Design and Optimization Method of Computer-Aided Teaching System based on Virtual Reality

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Abstract. With the continuous development of computer-aided teaching technology, computer-aided teaching has been popularized and applied in more and more colleges and universities. Restricted by the limitations of the traditional computer-aided teaching system, the system has multi-dimensional limitations of time and space. The system cannot provide targeted auxiliary teaching for students with different learning abilities. In this paper, based on virtual reality technology, the design of computer-aided teaching system is carried out. The content of the design includes the selection of servers and peripheral devices. Carry out the development and design of software based on virtual reality technology such as computer-aided teaching display and student learning behavior evaluation. Compared with the traditional system, the system has many advantages. The content includes multi-dimensional application value such as more correct allocation of teaching resources, stronger pertinence, and more application value. By analyzing the development and characteristics of computer-aided teaching, this paper deeply studies the technical foundation of computer-aided teaching. In the specific practice work, the virtual reality technology is introduced into all aspects of the computer-aided teaching work. Through the development and construction of the system, improve the teaching quality of colleges and universities, and provide corresponding reference for the computer-aided teaching of colleges and universities.

Keywords: virtual reality; computer; aided design; teaching system
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1 INTRODUCTION

Virtual reality technology has a wide range of applications and high comprehensive application value. The development of its core technology is directly related to many application fields. From the 1930s to the present, virtual reality technology has gone through four stages of development: concept germination, technological exploration, breakthrough development and industrial application. As a key technical support, Zhang et al. [1] believed that this technology can be equipped with software and hardware, and can construct different immersive virtual reality systems according to requirements. Li and Li [2] believed that the technical solution of virtual reality can be suitable for many fields such as national defense and military, education and training, medical care, industrial manufacturing, entertainment and culture. Although in the current environment, the development of virtual reality technology faces many problems such as security, system and technology. However, this emerging technology has great potential for competition, and its application fields will continue to expand in the future. Li et al. [3] believed that virtual reality technology has developed rapidly in recent years, and this emerging technological innovation has become a focus of attention from all walks of life. Low-cost consumer-grade virtual reality products have emerged in recent years. This product brings virtual reality technology to the market quickly. This technology has been deeply developed and applied in various industries such as medical, manufacturing, and military. Shan and Sun [4] believed that this core technology is highly malleable, and the technology has a wide range of applications. In the process of continuous development, virtual reality technology gradually improves and evolves, and may become an important cornerstone of technological innovation in the next era. The research on virtual reality technology in western society started earlier, and their understanding of virtual reality technology involves various aspects such as technology, system and application development. The research of virtual reality technology originated from computer graphics and has now been extended too many disciplines such as simulation and sensing. Pratticò et al. [5] believed that virtual reality relies on three-dimensional head-tracking display technology, as well as body-tracking sensing technology. The superimposed application of these technologies brings users an immersive multi-sensory experience. Some scholars believe that with the help of specially designed sensors, users can interact with three-dimensional images. By further manipulating virtual objects, the system enables users to perceive a virtual environment equivalent to the real world. Qin et al. [6] believed that computer-assisted teaching is the completion of various teaching activities by teachers with the assistance of computer technology. Teachers and students conduct discussions on teaching content, class schedules, teaching training and other teaching links. Specifically, the theory of computer-aided teaching is a teaching method that completes interaction and communication in the form of dialogue. With the continuous progress of modern science and technology. Shadrina et al. [7] believed that the computer-aided teaching technology has been comprehensively applied with the help of various multimedia technologies. Since the popularization of virtual reality technology in 2016, virtual reality technology has been explored in different fields. Mokni et al. [8] believed that we investigated the application effect of this technology in different fields, and found that there is still a big gap between the application of education in virtual reality technology and entertainment. Through the application of virtual reality technology, the development difficulty and technical bottleneck of computer teaching application can be solved continuously. In order to solve this problem, the project team designed an Internet-based virtual reality computer-aided teaching system. The system is divided into two parts: teacher side and student side. Among them, Malagnino et al. [9] believed that the teacher side integrates the virtual reality courseware writing system, virtual reality tool components and courseware cloud. These modules are integrated and packaged together to share with users, realizing the combination of virtual reality technology in the process of making and uploading teaching courseware. With and Govert [10] believed that the student port integrates the courseware playback system of virtual reality technology, the courseware cloud reading system and the courseware cloud evaluation system.

