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VIRTUAL REALITY ASSISTED TEACHING SYSTEM FOR IMPROVING ENGLISH READING COMPREHENSION ABILITY

HONGYING YANG* AND ZHENQIU YANG†

Abstract. In order to enhance students' enthusiasm for learning English, the author designed an English reading assisted teaching system based on virtual reality technology. System hardware design, selecting HTG Vive head mounted devices and high-performance computers to build the architecture; System software design, collecting teaching images through virtual graphics cards, using hierarchical network coding technology to remotely transmit teaching data, building a virtual teaching environment, and using collision detection algorithms to achieve human-computer interaction teaching. The test results indicate that the system has an average response time of 29.14 seconds for different quantities of English reading resources, demonstrating good operational performance. The traditional way of reading English is too monotonous and boring. Virtual reality technology has increased the fun of reading and profoundly influenced the transformation of English reading classrooms.

Key words: Virtual Reality Technology, English reading, Human-computer interaction, Assisted teaching

1. Introduction. Reading is an activity in which people acquire information and understand the world. Through reading, people understand, comprehend, and absorb knowledge, change their thinking, and enhance their cognition. With the development of the Internet in the information age, "fragmented reading" and "fast food entertainment" methods such as microblog, circle of friends, and short videos have become the mainstream way of information intake. Traditional reading methods face greater challenges, and it is crucial to seek reading development [1]. Language learning includes four aspects: listening, speaking, reading, and writing, among which "reading" occupies an important position, especially for English learners. English reading not only plays a crucial role in English learning activities, but also plays a key role in improving overall language learning abilities. The value and significance of English reading goes far beyond just increasing knowledge. Reading not only cultivates English learners' sense of language, but also promotes the accumulation of English vocabulary, improves their English reading and writing abilities [2]. From this perspective, English reading is an important means and effective way to learn English well. Meanwhile, the improvement of English reading ability is of great help in enhancing the overall English proficiency of English learners. The key to improving reading proficiency is to master the methods and enhance efficiency. How to combine the skills and methods of English reading with modern technology and English reading, explore new paths and methods of reading, enhance English learners' interest in English reading, and conduct English discourse reading more efficiently and quickly has always been a topic of discussion for English educators and learners [3]. The Ministry of Education has proposed the construction of a national level virtual simulation experimental teaching center. Virtual Reality VR technology, as a multidimensional experience platform, has brought new opportunities and challenges to the development of English reading.

Virtual reality (VR) technology is a computer simulation system used to create and experience virtual worlds. This simulation system combines virtuality with reality and has its own uniqueness. It can use computer systems to generate a virtual simulation environment, allowing participants to immerse themselves in this simulation environment and provide them with an immersive experience. This immersive experience can mobilize multiple senses to create a sense of immersive participation for users. Virtual reality technology can transform a single text content in a book into a relatively multidimensional and three-dimensional reading environment, allowing users to experience an immersive reading experience. This immersive reading experience

*Department of Foreign Languages, Qinhuangdao Vocational and Technical College, Qinhuangdao, Hebei, 066000, China.
†Department of Foreign Languages, Qinhuangdao Vocational and Technical College, Qinhuangdao, Hebei, 066000, China (Corresponding author, yzq8008@126.com)

is different from traditional regular reading, as it allows readers to fully immerse themselves in this multidimensional and three-dimensional reading environment [4]. This three-dimensional, rich, and multi angle reading method enhances readers' interest in reading and also improves reading efficiency. For English educators, this multidimensional reading experience can make the classroom more diverse, allowing students to experience the situation more vividly, enhancing the interactivity of the classroom, and thus improving teaching efficiency. By applying virtual reality technology to the classroom, teachers can better stimulate students' creative thinking and innovative abilities, allowing them not only to understand the content in the text, but also to connect with the future through these contents, and generate valuable ideas for the future through creative thinking. This is the deeper meaning of reading. The application of virtual reality technology in the education industry can enhance students' interest in learning and strengthen their ability to master English reading by creating a teaching environment of "self-directed learning and human-computer interaction". Therefore, a virtual reality technology-based English reading teaching system is designed. This system breaks the traditional teaching concept by transforming students' passive learning into active learning, and transforming modular English reading into dynamic virtual scenes; Students improve their English reading ability by engaging in conversations with virtual characters; Human computer interaction allows students to ask questions in real-time in the teaching system, which then provides feedback to students or teachers, achieving diversified teaching methods.

