and the previous step; $U_{sh}^{(l)}$ represents the weight matrix between the data of the output gate and the previously hidden layer.

B. IOT-BASED MODELING

Modeling is carried out according to the data samples. If the given data samples are datasets $\left\{(x_1, x_2, \ldots x_i, \ldots x_L), y^{(t)}\right\}$, the specific calculation is as follows:

$$\text{loss}(\hat{y}, y) = \frac{1}{2}\sum_{j=1}^{m}\left(y^{(t)} - \hat{y}^{(t)}\right)^2 + \frac{1}{2}\lambda\sum\theta^2 \tag{32}$$

$y^{(t)}$ represents the real value of the data; λ means a data parameter; θ indicates the model parameters. The specific modeling system includes the requirements for students, teachers, and administrators. The basic system of digital education based on IoT is displayed in Figure 3.

Figure 3 reveals that the administrator is the specific operator of the whole digital education platform, and teachers and students belong to the participants of this system. The basic information of teachers and students must be input into the system to improve the platform's structure. In system operation, the administrator must perform specific maintenance and system establishment.

IV. RESEARCH RESULTS

A. DATA PROCESSING BASED ON IOT AND DL

First, IoT is used to process different data. Its outstanding advantage is that it can fill in missing values. Figure 4 portrays the effect comparison before and after missing value filling.

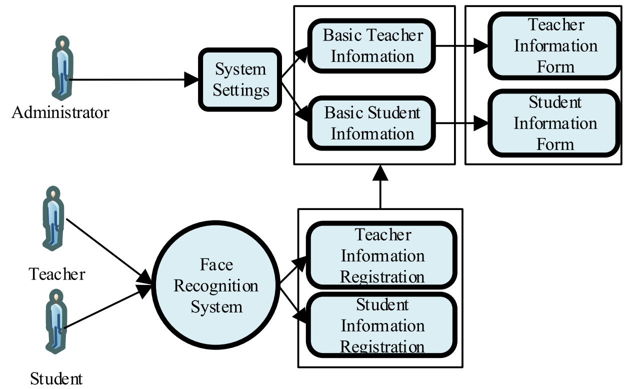

FIGURE 3. System diagram of IoT-based digital education platform.

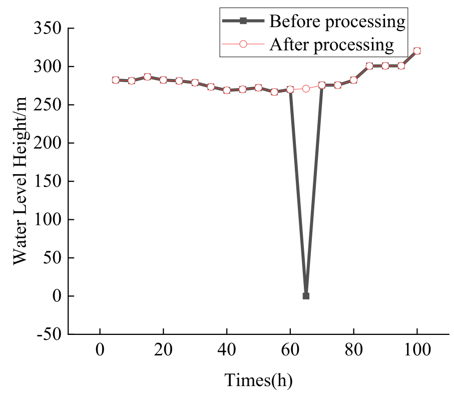

FIGURE 4. Effect diagram of missing value filling.

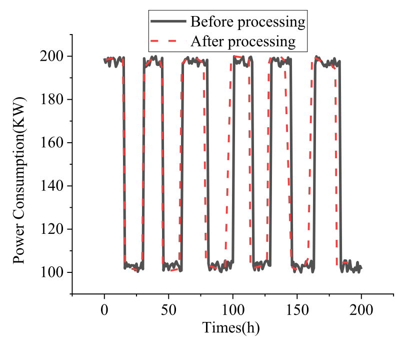

FIGURE 5. Effect of dimension reduction.

Figure 4 reveals a piece of data missing between 3-4 in this data group, resulting in a large deviation in data analysis and an inability to carry out result analysis. After missing value filling, the curve form between data with time between 3-4 and other data fits perfectly. The normal research results can be obtained through data analysis. Moreover, IoT can also process data dimensions. The time data, before and after processing, exhibits a negligible divergence. The value of each time point remains the same before and after the processing, indicating that the processing does not make any changes to the time data. Figure 5 demonstrates the data comparison effect before and after down-sampling.

Figure 5 suggests that too high a frequency of the original data will lead to more nodes in the analysis process, and the gap between nodes is small, often giving rise to substantial complexities in the domain of result analysis. After down-sampling interventions, the data representation undergoes a smoothing process, making the result analysis simpler and more accurate.

B. OPTIMIZATION OF DIGITAL TEACHING PLATFORM BASED ON IOT AND DL

In the digital management system, the information management system of students and teachers should be first established, covering the basic information table of students and teachers. The basic contents of the digital management system are exhibited in Table 1.

TABLE 1. System contents of digital teaching platform.

