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Retraction

Retracted: Interactive Knowledge Visualization Based on IoT and Augmented Reality

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] H. Sun, "Interactive Knowledge Visualization Based on IoT and Augmented Reality," *Journal of Sensors*, vol. 2022, Article ID 7921550, 8 pages, 2022.

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Research Article

Interactive Knowledge Visualization Based on IoT and Augmented Reality

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In order to solve the integration value of information technology and education, it is mainly reflected in the container for storing and disseminating information, the problem is that learners lack the proper self-learning ability, and the author proposes an interactive knowledge visualization system based on the Internet of Things and augmented reality technology. According to the applicable characteristics of augmented reality technology applied to IoT data presentation and interaction, the method can analyze and describe its application possibility. In the design of interactive electronic technology computer-aided teaching system based on NET platform, the system hardware structure consists of user interface layer, business selection layer, and data management layer. Users such as teachers and students enter their identity information at the user interface layer to log in to the system and enter the business selection layer and click the corresponding program according to their application requirements, the service selection layer transmits the user's selection instruction to the data management layer, and the data management layer selects the corresponding resources according to the user's needs and feeds it back to the user. The interaction of the system is mainly reflected in interactive teaching and information interaction, and interactive teaching is reflected in the online teaching of teachers and students. Information interaction is embodied in the information transmission of the system information interaction model. Experimental results show that after applying the system, the number of students with high self-efficacy increased from 11 to 21 and the proportion increased from 21.4% to 34.8%. The system designed by the author has strong antipressure ability, can respond to the application instructions of a large number of users in real time, and has a good interactive teaching effect, which improves the self-efficacy of students.

1. Introduction

With the development of information technology and the promotion of educational modernization, diverse learning technology tools have been applied in educational fields such as educational technology and learning design [1, 2]. In recent years, under the background of "Internet+education," Internet-related technologies and education have been continuously integrated, and the application of information technology in education has become more and more frequent. However, research shows that the current integration value of information technology and education is mostly reflected in the container for storing and disseminating information, that is, in the teacher-student dialogue structure centered on teachers, equating electronic teaching materials running on learning tools such as tablet computers, digital collaboration software, or online concept maps to the digitization of paper teaching materials and using learning tools as auxiliary teaching aids for demonstrating content in teaching. The Internet of Things has been widely used in many industries, sensing, and collecting a large amount of data all the time. Large-scale IoT systems contain many modules, and each module is provided with diverse information by multiple IoT devices, which makes traditional data presentation methods such as LEDs, meters, and displays incapable of detecting and synthesizing outliers for a large number of devices. To support for analysis, performance evaluation, problem location, etc., it is impossible to freely switch between different fine-grained information presentations, which brings challenges to data monitoring, analysis, and equipment maintenance. It is urgent to support the Internet of Things in a user-friendly way. At the same time, augmented reality (AR) technology has a strong ability to superimpose virtual content on reality. Under such circumstances, it is necessary to explore the use of AR technology to optimize and expand the presentation and interaction of IoT data. Augmented reality (AR) technology is an emerging technology that superimposes computer-generated virtual information into the real world and is an important branch of virtual reality technology. It improves the user's perception of the real world and provides a new way for humans to communicate with the world and has received extensive attention from researchers in recent years.

Although advanced educational technology is used to reinforce the traditional educational model, such a complex and abstract body of knowledge is thrown at students without any division, learning is only seen as the output object of the teacher's external knowledge, tools and people go their separate ways, and learners struggle with heavy low-level thinking activities, and it is difficult to intuitively perceive the essence of things from the metaphorical natural representation to construct the main cognitive schema. The construction of classroom teaching in the future should break the above situation; that is, the application of information technology should reflect the learner-centered constructivist design concept, and the external presentation of knowledge should echo the learner's internal cognitive structure [3–5]. As a new way of integrating information technology and curriculum, visual cognitive tools are used to imitate the thinking process from the aspect of information processing to reduce cognitive load and help learners to process information to build their own cognitive pattern [6]. At present, with the development of information technology, the research on cognitive tools has developed from the initial conceptual exploration stage to the empirical case application research stage based on cognitive tools [7]. As a new medium or knowledge presentation method, most of the knowledge in visualization research does not solve the problem of how to construct knowledge through visualization technology in group knowledge [8, 9]. Visual cognitive tools are the product of the combination of knowledge visualization theory and educational cognitive tools; in education and teaching, visual cognitive tools use its inherent semantic network tools, dynamic modeling tools, and information interpretation tools to realize concrete cognition and visualize the internal knowledge structure of learners; thereby, it has the effect of constructing the cognitive structure scientifically, promoting the explicitness of the invisible knowledge and reducing the cognitive conformity of the learners. However, whether it is the research on the construction of knowledge visualization model or the specific application of visual cognitive tools, researchers tend to explore the application of knowledge visualization technology.