2. Literature Review. With the rapid advancement of global technology, coupled with the rapid development of communication and network technology in China in recent years, China's VR technology has also made significant progress under this trend. Based on the characteristics of VR technology and actual project requirements, science and engineering subjects are the areas that best reflect the advantages of VR technology. Especially in disciplines such as architecture, mechanics, and physics. With the use of advanced technology, learners have a new way of learning. In virtual laboratories, learners can intuitively observe various well-known buildings and carefully study and research the various technical details contained in the buildings, thus breaking the limitations of traditional book teaching and graphic display. Virtual reality technology combines multimedia and graphic simulation techniques, allowing learners to fully immerse themselves in a virtual environment. With the popularization of computer and VR technology, the way of learning English is shifting from traditional textbooks and classroom teaching to computer-assisted language learning (CALL), and even towards gamified learning. This transformation provides learners with a more immersive experience, stimulating their interest and participation in learning.Yuanxuan, M.A. et al. investigated the factors and regulatory strategies that affect second language reading ability through a scale survey. It has important theoretical and practical value in improving the reading ability of second language learners [5]. Ostovar Namaghi et al. conducted a study on the impact of interactive games on English learners' reading comprehension ability and game attitudes. They found through evaluating participants' perceptions that they hold a positive attitude towards this type of game.The research results indicate that interactive games are an effective means to enhance students' participation, motivation, and learning outcomes in the classroom. In addition, the study provides some practical suggestions for future in-depth exploration [6]. Lijun, H. U.'s research found that in the teaching mode of virtual reality, teachers are no longer the leaders of the reading classroom, but supporters, participants, and researchers in the reading process of students. The reshaping of this role not only helps to strengthen good interaction between teachers and students, but also promotes communication among students, bringing new vitality and motivation to the classroom, thereby improving students' reading level [7]. Su, C. and his co authors delved into the connotation and characteristics of ESA theory from its perspective, and explored the feasibility of applying ESA theory in business English reading teaching. They analyzed the main problems in business English reading teaching in vocational colleges and proposed a series of new reform strategies to evaluate learning effectiveness and improve teaching level [8]. Liu, X. studied the implementation steps of comprehensive English literacy teaching and established a digital comprehensive English literacy teaching model. Research shows that combining English literacy with digital teaching directly affects students' overall English learning outcomes [9].

With the maturity of virtual reality technology and the widespread use of high-performance hardware, the opportunity to integrate virtual reality technology into English reading comprehension skills is also becoming more mature. By transforming it into an intuitive sensory experience, learners will definitely be deeply impressed by the entire process, and their corresponding memories will also be more profound. In addition, due to the