Personnel	Details
Manager	Information management, System Construction, and Maintenance
Student	Name, Class, Gender, Course, Student ID, Transcript, et al.
Teacher	Name, Course, Attendance, Call Number, Job Title, et al.

Table 1 details that managers, students, and teachers are the three objects to be included in the digital teaching platform. The basic work of managers is the information management of students and teachers and the system's construction and maintenance. The content of students is basic information and performance in school. The content of teachers is basic information and work performance in school. The management and use of digital teaching platforms based on IoT and DL can reveal the students' daily class state and learning performance and reflect the teachers' everyday working state and essential performance, significantly improving teaching transparency and the simplicity of management. The specific performance of students during daily learning is suggested in Figure 6.

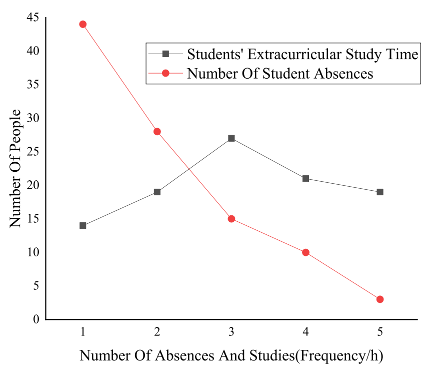

FIGURE 6. Comparison of students' extracurricular learning and absence times.

Figure 6 signifies the statistics of students' daily extracurricular study hours and daily absence times in the digital teaching platform system. The comparison depicts that in daily extracurricular learning, most students focus for about three hours a day, and multiple students study for more than four hours. Nevertheless, there are still lots of students who study for less than one hour. In the statistics of absence times in a month, 1 represents no absence, and 5 means the absence times are greater than or equal to 4. Statistics show that about half of the students have no absence. Employing IoT and DL, the digital teaching platform system can count students' daily performance and their daily learning mode. Figure 7 denotes students' learning styles and the sources of students' learning resources.

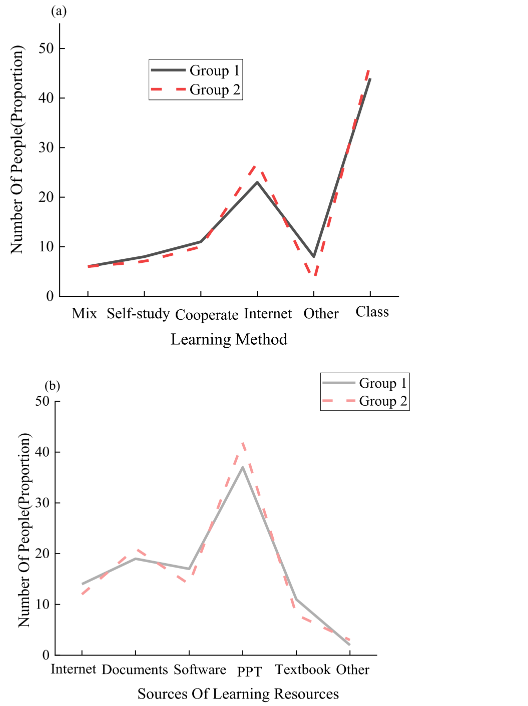

FIGURE 7. Statistical chart of students' daily learning (a: the statistical chart of students' learning methods; b: the statistical chart of the source of students' learning resources).

Figure 7(a) underscores the predilection for classroom-based learning methods, constituting nearly 45% of students' chosen. Simultaneously, network-based learning strategies emerge as the second most prominent avenue, accounting for approximately 23% of students' preferences. Figure 7(b) reveals that teachers' PPT is students' primary learning resource, and other learning sources are similar. It indicates multiple sources of students' learning resources, and the combination of the two groups is the same. In the digital platform, through the statistics of IoT and the calculation method of DL, the information uploaded by teachers and students and the information on daily activities can be analyzed. Besides, the learning difficulties that need to be solved urgently and the learning state in the everyday classroom can also be obtained. Table 2 outlines the challenges faced by students and their learning status.

Table 2 delineates that students face multiple difficulties in learning, affecting their daily learning effect and need to be solved. Among them, students with poor foundation

TABLE 2. Difficulties faced by students and their daily learning status.