This system provides teachers with a courseware-based cloud writing system, which is even more convenient and easy to use than the graphical interface. The teacher terminal and the student terminal can be connected through p2p to form an online virtual reality technology interactive multimedia classroom system. The system realizes online situational teaching based on virtual reality technology. The student side can also use the system alone to download and use the virtual reality technology courseware. The system can realize the situational teaching of virtual reality technology that breaks through time. Virtual reality technology has the characteristics of immersion, interaction and creativity. This characteristic advantage is unmatched by other auxiliary teaching modes. The system builds a virtual reality computer-aided teaching system for teachers to help the development of more virtual reality technology courses. The system also brings a better user experience to the dissemination of online interactive courses.

1.1 Review of Application Scenarios of Virtual Reality Technology

In terms of teaching mode, computer-assisted teaching has formed a greater impact and challenge on traditional education. This teaching mode has gradually become an important source of practice and application in the current emerging teaching mode, thereby realizing a new teaching mode and method. In order to make the content of the computer-aided teaching system more vivid, this paper proposes a system that integrates virtual reality technology and computer-aided teaching. This system improves the quality of teaching through an intuitive form of expression, combining virtual reality technology with computer-aided teaching. The construction of the system can gradually discover the computer-aided teaching mode based on virtual reality. This teaching mode can be further applied in the field of computer pedagogy. This system design mode breaks the constraints of time and space, and provides a broader teaching field for students' education. In addition, through the means of virtual reality and virtual reality, it provides a new teaching form for computer-aided teaching. In this paper, based on virtual reality technology, the research and design of computer-aided teaching system is carried out, and computer-aided teaching is introduced into a higher and farther development platform, and the work of computer-aided teaching is effectively improved. Virtual reality technology equipment can perceive various feedback methods such as user position input, handle key input, and voice input. Feedback to users through hardware HMD. The system software is designed in C# language based on the Unity physics engine. Through the virtual reality technology equipment, the teacher client is the host and the student client is the client, so as to realize the communication between the P2P system and the client. In addition, the system provides users to upload and download courseware and models by setting up a server as a material library. The Modular Design Framework of Virtual Reality System is shown in Figure 1.

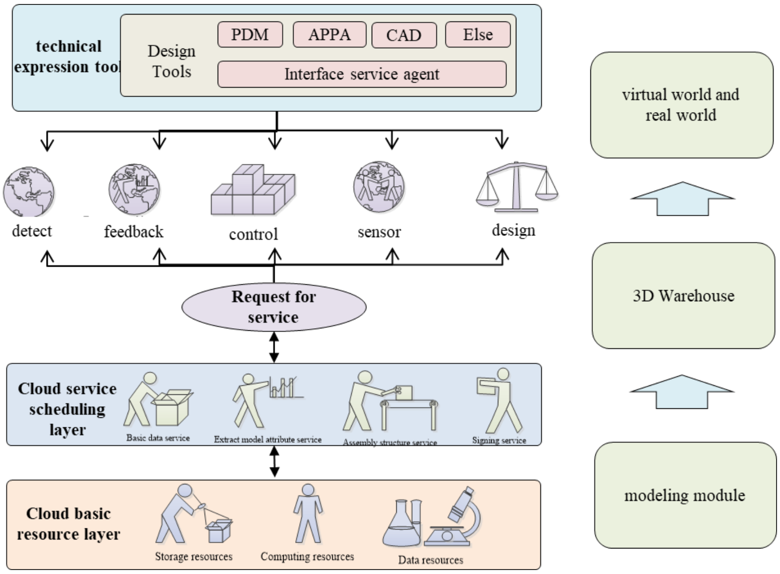

Figure 1: The Modular Design Framework of Virtual Reality System.