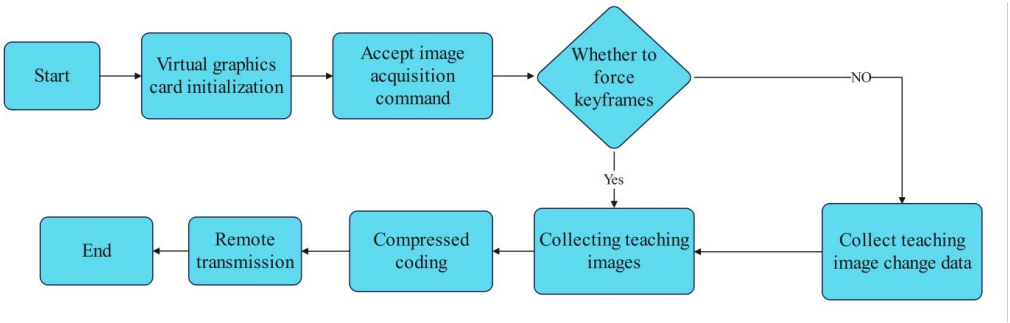

Fig. 3.1: Flow Chart for Collecting Teaching Images

ability of VR videos to stimulate learners' creativity, applying VR videos to daily English reading teaching may produce unpredictable 'chemical reactions'.

3. Design of English Reading Assistance Teaching System.

3.1. Hardware Design. Applying virtual reality technology to English reading can greatly improve the enthusiasm of English learners and bring good reading results. The hardware architecture of the English reading assisted teaching system mainly consists of computers, virtual reality (VR) devices, displays, and audio equipment. Select a high-performance computer with 8GB of RAM and an Intel i54 CPU as the data layer to process 3D models, audio, and image files for English reading instruction. There are many types of VR devices on the market, among which the HTC Vive headset has a large number of application development interfaces, making it very suitable for the English reading assisted teaching system designed by the author. The HTC Vive device is mainly composed of a headset, a positioning device, and a joystick, among them, two positioning devices are equipped with laser positioning sensors, so they can accurately locate moving targets without relying on cameras, track moving targets wearing head mounted devices and control handles, and follow the positioning targets within a certain range. To apply virtual reality technology in the education system, it is necessary to establish three-dimensional models of teaching content and enhance students' immersion through virtual models. In the process of modeling English teaching, traditional hardware devices cannot simulate such models, and virtual digital models are generated through computers.

3.2. Software Design.

3.2.1. Collecting Teaching Images. The main function of the auxiliary teaching system is to assist teachers in teaching. When teachers use the system to teach, to ensure the quality of teaching, the system must accurately capture real-time images and audio data of the teacher, transmit them to the server for processing, and then display the processed content to students within virtual scenes [10]. By capturing image changes through a virtual graphics card, the system avoids the need for full-screen copying and processing, thus significantly reducing the workload involved in processing screen data. Figure 3.1 illustrates the program flow for capturing teaching images.

As depicted in Figure 3.1, when teachers employ the author's system for remote teaching, they begin by initializing the virtual graphics card and awaiting the image acquisition command from the teaching system. Upon receiving this command, the teacher commences remote teaching. During this process, the teaching system automatically captures teaching images. Each image captured undergoes automatic background compression and encoding, after which the compressed image is remotely transmitted to the server for additional processing. By repeatedly running this process, continuous collection of teaching images for teachers can be achieved. The fundamental significance of teaching design is to find out and solve the various problems existing in the actual teaching process.

3.2.2. Remote transmission of teaching data. In order to ensure the stability of remote transmission of teaching data and enable students to learn English reading courses in a stable virtual teaching environment,

hierarchical network coding technology is adopted to optimize the remote transmission process of teaching data, obtain the average delay of coding, and ensure a stable transmission port for teaching data [11]. Assuming a directed acyclic graph is used to represent a single source multicast network, where the directed acyclic graph is a set of nodes and directed edges. All nodes in the directed acyclic graph are input with data characters to make it a linear channel set of a finite field. Then, the output channel of the nodes is encoded and processed, and the data characters that need to be forwarded are:

$$Z(h) = \sum_{h' \in ln(h)} C_{h',h} Z(h') \tag{3.1}$$

In the formula, where $Z(h)$ represents the data forwarding character,h denotes the channel arc before forwarding,h' indicates the forwarded channel arc, ln(h) represents the set of input channels for data nodes, and C denotes the secondary data of the Galois field. First, calculate the average delay of network encoding and integrate it into the subnet system.The connection point is the source point of the subnet system and also the destination point of the English reading auxiliary teaching system, ensuring stable remote transmission of teaching data.