2. Literature Review

At present, in many fields of society, the education field has a strong degree of integration and compatibility with the NET platform [10]. The integration of the NET platform and the computer teaching system has greatly improved the teaching effect of the school, solved the problem of "difficulty in hands-on" for students, lowered the threshold for students to learn knowledge, and promoted the innovative development of the teaching system [11]. With the popularization of information technology education, there are more and more types of educational technology tools; however, some studies have shown that the integration value of information technology and education is mainly reflected in the container for storing and disseminating information, and learners lack the ability to learn independently [12]. The construction of classroom teaching in the future should reflect the learner-centered constructivist design concept, and the external presentation of knowledge should echo the learner's internal cognitive structure [13, 14]. In the past, traditional classroom teaching was mainly conducted by teachers in front of the blackboard, which not only limited the classroom time but also had poor interaction between teachers and students, and students' learning enthusiasm was low, Exploring methods to improve teaching quality through online interactive teaching and making effective eduacational resources play a full role are problems worth thinking about at the moment.

The essence of knowledge visualization is a graphical process for interaction and negotiation among group members and the interaction and mutual transformation of explicit knowledge and tacit knowledge, which is the aggregation of group thinking and structural cognition [15]. However, in the interpretation, construction, and development of group knowledge, knowledge visualization has not effectively solved the problem of how to better represent prior cognition through visualization for group knowledge construction; for teachers and students, knowledge visualization is only regarded as a new medium or a way of presenting knowledge, and new research needs to be carried out based on this. The role of cognitive tools is to refer to technical tools that can build contexts shared by multiple people to facilitate interactive behavior among learners; that is, with the help of the sharing and intercommunication technology of knowledge technology tools, learners can realize the linkage of self-constructed knowledge among learners through interactive behaviors such as "knowledge sharing," "conflict of opinions," "negotiating knowledge," and "reaching consensus" and construct a trinity of classroom technology learning environment of "learner group-technology tool application-classroom subject" [16, 17].

NET platform can be understood as a bridge between contacts, information, and related devices [18]. Microsoft.-NET is also known as the Microsoft XML Web service platform. This platform ensures that the system realizes communication, interaction, and information sharing based on the Internet, regardless of whether there are differences in operating systems and programming languages. XML Web services can enable applications to communicate and share data in the Internet [19]. From the user's point of view, the .NET platform is transparent. Users only need to input applications and commands, and the program will run quickly and respond to the user's operating instructions. There is no threat to the .NET platform due to time, space, or external environmental factors, the operation is simple, and the data processing performance is excellent. The author designs an interactive electronic technology computer-aided teaching system based on .NET platform, in order to realize the interactive electronic technology computer-aided teaching.

3. Methods

3.1. Design of Interactive Electronic Technology Computer-Aided Teaching System

3.1.1. System Hardware Design. The interactive electronic technology computer-aided teaching system based on the NET platform belongs to the Web application program of Microsoft.NET, and the system structure uses the B/S mode, which can reduce the development cost [20]. The user login interface of the system is the same; through a simple login method, users with different identities can enter the system at different locations with user names that match their identities. Under normal circumstances, the client does not need to install other software, it can be used only by installing a browser, the connection between the server and the client is reduced, the danger of using program codes is reduced, and it is beneficial to the security of the system database.

The interactive electronic technology computer-aided teaching system based on the NET platform is composed of a three-layer structure system, followed by the user interface layer, the business selection layer, and the data management layer. Users such as teachers and students can enter their own identity information at the user interface layer to log in to the system and enter the business selection layer [21]. Teachers, students, and other users can click on the corresponding program in the business selection layer according to their own application requirements, and the business selection layer transmits the user's selection instructions to the data management layer. The data management layer selects the corresponding educational resources to feed back to the user according to the user's needs.