Difficulties To Be Resolved	Proportion	Learning Status	Proportion
Learning Target	11%	Proactive	38%
Can Not Understand	1%		
Too Many Courses	10%		
Poor Ability	48%	Passive	64%
No Power	28%		
Other	2%		

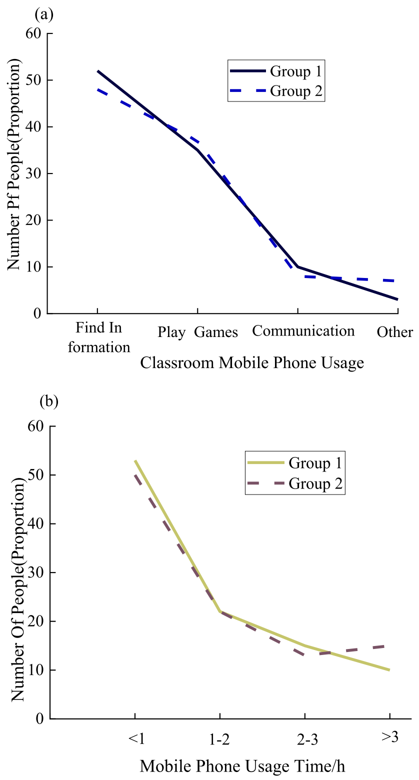

FIGURE 8. Statistical chart of students' daily mobile phone use (a: statistical chart of students' daily classroom mobile phone use; b: statistical chart of students' daily classroom mobile phone use time).

and insufficient ability account for the largest proportion, approximately 48%. Conversely, students encountering difficulties comprehending classroom content are in the minority, accounting for 1%. Moreover, students' enthusiasm for classroom learning can be counted through teachers' daily classroom interactions. Intriguingly, passive learning patterns, indicative of students who exhibit limited retention, command a notable share of 63%, surpassing the active learning contingent of 37%. In addition, utilizing digital teaching platforms can also statistically analyze the students' use of mobile phones in the classroom through IoT and DL calculation methods. The basic situation of students using mobile phones in class is plotted in Figure 8.

Figure 8(a) suggests that in Group 1, 52% of students use mobile phones for finding information, 35% for playing games, 10% for communication, and 3% for other purposes. Group 2 exhibits parallel tendencies, where 48% utilize mobile phones for information acquisition, 37% for gaming, 8% for communication, and 7% for other functions. By comparing the data of the two groups, it can be found that in daily class, students generally use mobile phones to obtain information and entertainment, among which finding information is crucial for using mobile phones. Although the proportion of playing games is also high, their use in communication is relatively low. Additionally, a minority of students use mobile phones for other activities. Figure 8(b) exhibits that many students access data via mobile phones, most confining their usage to less than one hour. Notably, in Group 1, a subset of students employs mobile phones for over 3 hours, while in Group 2, the corresponding timeframe hovers between 2-3 hours. This usage pattern remains largely consistent between the two groups. Furthermore, school managers can also use the digital teaching platform to investigate and count the students' daily class satisfaction through IoT and DL calculation methods to improve the teaching quality and examine the teachers' daily teaching effect. Figure 9 indicates students' satisfaction with teachers' daily teaching and school environment.

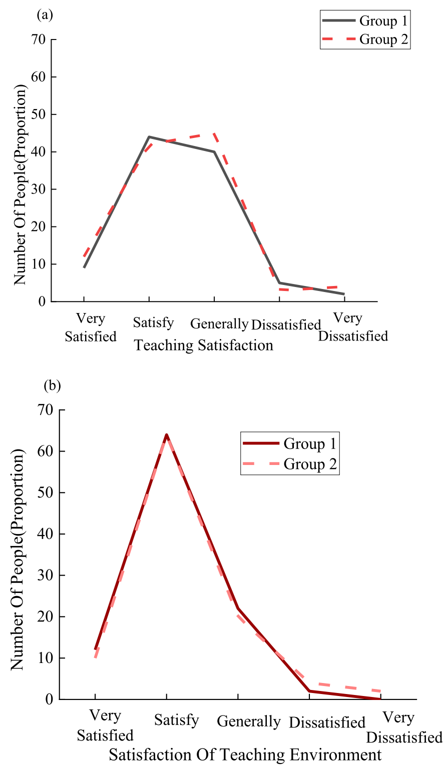

FIGURE 9. Survey of students' teaching satisfaction (a: he survey of students' satisfaction with teaching methods, b: the survey of students' satisfaction with teaching environment).

Figure 9(a) means that regarding teaching methods, most students express satisfaction or general contentment with the employed methods. Both groups exhibit approximately 44% and 42% of students registering the highest level of satisfaction, respectively. Concomitantly, only a few students articulate dissatisfaction or marked discontentment. Figure 9(b) elucidates that in terms of the teaching environment, most students show that they are satisfied or generally satisfied with the teaching environment. In both groups, 64% of students are most satisfied. Meanwhile, only a negligible proportion of students say they are dissatisfied or very dissatisfied with the teaching environment.