3.2.3. Building a Virtual Teaching Environment. In order to make the virtual teaching environment consistent with the actual scene, the size of individual geometries is first adjusted through an error function, and the precise individual geometries are assembled, spliced, and other operations to form the entire virtual teaching environment. Next, the parameters of the virtual teaching environment are adjusted according to the specific requirements of the English reading assistance teaching system. This optimization aims to enhance the display performance of the teaching system by achieving higher resolution in virtual scenes. Therefore, the calculation formula for pixels in virtual teaching environments is

$$\begin{cases} S_x = L_x cos\alpha tN \cdot S_z \\ S_y = L_y cos\alpha tN \cdot S_z \end{cases} \tag{3.2}$$

In the formula, equation 3.2 is utilized to construct a high-resolution virtual teaching environment where students can fully engage in English reading immersion. Here, S_x represents the pixel point in the virtual environment's horizontal direction, S_y in the vertical direction, and S_z the total pixel count. Additionally, L_x and L_y denote the horizontal and vertical dimensions of geometric objects in the virtual setting, while α signifies the lighting angle parameter in real scenes. N stands for the number of surfaces on a single geometric object within the virtual scene. This setup aims to enhance students' interest in English reading through immersive learning experiences in the virtual environment.

3.2.4. Implementing human-computer interaction teaching. In order to determine whether students have made contact with objects in the virtual teaching environment, collision detection algorithms are used to detect whether human-computer interaction has occurred. The collision detection algorithm creates a bounding box outside each geometric object in the virtual teaching environment, and uses the intersection test between the student and the bounding box to determine whether a collision has occurred. Therefore, the expression for axis aligned bounding boxes is 3.3:

$$0 = \{(x_r, y_r, z_r) | x_{min} \leqslant x_r \leqslant x_{max}, y_{min} \leqslant y_r \leqslant y_{max}, z_{min} \leqslant z_r \leqslant z_{max}\} \tag{3.3}$$

In the formula: in the virtual teaching environment, (x_r, y_r, z_r) represents the spatial coordinate of a geometric object, while $x_{min}, y_{min}, z_{min}$ and $x_{max}, y_{max}, z_{max}$ denote the minimum and maximum spatial coordinates of its bounding box, respectively.The procedure for detecting collisions between students and geometric objects in a virtual teaching environment, utilizing equation 3.3, comprises the following steps:Initially, identify and establish the spatial coordinates of every geometric bounding box present within the virtual teaching environment. Next, sort the projection list of the geometric center on each coordinate axis; Finally, based on the sorting results, it is determined whether the student coordinates overlap with the bounding box coordinates, in order to achieve the most realistic human-computer interaction teaching.

Before conducting formal teaching research, it is necessary to consider the operating environment or hardware support of VR videos and the actual experimental environment in which learners are located. In this teaching research, VR videos are played based on mobile devices, and the requirements for mobile phone configuration are not high. Therefore, before implementation, only a rough understanding of students' mobile phone situations is needed. And the experimental environment is quite important. Due to the immersive nature of VR videos, learners need sufficient activity space when using VR videos for learning, in order to avoid discomfort. At the same time, it is necessary to eliminate external interference to prevent learners from making cognitive errors, which can lead to cognitive dissonance.

The experimental environment refers to the physical space in which learners use VR videos for learning. In this experiment, a teaching laboratory with sufficient space and bright lighting was selected. Because learners need a certain amount of activity space when using VR video, and also need to eliminate external interference, it is necessary to choose a space that meets the above conditions to promote the smooth progress of the experiment. In addition, the overall environment of the experimental site is bright and spacious, making it an ideal experimental site. In this closed experimental environment, learners have enough space to freely rotate their bodies for multi angle observation, resulting in a stronger sense of immersion. The enclosed environment created by the laboratory provides learners with a sense of security and eliminates external interference factors. Learners can repeatedly use various senses for comprehensive feelings and experiences. On the contrary, if there is insufficient space or improper settings, learners will experience anxiety and unease, and even the virtual environment created by VR devices will make learners feel dizzy and disoriented. Learners will have strong rebellious emotions, which completely reverses the purpose of the experiment. Therefore, this study has sufficient space and moderate lighting to ensure that learners have a stable environment and the experimental results are guaranteed [12].