3.1.2. User Interface Layer. The user interface layer is mainly used to manage user information and provide human-computer interaction functions for users and systems [22]. Among them, the user registration module, login module, and management module are included. When a user registers, real-name authentication is required; after the user registers the information, the user information is stored in the data management layer of the system. The user login module has two units: front and back. The front unit is the user login interface; the user enters his identity information in the program of the login interface and then clicks the submit button to enter the service selection layer of the system. The backend unit uses .NET technology to respond to user operations and verifies the correctness of the user's input identity in a timely and rapid manner according to the .NET form verification plug-in, so as to avoid theft and intrusion by illegal users. The user management module provides users with functions such as modifying and viewing user information. There are three identities of teachers, students, and system administrators in the user interface layer, among which the system administrator has the right to manage the identity information of teachers and students.

3.1.3. Business Selection Layer. The business selection layer is set between the user interface layer and the data management layer and belongs to the middle layer of the system [23]. The business selection layer includes functions such as teaching and learning, self-assessment, questioning, assignment, and resource management. When the user enters the service selection layer from the user interface layer, the user can click the corresponding program according to their needs, and the service selection layer transmits the user's selection instruction to the data management layer. The business selection layer mainly completes the efficient access to the data management layer through .NET technology [24]. There are certain differences in the selection of services by users with different identities; taking the resource management function as an example, the schematic diagram of the teacher applying the resource management function in the service selection layer is shown in Figure 1.

In Figure 1, the teacher enters the user name and password at the user interface layer and enters the system service selection layer and enters the resource channel at the system service selection layer; in the resource channel, you can select courses or modify courseware according to your own needs, and you can also upload the courseware to the course resources for subsequent application [25].

3.1.4. Data Management Layer. The data management layer belongs to the core of the system, and the relationship between different data tables in the data management layer fully reflects the relationship between the applications in the overall system. The data in the data management layer belongs to teaching resources; after obtaining the program selection instructions of the business selection layer, the data management layer selects the corresponding educational resources according to the user's needs and feeds it back to the user. There are 12 tables in it, in the following order: user table for saving user information, department table for saving department information, course data table for saving course data, announcement of the information table used to save announcement information, courseware table used to save courseware, homework table used to save homework information, online communication table used to save the interactive information of online communication, user response information table used to save the user's response information, users select courses table used to save the user's selection of courses, user log in information table for saving user login information, operational history information table for saving user operation history information, and online exam question table for saving online exam questions.

3.2. System Interactive Design. System software design mainly revolves around interactive design, which is mainly reflected in interactive teaching and information interaction.

3.2.1. Interactive Teaching. The interactive teaching use case diagram of the interactive electronic technology computer-aided teaching system based on the NET platform is shown in Figure 2.

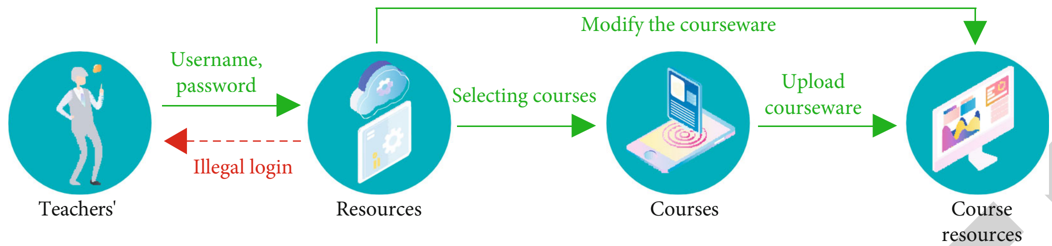

Figure 1: Schematic diagram of the resource management function of the service selection layer.

