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Research Article

The Application of VR Technology in Environmental Design Based on Human-Computer Intelligent Interaction and Computing

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Virtual reality technology makes environmental design more convenient, and the effect is more intuitive, so designers can create more diverse design works. The practical application of virtual reality technology can make the expression of environmental design extremely realistic, can make the public's visual, auditory, and tactile feelings different to a certain extent, so that people can enjoy the immersive feeling brought by various virtual environments, and can also concentrate people's attention to a certain extent, so that people's impressions continue to deepen, and deepen the image of environmental art to a certain extent, so that it plays a role in beautifying the city. The continued maturity of virtual reality technology has made it widely used in many industries in society, as has environmental design expression. Virtual reality technology has a variety of characteristics, such as interactivity, conceptuality, and multidirectional perception. It breaks through the time and space limitations of traditional environmental design and can better display and highlight the design effect to customers.

1. Introduction

The VR industry is originally a component part of the cultural industry, and its technological components and other cultural industries show a form of cross-border interaction and integration. Its comprehensiveness and innovation have brought new challenges and opportunities to the development of the cultural industry [1]. VR, all known as artificial virtual reality, or artificial virtual augmented reality, is a tablet computer and mobile network operating system that can automatically manually create and control, perform and output, and manually create a virtual reality world. Because this video system cannot only directly bring a strong sense of visual immersion to everyone's vision, with good video interaction, but also because it can directly realize the fictional visualization, it has developed into the hottest video technology in the video market in recent years. VR innovation-driven trends are very strong [2]. These trends are mainly manifested in the five important aspects of their entire industrial chain, namely, the comprehensive revolution and innovation in tool devices, content, development platforms, industry applications, and related services. At present, computer optics has been widely studied and introduced in digital image real-time shooting, display, transmission and processing devices, and other related computing software. Digital image light processor, millimeter microwave image sensor software, light image projection processing device, and other hardware equipment are constantly in research and development. Science and technology capital are crazy fast into, after several recent rounds of fierce market competition, in the field of product research and development. Some famous international technology giants, such as Samsung, HTC, and Google are gradually developing into its competition in the industry. At the same time, the specialization and technical standards of hardware have been gradually established and constantly improved. VR has always been relatively weak in other content integration and innovation capabilities. If 2016 should be the first year of continuous innovation in mobile hardware content technology, 2017 is mainly focused on the integrated development of hardware content. At present, the industry has seen a lot of VR technology content expertise, and the shortage of professional funds restricts the effective promotion of many VR professional content. As a result, major software companies have been considering setting up various solution platforms to support integrated development based on VR content. In the process of interacting with people, smart products will generate a lot of physiological and human factors data that are worthy of deep mining in the backend. Taking smart insole as an example, the early design of smart insole is usually based on the theory of human foot kinematics and piezoelectric effect, and a complete plantar pressure distribution monitoring system is designed [3]. The system is applied to collect the plantar pressure signals of different groups of people and different exercise postures [4]. By wearing pressure test insoles, the mechanical characteristics of the soles of the feet under different exercise states are revealed, and the differences in the distribution of plantar pressures of different samples can be simply analyzed [5]. In 2017, the treehouse company launched the Marco-X smart insole in response to the current situation where people pay more and more attention to health [6]. In addition to the basic functions of traditional smart insole collection and extraction of human data, Marco-X takes the extraction and screening of user gait data as a focusing on-gait data management as the axis, real-time monitoring, and transmission of data and big data analysis through mobile app [8]. On the other hand, the data is collected and fed back to the insole manufacturer, so that it can continuously debug and improve the design of the insole [9]. If the early smart insole is from a design point of view, with production and sales as the core and data extraction is only a derivative of this core value, then the emergence of a new generation of smart insole from the perspective of people with social attributes, the insole manufacturing and human factors data are placed under the same system, combined with current artificial intelligence and big data analysis, to create an open intelligent design and manufacturing production chain [10]. This also confirms the advanced nature of the current human-oriented industrial design method. For designers, after obtaining human factors data, they can dig it deeply and use it repeatedly to build a product-cloud platform based on big data, which may broaden their design ideas [11]. Perception includes all human perceptions [12]. In addition to computer-generated visual perception, there are other perceptions such as hearing, touch, and movement [13]. In the future, smell and taste may also be added [14]. Natural skills include human head turning and body movements [15]. After the computer analyzes the participant's actions, a series of processing is performed, and finally the feedback is fed back to the participant's facial features [16]. With the rapid popularization of virtual reality technology, the field of environmental art design in China has also been reformed. As a mainstream technology that simulates the real environment through virtual technology, virtual reality technology has become an indispensable ability in the display and demonstration of modern environmental art design. Virtual reality technology has many characteristics, such as interaction, imagination, and multidirectional perception. It breaks through the limitations of space and time in traditional environmental design and better responds to customers' display and highlights the design effect.

1.1. Efficiency. The design model is displayed to the user in real time, which takes advantage of the network and displays the effect of the work vividly, which greatly improves the efficiency of the design [17].