The user's first impression of VR videos mainly comes from the clarity and playback frame rate or smoothness. In this experiment, as long as the software can be opened smoothly, the hardware requirements for the virtual reality videos produced in this study are not high. Choose teaching experiments with ample activity space and bright lighting. At the same time, ensure that there are no foreign objects on the ground to avoid tripping and other situations. Upload relevant resources to the public cloud drive before the experiment officially begins, accompanied by relevant explanatory documents and videos, to help learners master the basic knowledge and skills.

The application implementation process mainly utilizes VR videos to conduct teaching research, test learners' satisfaction with this teaching experiment, and then compare the two with traditional teaching methods. Analyze and evaluate based on these results. Based on the final evaluations, guidance, and comments provided by the learners, comprehensively analyze the shortcomings in this actual production and provide reference for further optimization and improvement in the future. Throughout the implementation process, learners' experiences and sentiments will be collected via questionnaire surveys and interviews. The questionnaire was initially crafted to encompass personal metrics across three dimensions: sensory perceptions, interactive engagement, and cognitive understanding.Then use interview methods to gain a deeper understanding of learners' experiences and enjoyment of VR videos, in order to conduct comprehensive testing and evaluation of VR videos. If the problem is caused by the real environment, simply making modifications on the design side is useless. So, identifying the root causes of various problems during the design phase has a decisive guiding role in the overall direction of the design.

4. System operation testing. In order to test the performance of the system, the traditional teaching system is compared with the designed system to find out its functional differences.

4.1. Determine testing environment and indicators. After the design of the English reading auxiliary teaching system is completed, it is necessary to test it, promptly discover and handle relevant errors in the system, and ensure the reliability of the system operation. The main purpose of this experiment is to test the functionality of the system, namely black box testing. The relevant equipment parameters for setting up the testing environment are shown in Table 4.1. Based on this environment, conduct experiments to test the response time of the designed system and evaluate its performance based on the test results.

The testing indicators this time are rooted in user experience theory. Marketing expert Bernd Schmidt categorizes consumer experience into five primary experiential factors: senses, cognition, creativity, behavior,

Table 4.1: Equipment Parameters for Building Test Environment

Server side			Client	
WEB server Inter Pentium G3250,Memory 8 GB, CPU frequency 3.2 GHz	Application server Inter Pentium G2020, 8GB memory, CPU clock speed of 2.9 GHz	Communication Bandwidth 8MHz	PC Inter Pentium G3250,Memory 8 GB, CPU frequency 3.2 GHz	Communication Bandwidth 4MHz