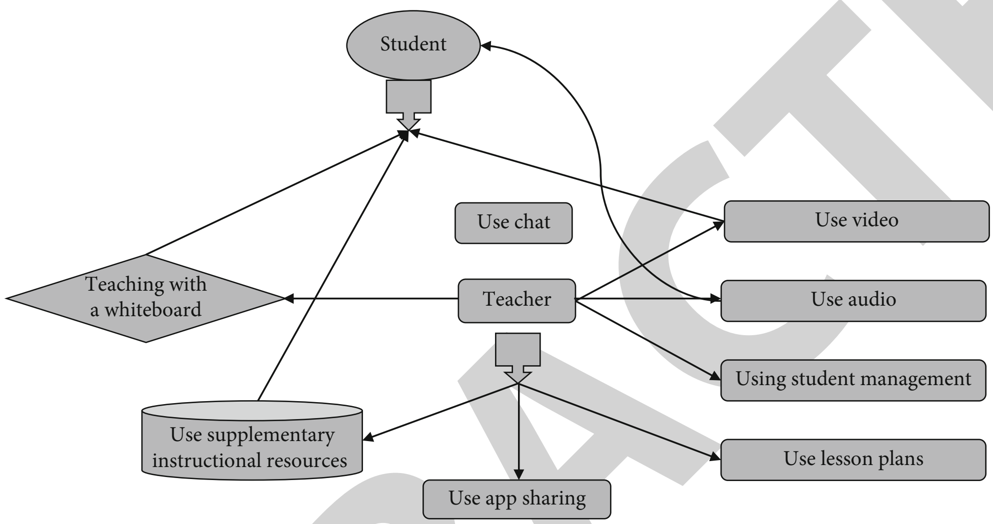

Figure 2: System interactive teaching use case diagram.

The interactive teaching use case diagram describes the interactive teaching function of the system. As can be seen from the use case diagram, teachers share through chat tools, video, audio, student management, lesson plans, program sharing, auxiliary teaching resources, and whiteboard teaching realizing interactive teaching with students. The most direct interactive communication method between students and teachers is the chat tool. Students are the recipients of interactive teaching.

3.2.2. Information Interaction. The data generated by IoT devices has the characteristics of real time. Combined with the support of AR technology for real-time natural interaction, it opens up new possibilities for more intuitive and panoramic data analysis and interactive behavior. Through the nature of AR superimposing virtual content in the physical space, it will be possible to realize the seamless integration of the two aspects of interaction based on the physical device and the AR device and provide real-time feedback on the results of the interaction, providing invaluable information for detection and analysis operations in complex systems or lack of support. At the same time, interaction can also provide important contextual information for IoT data presentation and provide an important basis for data screening. The interactive electronic technology computer-aided teaching system software program based on NET platform includes interactive management server, database server, Web server, and node program. The interaction management server is mainly used to assist and manage the information interaction between members and groups in the study group; its functions mainly include the following aspects:

Course group management: for example, user login, registration, logout, and user identity management

Control information release: add and remove study group member information and stop course management

Discussion management: transfer the discussion information uploaded by each user to the clients of different group members

The functions of the node program include the following: acquisition and recovery of video and audio data, compression and decompression, and acquisition and transmission; group members apply for the transmission of learning information; group member information management; and transmission of learning information under text discussion.

Based on the above analysis, the information interaction model of the interactive electronic technology computer-aided teaching system based on the .NET platform is shown in Figure 3.

As can be seen from Figure 3, the information interaction between the interaction management server and the nodes is mainly realized through the UPD/TCP hybrid connection mode and the TCP connection mode.

3.2.3. Data Association. The AR-based IoT data presentation has spatial integration capabilities, distance-based information screening capabilities, and diverse information