1.2 Application Review of Computer Aided Teaching System

The virtual reality technology tool component is developed to help and support the development of courseware and improve the quality of the courseware. The interactive interface using virtual reality technology can be used to make built-in components of courseware materials. In addition, the system also provides independent model making tools, which can create 2D images or 3D models in virtual space. This model includes basic graphic construction tools, deformation tools, brush tools, color tools, sculpting tools, copy and paste tools and many other types. In addition, the system also provides welding unbinding tools and scene creation tools, which can edit the current virtual scene. Specifically, the editing content of the scene includes a variety of tools such as terrain sculpting tools, scene material selection tools, and model import tools.

2 DESIGN OF COMPUTER-AIDED TEACHING SYSTEM BASED ON VIRTUAL REALITY TECHNOLOGY

2.1 Courseware Writing System based on Virtual Reality Technology

The application of virtual reality technology to the courseware writing system can save teachers the cost of learning programming language. The virtual reality technology interactive interface designed by the system is built into the software group. The system also sets up a material import module, which can import externally prepared pictures, text, audio, video, models and other materials. This module can also directly call the models, animations, scenes and other content in the material library. The system provides a text editing module, which can create text boxes in three-dimensional virtual space. This three-dimensional text box is used for inputting text and can edit the attribute format, and the text input is realized through the touch pad and the virtual keyboard on the controller. The system also provides an animation production module, which can record the motion paths and property changes of imported materials. This module can realize the recording of the whole scene movement and change process through the time axis and the record button. By building a speed editing tool, the system can control the movement speed of the object as a whole. Users can decide to pause, play, fast-slow and rewind anywhere. The system provides users with a more intuitive display through the teaching display hall, and optimizes the teaching process for students with different learning abilities. At the same time, students can also manage courseware independently through the system teaching display hall. The relationship between the main functions of the computer-aided design teaching exhibition hall is shown in Figure 2.

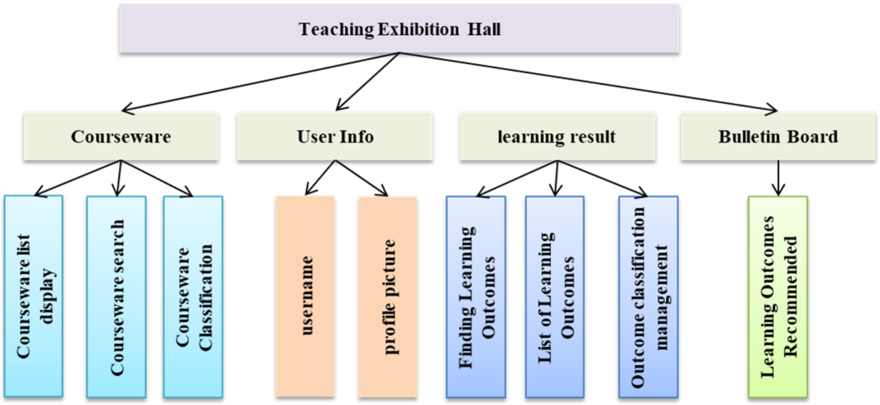

Figure 2: The relationship between the main functions of the computer-aided design teaching exhibition hall.

2.2 Object Relation Module based on Virtual Reality Technology

This module can specify the relationship between the class and the object of the imported material, which is convenient for the unified setting and management of the system. Users can create their own or directly apply the preset function modules. For example, objects set to "background" will not be affected by other physics effects, but other objects set to physics will be affected by the laws of physics. The system also sets up an interaction module, which can determine the interaction mode between the user and the material. The interaction modes of the system are mainly divided into four modes: grasping interaction, contact interaction, eye contact interaction and no interaction. The grab interaction module is triggered when the user grabs an object. Contact interaction specifically refers to the collision process that the user receives in the virtual space, and the different groups of objects that the user encounters during the collision. Eye contact interaction refers to the image displayed in the user group HMD when the user performs your action. The center line of sight of the image makes contact with the object, which in turn triggers the module to work. The non-interaction process specifically refers to the absence of interaction between the object and the user. The action content of the system includes the playback of audio and video, the playback of animation, the display of models, the display of text, and the switching of scenes. The proportion of different wearable display function modules in virtual reality system is shown in Figure 3.