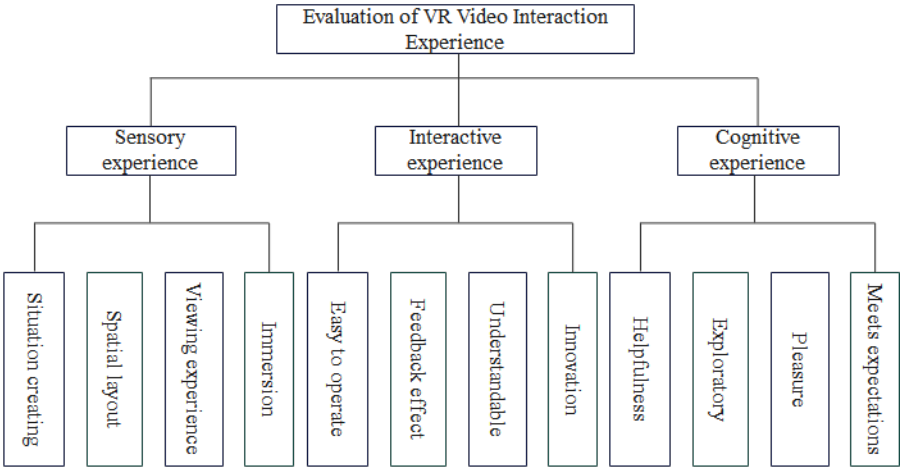

Fig. 4.1: VR Video Evaluation System

and association. VR videos have immersive, interactive, and imaginative qualities. Therefore, the author's implementation also refers to the following aspects of this theory: In evaluating the VR video, we initially focus on sensory immersion, examining whether it provides learners with an enriching sensory experience and a truly immersive environment. Secondly, we assess the overall system's usability, determining if it is intuitive, easy to learn and control, and capable of fostering new cognitive experiences for users. Ultimately, we gauge whether learners are able to utilize the VR video effectively, gaining valuable new content and insights through their learning experience [13]. The evaluation system, depicted in Figures 4.1 and 4.2, is structured into three dimensions according to the aforementioned theory, each containing four specific indicators. A questionnaire has been developed based on these five indicators, where students provide ratings based on the questionnaire prompts. Ratings are conducted on a five-point scale, ranging from 1 to 5, with 1 indicating the lowest satisfaction and 5 indicating the highest satisfaction.

4.2. Analysis of Test Results. A total of 50 people participated in this test, and the final valid answer received was 50 points. Through both horizontal and vertical analysis of the collected data, it is evident that students rated comprehension and cognition highly, scoring 4.3 and 4.5 respectively. However, there is an imbalance in the level of interactive experience, which received a lower score of 3.8. This suggests that while the VR films in this study are effective in providing multisensory experiences, they fall short in terms of interactive engagement.

Among the 12 indicators in Figure 4.3, the item with the highest overall score is the one with clear expression of content. The scores for immersion, overall restoration, and pleasure are also high. However, it performs poorly in terms of interactive experience and feedback experience. This result is actually not surprising. The parts that perform well showcase the unique characteristics of VR videos [14]. The lower scoring part is mainly due to two reasons: Firstly, the overall video production still uses 3D modeling methods, which still have a significant gap between real scene rendering and live action shooting. The second reason is that the production volume is

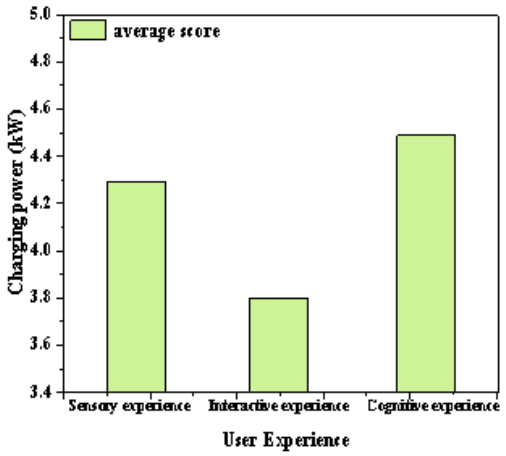

Fig. 4.2: Average Statistics of Three Dimensional User Experience

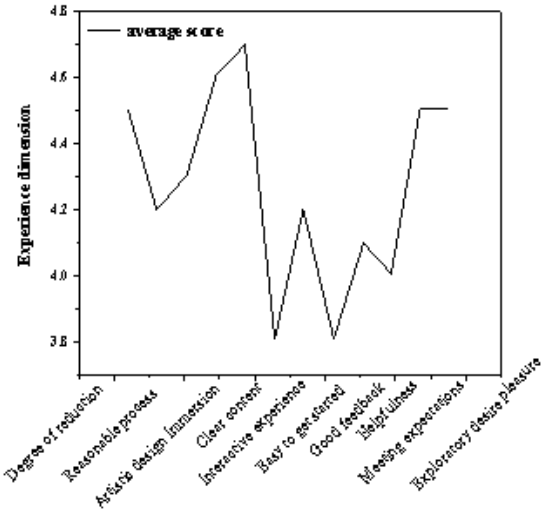

Fig. 4.3: Statistics of Student Satisfaction with VR Videos

large, and it is impossible to take into account all the elements during production.