V. DISCUSSION

Drawing upon antecedent scholarly investigations, the aforementioned research findings are amenable to further elucidation. Gorbunova et al. explored the behavior and impact of students using mobile phones in the classroom [33]. The findings denoted that students' excessive use of mobile phones in class could potentially negatively impact their academic achievements. Excessive use of mobile phones may distract students and reduce their understanding and participation in class content. This corroborates the present study's findings, revealing that middle school students predominantly employ mobile phones for information retrieval and play games. This may mean students are more inclined to use their phones for personal needs rather than focusing on classroom learning. However, Mercader et al. noted that moderate use of mobile phones may sometimes positively impact students. Using mobile phones to find information can help students obtain more learning resources and knowledge, improving their learning outcomes [34]. Furthermore, using mobile phones may promote students' cooperation and communication. Thus, different mobile phone use behaviors and their potential effects should be considered when developing management measures and teaching strategies. In the study on implementing a digital art teaching platform, Gao et al. suggested applying and optimizing digital technology in education [35]. By building a digital teaching platform, schools and teachers can better understand students' learning, including their mobile phone use behavior. This can provide teachers with information about students' learning habits and engagement to personalize instruction and guide better and support students accordingly to their needs. To sum up, the results of this study are consistent with previous studies by scholars and offer empirical data on students' mobile phone use behavior in the classroom. This provides the basis for schools and teachers to manage and guide the use of mobile phones by students, thus optimizing the teaching environment and teaching methods, and improving students' learning effect and participation.

The IoT and DL are utilized to build a digital teaching platform. Compared with Brain-like Distributed Control Security in Cyber-Physical Systems (BLCS), BLCS primarily concerns brain neural models and distributed control security in cyber-physical systems. Its goal is to achieve the security and robustness of cyber-physical systems by drawing on the principles of the brain's nervous system and distributed control mechanisms. Yang et al. applied brain neural models, developed distributed control algorithms, and employed machine learning and DL methods to deal with security problems in cyber-physical systems [36], [37]. The established DNN model fills the data more accurately based on big data analysis, eliminates the systematic error in the data supplement process, reduces the data sampling frequency, and makes the displayed result curve more smooth and accurate. After establishing a digital education platform model based on neural networks and IoT technology, the results optimized for the digital education platform show that most students spend 3 to 4 hours daily in extra-curricular learning, 45% acquire knowledge mainly through classroom learning, and 23% through online learning. The top difficulty in the learning process is learning ability, accounting for 48%, followed by energy, accounting for 28%. Active learning accounted for 37% of students, and passive learning accounted for 63%, far exceeding active learning students. For students' learning time, learning objectives, learning methods, learning pathways, learning problems, and cause analysis can be counted in the form of data, which has high practical value and theoretical significance in promoting and applying. The proposed methods and models combined with IT and artistic practice allow students to explore new media, technologies, and forms of expression to create more cutting-edge and unique works in the field of digital art. Currently, both the digital arts and IT fields are constantly evolving. Integrating these two fields will not only provide students with an up-to-date education but also produce artists and technologists who are adapted to the needs of the future industry and contribute to the development of the digital art industry.

VI. CONCLUSION

This study aims to study the digital art teaching platform based on IoT and DL from the perspective of IT. The results manifest that the digital technology teaching platform is of great help to the management of the school. During management and improvement, students can also express their dissatisfaction with the current teaching environment and teaching methods through the digital teaching platform, and give feedback to the school and teachers [38]. Then, the adjustment of schools and teachers can improve the deficiencies of schools more quickly and to a greater extent, to make students enjoy a better teaching environment and methods and improve their learning quality. In short, a digital teaching platform based on IoT and DL is the best way to enhance traditional teaching methods. Modern fields such as IT, IoT, and DL offer a variety of tools and techniques [39]. The details and characteristics of students' creative process can be deeply explored. By interconnecting these different fields of knowledge, new possibilities can be opened in digital arts education to provide students with a more holistic, in-depth learning experience. IoT technology enables various devices and sensors to capture and transmit data in real-time. Combining IoT with DL can identify students' drawing patterns, color preferences, creative speed, and more by analyzing large amounts of real-time data. This provides art teachers with deeper insight to help them better guide their students and enable students to understand better and develop their artistic style [40]. It is imperative to speed up its establishment. Although multiple hypotheses of research methods have been made, there needs to be more research on practical application, which does not highlight the advantages of digital teaching platforms to a greater extent. Future exploration will focus on strengthening the valuable application research of digital teaching platforms and improving the construction of the platform.

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