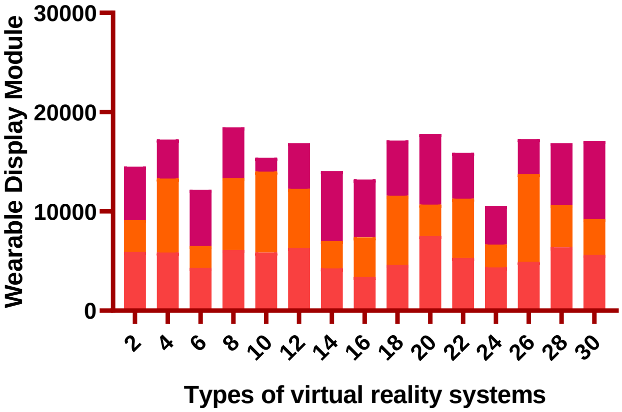

Figure 3: The proportion of different wearable display function modules in virtual reality system.

2.3 Design of Learning Evaluation Module for Student Groups

In addition to the display output of the virtual reality technology head, the system can also adopt two forms of traditional display output and holographic projection output. While the virtual reality technology head display is output, the traditional display on the PC side can display the content of the virtual reality technology display. The advantage of this technology is that bystanders can also see the behavior of the wearer of the virtual reality technology device. In addition, the PC side can perform part of the design, material import and other operations through keyboard and mouse operations. In this way, the user interacts with the wearer of the virtual reality technology to a certain extent. For the models and materials created by users in the system, the system also adds the output mode of holographic projection. The model established by the system can be packaged and exported in obj format. On the one hand, it is convenient for the unification of material formats and the overall upload of the material library; on the other hand, it can be output through holographic projection mode, and teachers can use 360-degree holographic display technology exhibit. In a normal teaching environment, student groups can observe the model displayed in the panorama. The relevant information in the transmission process is processed through the digital resource information processing core, and the result is transmitted to the display expression layer. The Systematic evaluation process system of student learning behavior is shown in Figure 4.

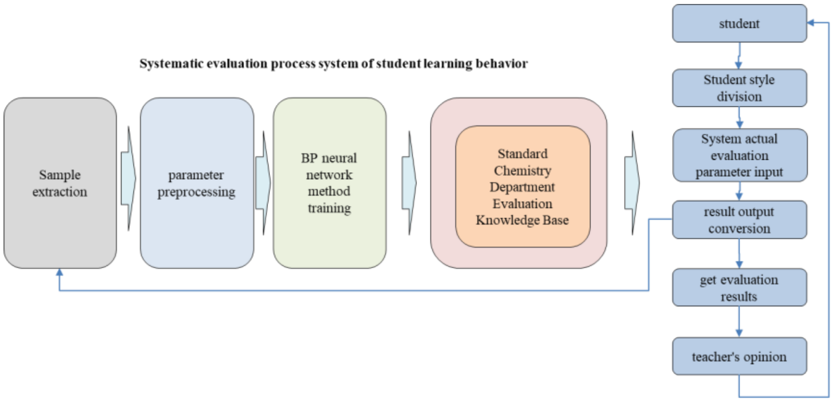

Figure 4: The Systematic evaluation process system of student learning behavior.