The application of VR technology to environmental design can show a very high level of interaction skills [18]. The various perspectives and tactile sensations of the landscape can mobilize the multiple senses of the experiencer, and the real interactive experience can better meet the needs of users [19]. We can apply the whole virtual scene to the designer's design of environmental art through R technology. By modifying the virtual scene, the designer will show the changes of the virtual environment in the display. Through this interaction, we will produce a shocking effect of the real environment in the virtual environment. This technology of human-computer intelligent interaction can give people a visual enjoyment.

VR technology is used in environmental art, which puts forward quite high requirements for image processing. Panorama, 3D modeling, FLASH, and other forms, make the image perfectly displayed, and the artistic value is very high. By observing the images, the user not only understands the project structure but also perceives the materials used. The effect seems to be very good so far [20].

Virtual reality technology gives users a strong sense of immersion, resulting in an immersive and lifelike feeling, and most importantly, VR fully considers our psychology and senses. To a certain extent, intrusiveness can also be understood as existence and presence, which mainly reflects the real degree that users feel in the virtual world. By wearing special helmets and gloves, the experiencer can feel the virtual environment world and achieve the best effect, as if they are in the most real environment [21]. Since people are multisensed to the external world, including touch, hearing, movement, and perception, VR technology is also committed to the study of multisensing, so that users can produce the best experience. In the future, the perception of smell and taste will also appear [22]. VR technology can take into account many of the above problems in environmental art design, but there will still be a series of practical problems, such as the display environment is too ideal and difficult to realize in practice. However, in the process of the rapid progress and development of science and technology in the world, these technical problems will be gradually solved, and the problems of VR technology will gradually be made up by powerful scientific and technological forces. Therefore, VR technology will gradually become the mainstream of environmental art design, and it will give new vitality to environmental art design.

2. State of the Art

2.1. Overview of AI Interaction. Artificial intelligence (AI) is one of the three cutting-edge technologies in the 21st century. AI can be divided into "strong AI" and "weak AI". AI that performs tasks requiring intelligence is "strong AI",

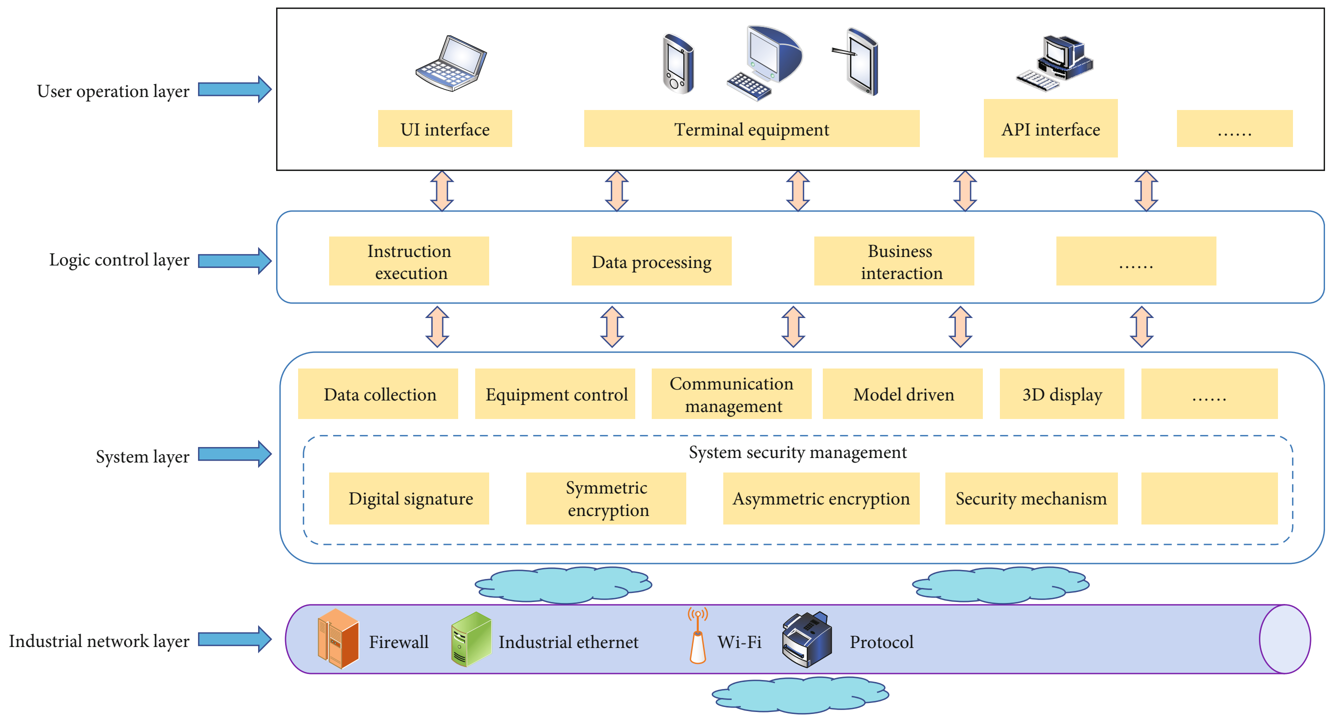

Figure 1: Human-computer interaction framework model in virtual reality environment.