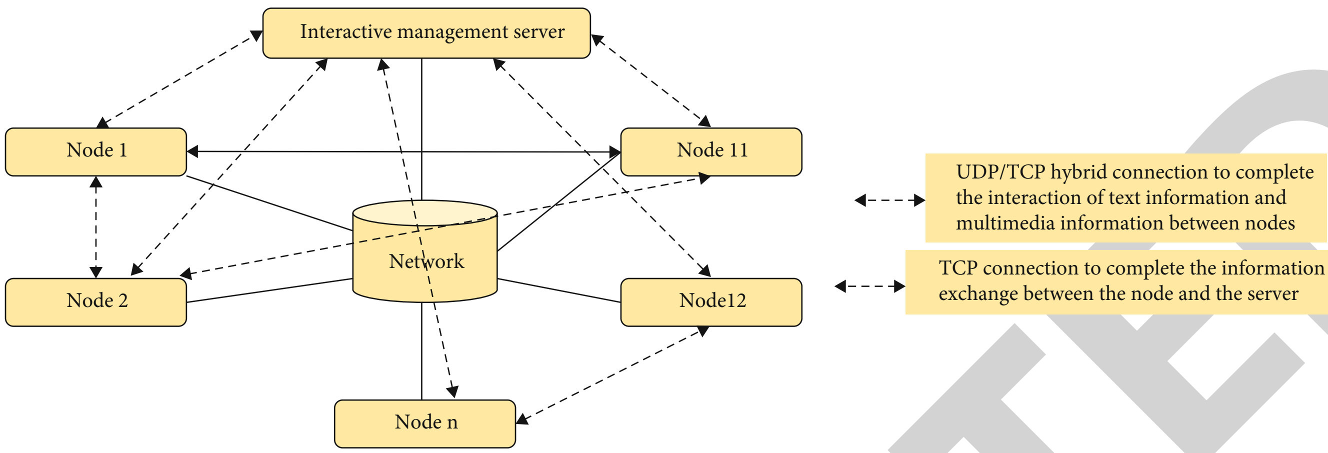

Figure 3: Information interaction model.

presentation methods, which can support the overlay presentation of IoT device data in complex systems with its related data, historical data, and reference data, and supports switching between different fine-grained freely, making it possible to associate data with multidimensional and multilevel of detail.

(1) Presentation of linked data: by analyzing the correlation of data (input and output relationship, influence relationship, similar relationship, etc.), comprehensive parameter input, device connection, etc., to present the relationship between data, a single data can be placed in its environment to assist in making changes and accurate judgment

(2) Control presentation: the historical data and indicator data are superimposed on the data presentation of the concerned equipment and its associated equipment to support on-the-spot comparative analysis of the current data

(3) The associated presentation with global data: correlate the presentation of local data with the visualization of global data to provide context for local data analysis

3.3. Key Technologies of Augmented Reality Technology. Augmented reality technology is developed on the basis of computer graphics, computer image processing, and machine learning. It superimposes the entity information originally in the real world into the real world through some computer technology to be perceived by human senses, so as to achieve a sensory experience beyond reality. In order to enable users to interact with virtual objects, augmented reality systems must provide high frame rate, high resolution virtual scenes, tracking and positioning devices, and interactive sensing devices.

As an immersive learning method, augmented reality technology can integrate rich resource information and other data into the real scenes that users can observe, provide teachers and students with an immersive learning environment, stimulate students' interest in learning, and increase subjective positivity. At the same time, augmented reality technology can build and display the three-dimensional model of the target object, and students can enhance their understanding of the target object by observing the model from different perspectives and interacting with the virtual model. In addition, the real-time interaction of augmented reality system weakens the limitation of location and space. Teachers can guide students in class or remotely, which makes up for the lack of equipment in the real environment and realizes resource sharing.

3.4. System Test

3.4.1. Module Function Test. Take the students of a certain class of senior two in a university as an example, applying the system in the information technology course of this school; when students and teachers enter the system through the user login interface, set up six module functions: user management, administrator authority test, student self-learning, student courseware application, teacher course management, and teacher Q&A interaction; test whether the corresponding module functions of this system are effective. The test results are shown in Table 1. According to the test results in Table 1, the application results of the system for six different functions are consistent with the ideal effect, indicating that the module function validity test of the system has passed.

3.4.2. Interactive Test. The interactive test is mainly tested from two aspects: one is human-computer interaction, which is reflected through the user login system, and the user can access the system according to the login interface. The second is the interactive teaching between teachers and students; the author takes the students submitting the answer board and the teacher receiving the answer board and replying as an example and verifies system interactivity. When the students submit the answer board in the system, the teacher can reply to the questions raised by the students online, which shows that the system has better interactivity.

Table 1: System module functional test results.

System module function settings	Ideal effect	System application results
User management	If the user login information is incorrect, it will prompt	The desired effect
Admin privilege test	Editing user information for students and teachers	The desired effect
Student self-study	Select the courses you need to study, take exams, etc., and upload the exam papers independently	The desired effect
Student courseware application	Students can choose their own courseware to realize online learning	The desired effect
Teacher course management	Teachers can edit the relevant content of their own courses	The desired effect
Teacher Q&A interaction	Teachers can respond online to questions uploaded by students	The desired effect

Table 2: System stress test results.