3 DESIGN OF COMPUTER-AIDED TEACHING DISPLAY MODULE BASED ON VIRTUAL REALITY

3.1 Strengthen the Online Sharing of Courseware Information

The courseware online sharing module refers to all materials created by users in the system, including single materials (such as produced models and animations, etc.) or the entire courseware project. Through the system, these materials can be uploaded to the Internet for sharing. The system supports users to download and use various resources in the material library through this module. The application of the student port, including the virtual reality technology courseware playback system. The system allows users to load courseware projects made by teachers and allow user groups to interact within the platform. Through courseware recording, virtual reality technology enables users to record their own or other users' achievements, and supports the interaction and interaction of different users' courseware. Courseware network download module, this module enables students to download courseware items uploaded by teachers from the material library. Courseware online evaluation module, this function allows students to evaluate the overall courseware, and the evaluation will be displayed on the download page of the courseware. The system material library is a collection of materials that can be used by the system, from which users can extract or upload materials. According to the type, it can be divided into online material library and local material library. The local material library mainly stores the material preset by the system members and the material saved by the user. The local material library is also responsible for retaining the material saved locally by the system user. The results of Classroom Teaching System Hardware Performance Evaluation is shown in Figure 5.

Based on this, the system can determine whether students do not understand the knowledge received at this time. Based on the consideration of control cost, the micro video sensor designed by the system can analyze the wavelength of visible light. In the process of subsequent upgrades, the system can work in the mid-wave infrared band to collect subcutaneous blood flow and flow velocity. The system can also identify and judge more emotions, and achieve a breakthrough in the emotional dimension in the virtual display. The motion capture device uses 4K high-definition cameras to effectively identify indoor human body parts. The motion acquisition device is placed five meters in front of the students, and monitors the movement changes of the students' limbs in real time with a slight bird's-eye view.

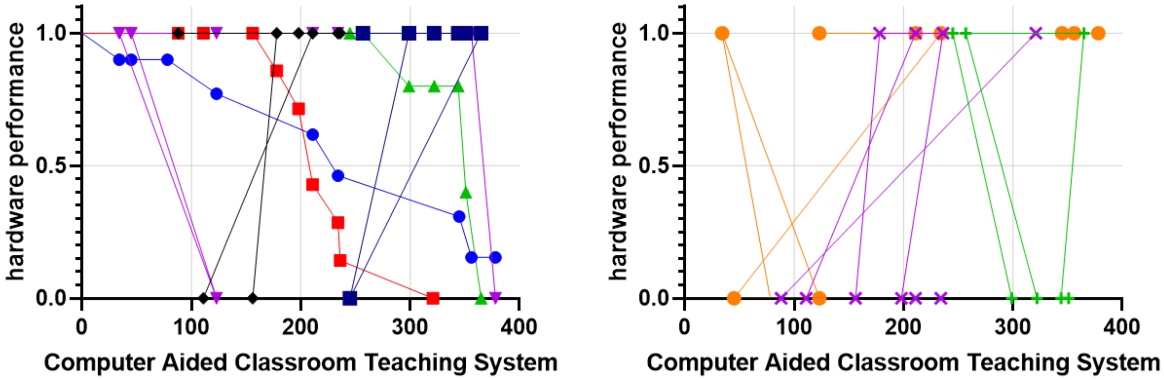

Figure 5: The results of Classroom Teaching System Hardware Performance Evaluation.

The instrument captures important nodes of students, such as head, neck, chest, hands, forearms, upper arms, shoulders, hips, thighs, knees, calves and other parts. Before using the virtual classroom, it is necessary to debug the camera of the motion capture device and align the center of the field of view with the center of the student's body. This operation can ensure that the student's body is all within 3/4 of the field of view. In order to facilitate the layout of the virtual classroom, the camera of the motion capture device should be placed on the turret to automatically capture student behavior through portrait recognition. By automating the layout of the instrument, the convenience of using the equipment is improved. The system can distribute the left and right motion acquisition devices through the upgraded version, so as to realize the pickup of the side motion of the body, and then realize the stereoscopic image acquisition. The data transmission adopts a gigabit private network to meet the bidirectional transmission bandwidth requirements of high-definition video streaming and multi-channel voice.