In this educational research, a comparative survey was conducted to assess learners' experiences with traditional teaching methods versus VR teaching videos. Specific findings are detailed in Table 4.2. The analysis reveals that a majority of students perceive VR teaching videos to more accurately reproduce explained content compared to multimedia materials used in traditional teaching methods.Additionally, VR teaching videos provide a more compelling intuitive experience and immediately capture learners' attention. Moreover, they inherently offer a certain level of enjoyment. However, some students have reported experiencing discomfort

Table 4.2: Comparison between VR Video and Traditional Teaching Methods

Order number	Problem	Traditional teaching methods	VR teaching video
1	The degree of restoration of the explained content		
2	The strength of intuitive perception		
3	The fun of overall design		
4	Do you feel any discomfort during the learning process		
5	Emotional mobilization throughout the entire process		

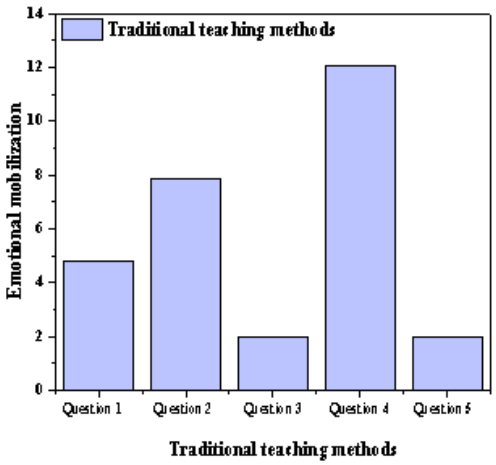

Fig. 4.4: A survey of the attitudes towards traditional teaching methods

while using this technology.Given that some students are new to this technology and may encounter challenges with certain operations and usage methods, these issues can be addressed gradually through future revisions and updates. The final question reveals that most learners believe VR video technology effectively addresses the limitations of traditional textbooks. Converting ordinary content into specific situations and visual representations significantly enhances emotional engagement, specific data are shown in Figures 4.4 and 4.5.

After completing the use of VR teaching videos, interviews were conducted with learners, and some conclusions were drawn by summarizing and analyzing their responses. Ninety percent of individuals are intrigued by this technology, convinced that the intuitive sensations and experiences it offers can create lasting impressions quickly, greatly aiding subsequent learning and memory retention.

In conclusion, the majority of surveyed students maintain a positive outlook on VR video teaching. They expressed a desire for more high-quality VR teaching videos in future educational settings. Based on the findings of this experiment, it's evident that VR teaching videos have considerable potential for growth in educational applications. As a cutting-edge technology with distinct advantages, it has the potential to address some of the inherent challenges in traditional teaching methods [15].

In this system testing experiment, a certain teaching system was selected as the experimental comparison to set different numbers of English reading resources. Two systems were loaded separately to obtain images. The response time results of the two systems to different numbers of English reading resources are shown in Figure 4.6. As shown in Figure 4.6, the English reading assistance teaching system based on virtual reality