Test process	Operation content	Input	Server details	Test results
1	Start the system			
2	Log in			
3	Set Stresstesting, click Start	Number of threads 110	Access is successful	No exception occurred
4	The first test, set Stresstesting	160 threads	Access is successful	No exception occurred
5	The second test, set Stresstesting	Number of threads 210	Access is successful	No exception occurred
6	The third test, set Stresstesting	Number of threads 260	Access is successful	No exception occurred
7	Stop test			

4. Results and Discussion

Since the user role of the system is not only a student, the permission settings are diversified, and the data processing volume is also huge. When students and teachers use the system to teach interactively, use Microsoft Web Application Stress Tool as a test tool, set the number of threads to 50, and the number of threads reflects the details of the amount of data processed by the system; the system was stress tested and the results are shown in Table 2.

Self-efficacy is used to describe the control effect of students on their own behavior, reflecting students' autonomous learning ability. In this subsection, the number of groups with high self-efficacy, the number of groups with general self-efficacy, and the number of groups with low self-efficacy are used to describe the application system, whether the interactive learning style of students and teachers has a positive impact on students; the results are shown in Figure 4.

As can be seen from Figure 4, after the application of the system, the number of students with high self-efficacy increased from 11 to 21, and the proportion increased from 21.4% to 34.8%; it can be understood that the application of the system has increased the number of people with high self-efficacy. The number of students with general self-efficacy and the number of students with low self-efficacy decreased slightly, indicating that after the application of the system, the interactive teaching method improved the self-efficacy of students, the students' autonomous learning ability was greatly improved, and the system application effect is better.

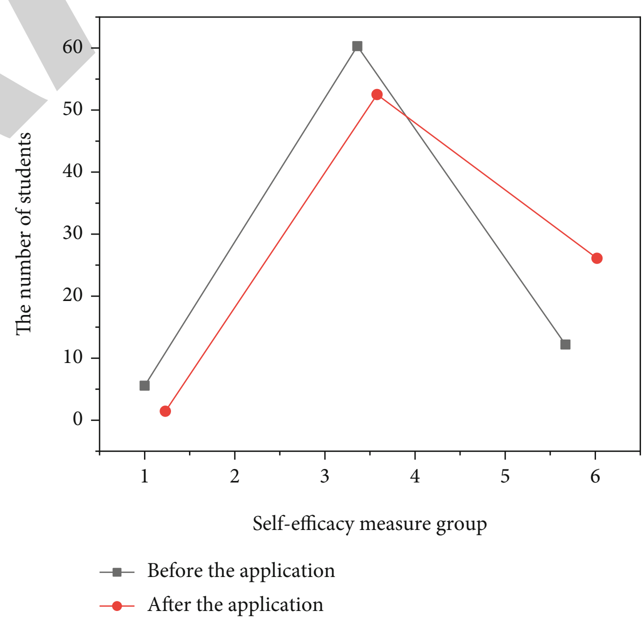

Figure 4: System application effect test results.

5. Conclusion

This paper proposes an interactive knowledge visualization based on the Internet of Things and augmented reality technology. With the maturity of information and communication technology and the rapid development of the Internet, the intelligent, interactive, and integrated education management is the core direction of the current education system research and development field. This paper designs an interactive electronic technology computer-aided teaching system based on NET platform. The hardware structure of the system is composed of a user interface layer, a business selection layer, and a data management layer. Teachers, students, and other users enter their identity information at the user interface layer to log in to the system and enter the business selection layer and click the corresponding program according to their application requirements. Select the corresponding resource to feed back to the user. The interaction of the system is mainly reflected in interactive teaching and information interaction. Interactive teaching is embodied in the online teaching between teachers and students; information interaction is embodied in the information transmission of the system information interaction model.

For the environment where the Internet of Things has been widely used, AR technology can be integrated into the production, use, and maintenance process without making changes to the existing infrastructure or only adding identification marks, camera equipment, etc. and presenting data and data analysis results. This provides important assistance; by applying collaborative operation in a distributed IoT environment, it can break through the barriers in space and reduce the time and labor costs of collaboration; for hard-to-reach and high-risk environments, it can also provide intuitive and effective remote enhancements and remote operation. Augmented reality technology has broad application space in Internet of Things data presentation, data association, data interaction, data simulation, remote enhancement, collaborative operation, etc. More diverse forms of presentation and interaction help to build a more intelligent and easy-to-use IoT system.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The author declares no conflicts of interest.

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