3.2 Build an Online Material Library of Computer-Aided Information

The online material library mainly saves materials uploaded by users or officially updated. The content of the material library is mainly classified into courseware, models, scenes, animations, chemical simulations, objects, functions, logic, tools and other content. The material library is classified into system functions through this classification system. After users upload a large number of courseware and materials, they can also be classified by subject, time, field, evaluation results and other requirements through big data. Online virtual reality technology multimedia teaching system. Innovation and improvement of multimedia systems based on virtual reality technology. Through the Internet p2p technology, the teacher client is the host, and the student client is the user group, and the system is connected. A host can correspond to multiple clients, so a teacher can interact with multiple students at the same time. On this basis, if other teachers join as clients, a scenario where multiple teachers and students interact together can be realized. In the same virtual space, the teaching process is upgraded and optimized through an immersive teaching method. The comparative analysis of the use effect of different teaching system platforms by student groups is shown in Figure 6.

Also, choose P2P instead of c/s mode. The p2p mode does not need to establish another server, and the use cost is lower. At the same time, this kind of system also avoids problems such as system delay caused by poor connection with the server. And can use the local area network to connect quickly in the real classroom environment. Therefore, this system can not only realize the teaching of teachers and students in any place with Internet in the world, but also can be applied in traditional classrooms.

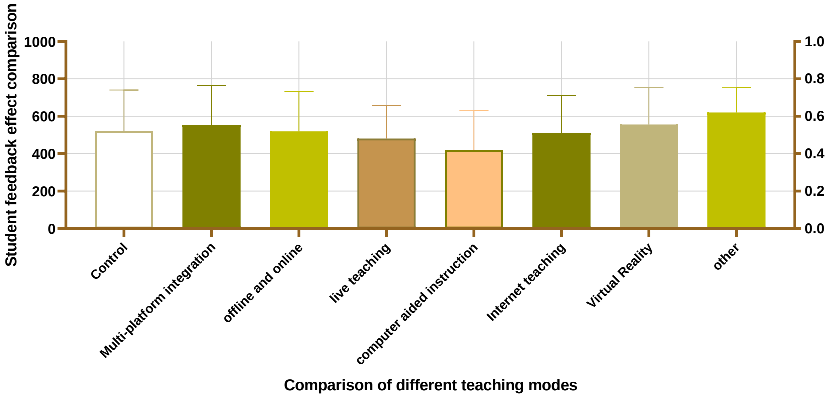

Figure 6: The comparative analysis of the use effect of different teaching system platforms by student groups.

The virtual reality technology equipment has its own voice input system, where teachers and students can communicate by voice. Teachers can demonstrate and explain courseware to students through this system. Teachers can also allow students to interact with courseware content. In addition, the group of teachers creates teaching content through on-site use of courseware writing tools and material libraries. Teacher groups can build or provide open tools for students to make together for heuristic teaching. While interacting with teachers, students can also interact with classmates. Students can record the content of the class through the recording system, and review and review it later.

3.3 Hardware Equipment of Computer-Aided Teaching System

In the process of rapid development of computer-aided teaching, different groups of students receive different information. The traditional computer-aided teaching system has advantages in learning methods and teaching resources. For students with different learning ability levels, the system cannot give targeted suggestions, nor can it assist the team. We need to note that the system can assist students of different ability levels in teaching through different teaching methods and appropriate teaching modes. This demand also makes the computer-aided teaching system a higher requirement. The computer-aided teaching system enables computer-aided teaching to be better presented and more intelligent. Research scholars in the field of education have proposed more teaching methods to improve the performance of the system. This article selects the appropriate type of server, the server has two options of graphics processing and field programmable logic gate array. The server also fits the general capabilities of any system application.

The operation of the system provides a good platform guarantee for the computer-aided teaching system. The dual-core multi-channel system in the hardware device can achieve balance among network accelerators, storage devices and teaching resources, and can maximize the performance of system applications. Based on virtual reality technology, virtual reality equipment that supports computer-aided teaching systems in the mainstream market is selected. In particular, virtual reality glasses, which can support PC, HTC Vive, 3Glasses and Oculus virtual reality technology demonstrations. This virtual reality hardware device can complete the connection of corresponding external devices. The hardware can be systematically linked by selecting the corresponding equipment in the computer-aided teaching courseware. So as to realize the effective management of students' teaching courseware. In addition, the operation of the virtual reality system also requires the addition of other peripheral devices such as Bluetooth controllers and Touch controllers. Thereby, it is convenient for students and related personnel to connect through the interactive functions in the system. The support system operates and manages the resources in computer-assisted teaching. The Market share of computer-aided teaching systems on different technology platforms is shown in Figure 7.