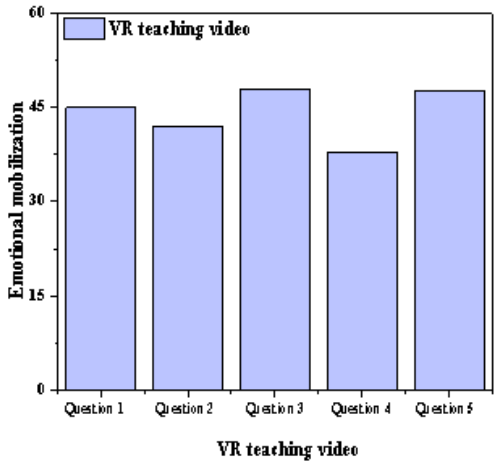

Fig. 4.5: Attitude survey on VR teaching videos

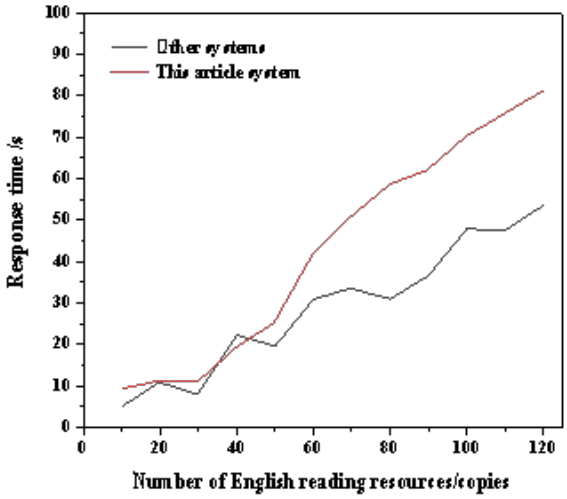

Fig. 4.6: Comparison Curve of System Response Time

technology has a faster response time, better performance, and is more suitable for English reading assistance teaching.

4.3. Overall Effect Evaluation.

4.3.1. Overall Design Evaluation. The design of VR videos highlights key knowledge points and emphasizes commentary, allowing students to better grasp the key knowledge points. From the final result, the overall experience is still quite good. At the same time, the opinions and suggestions raised by students regarding VR videos have been uniformly organized, and finally summarized as follows:

Due to hardware and production limitations, some detailed scenes and actions cannot be well restored.

If more resources can be obtained, better modeling and sound effects can be achieved, further enhancing the learning experience for learners.

There are some shortcomings in the design of interaction. The overall focus is still on explanation and analysis. You can try adding some small tests or interactive elements in real time during the explanation process.

5. Conclusion. In China, English learning remains a significant challenge due to limited exposure to immersive language environments and other factors. As a result, many students face difficulties in attaining effective English communication skills, leading to lower proficiency and application abilities overall. To tackle this issue, the author has combined virtual reality and artificial intelligence technologies to create a tailored immersive English reading and learning system for learners. The system is based on virtual reality, simulating a real English communication environment and providing various practical application scenarios, such as speeches, visa interviews, etc., aiming to improve learners' English reading, communication, and application abilities.

With the advancement and development of technology, virtual reality technology has received attention from many fields. The author applies virtual reality technology to an auxiliary teaching system for English reading, which has good human-computer interaction while ensuring system stability, and greatly helps to improve students' interest in English learning. The system test results have verified that the system has a fast response time and meets the design requirements in terms of operational performance. However, there are still certain shortcomings in the precision and smoothness of the virtual scene modeling of the system. In the future, further research will be conducted to make the English reading auxiliary teaching system play a better role and contribute to improving students' English reading learning efficiency. Utilizing virtual reality technology to enhance English learners' interest in English reading, improve the effectiveness of English reading, and construct a reasonable English reading learning system are the current issues that English teachers need to consider. The rapid development of virtual reality technology is bound to have a profound impact on English reading education and teaching. Integrating virtual reality technology into the teaching system represents a novel approach that significantly enhances students' proficiency in English. This innovative mode not only alleviates the need for teachers to search for materials during lesson preparation but also enhances their ability to monitor and control the teaching environment and process. Through timely questioning and real-time feedback, students can address learning challenges and improve their grasp of English concepts. However, the system's complexity in managing raw data collection and integration underscores the necessity of robust data processing capabilities.

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