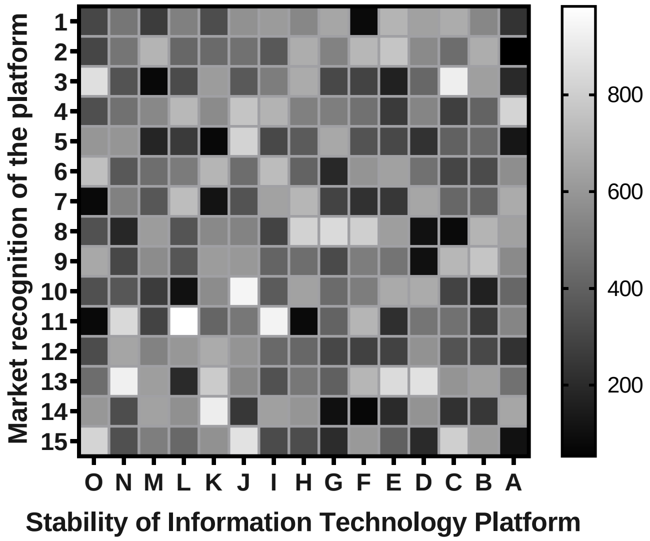

Figure 7: The Market share of computer-aided teaching systems on different technology platforms.

4 CONCLUSION

Generally speaking, virtual reality technology based on "Internet +" technology can solve many problems. In this paper, a computer-aided teaching system is used to integrate and integrate technologies such as virtual reality platform, Internet, computer system, and Unity engine. By using C# programming language, database and other technical development methods, this paper designs a teaching application system that conforms to the theory and law of pedagogy. The system can realize courseware design on the virtual reality technology platform, as well as online teaching and feedback. The use of the system can simplify the production difficulty of virtual reality technology courseware. The system can lower the technical threshold for teachers to make virtual reality technology courseware, and expand the range of users of virtual reality technology courseware. The technology has great market value and development space. In the virtual classroom, the two-way communication between students and teachers is the key design part of the teaching system. The teacher's explanations with pictures and texts can clarify doubts and knowledge points in a targeted manner. Students can also support feedback in the classroom, including voice feedback, facial feedback and motion feedback.

The information transmission from the teacher to the students adopts the audio and video functions of virtual reality technology glasses, and the sound adopts the stereo scene restoration technology. This technology mainly relies on four-way loudspeakers placed on both sides of the virtual reality technology glasses, which are integrated into the ear brackets of the virtual reality technology glasses through conformal design. Taking into account the auxiliary education function of the virtual classroom, the bass part of the amplifier is strengthened in the design to achieve a sound effect closer to the real environment. In the video display part, a two-way "Face" prism optical refraction module is designed, which utilizes the different refractive indices between optical materials to achieve optical path folding in a narrow space. The advantage of this technology is that the display fusion of the close-up scene and the background can be achieved within a nearly 160° field of view. The technology can bring students a virtual experience that is closer to a real classroom. The feedback information from students to the teacher is mainly composed of three parts: voice collection, facial expression collection and action collection. Voice acquisition is relatively simple, and is completed by using a mature voice recognition module with embedded semantic analysis software. The voice acquisition and transmission module is also integrated into the glasses and headsets of virtual reality technology. The transmission of students' voice and video data share the transmission channel and are frequency-multiplexed. Expression collection and action collection are the difficulty and focus of system design, and its goal is to recognize students' facial micro-expressions and body movements. The expression collection work specifically integrates two micro-cameras on the virtual reality glasses, and the center of the visual axis is aimed at the students' eyes respectively. This work is able to capture the micro-expression changes of students' eyebrows, eyelids, corners and cheekbones in real time, extract feature values and embed them into virtual reality glasses. Through the processing of emotional results by the system, we can judge happiness, doubt, thinking, confusion, etc.

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