while AI that can only perform specific or set tasks (such as playing chess, and assembling products) is called "weak AI". The British Engineering and Physical Science Research Council believes that the purpose of artificial intelligence technology is to reproduce or surpass the "intelligence" required for some tasks to be performed by human beings in the computing system (such as learning ability, adaptability, reasoning and planning ability, creativity, sensory understanding and interaction ability, knowledge extraction and processing ability, and prediction ability). Born in the 20th century, robotics is a highly interdisciplinary subject involving multiple disciplines and fields, attracting talents from multiple industries to join the research of robotics, and promoting the rapid development of robotics. In the late 1960s, the first intelligent robot was born in the United States. The intelligence of the robot lies in its ability to receive commands wirelessly, find targets, and perform actions autonomously [23]. Since the 1980s, some developed countries abroad have begun to develop dual-arm robots, such as the Baxter dual-arm collaborative robot produced by Rethink Company in the United States and the FRIDA robot produced by ABB Company in Switzerland [24]. In the 1990s, the American TRC company began to sell service robots, and the history of service robots began. At the end of the 20th century, the humanoid walking robot was born in Honda. After that, Honda developed a bipedal humanoid robot with predictive motion control and released the ASIMO robot in 2000. In recent years, Boston Dynamics has developed a large number of high-capacity robots, such as the Spot Mini puppy robot and the Atlas humanoid robot. These robots are capable of performing amazing movements. At present, Atlas humanoid robots cannot only complete simple movements such as walking and jumping but also complete complex movements such as backflips and single-leg jumps. The progress is amazing. The Spot Mini puppy robot can complete self-balancing adjustment on slippery ground, cooperate with two robots to complete tasks, and dance to music [25–27].

With the large-scale application of robots, the interaction between humans and robots seems to be inevitable. Robots and humans work together to complete tasks. In some special tasks, robots can perform better than humans. With the development of technology, robots have become more and more friendly. In addition, the perception capabilities of robots are also increasing. The study of human-computer interaction technology is crucial for taking care of machines. Cooperation between robots is essential, so the interaction technology between humans and robot groups is even more important. Due to the needs of the application, the robot needs to complete more complex actions in the work scene. Complex actions are generally combined with the work scene, and the robot needs to link the front and back actions in the scene to better understand the action as shown in Figure 1.

2.2. Overview of Virtual Reality Technology. 2016 has been dubbed "the first year of the VR explosion". In fact, VR technology has appeared in the middle of the twentieth century, and there was an industrial upsurge at the end of the twentieth century, but later fell into a trough due to technical limitations. VR technology has been on the rise again in recent years, and it seems even more powerful than the last time. Looking around the world, the value of VR technology is gradually being understood and accepted by people, and its

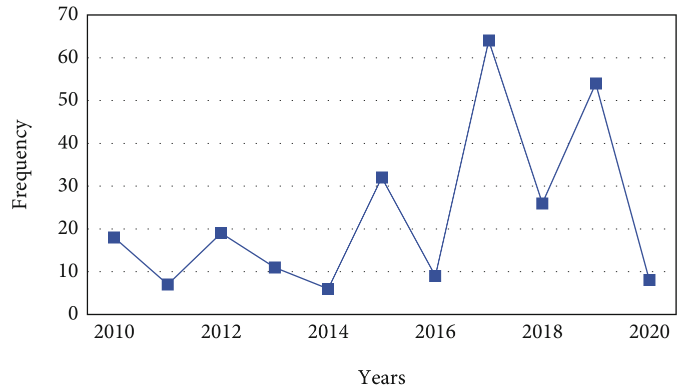

Figure 2: The research trend of environmental design since 2010.

powerful role also makes it an indispensable part of people's lives. Various fields at home and abroad have accelerated industry planning and industrial layout, and the design industry is no exception. In the field of environmental art design, related industries have begun to deploy, creating projects such as "VR + exhibition hall", "VR + real estate", "VR + urban planning", and so on. VR technology has begun to be applied in the field of environmental art design.

2.3. The Core and Value of Environmental Art Design. With the rapid development of computer technology, designers in the field of environmental art design in China now use computer technology to realize their own ideas and design effects, while R technology can better show the designer's design effects in front of customers, and at the same time, with the help of computer designers can better improve work efficiency. In the current environmental design, advanced Internet technology can better show and highlight the value and effect of environmental art design. Designers can show customers the most perfect design scheme through the lowest economic cost. From an objective point of view, the introduction of virtual reality technology into environmental art design from Figure 2 will indeed bring about a series of practical problems, such as the environment being too ideal. However, on the road of technological development, the characteristics of technology cause some problems that are inevitable. In this way, the support brought by virtual reality technology to environmental art design is still very strong. On the basis of realizing the estimation of environmental art design plan, it gives environmental art design new vitality.

Virtual reality technology breaks the limitations of time and space. Under the support of VR, environmental art design spans all conceivable physical environments and adjusts the plan while creating art, which has high artistic and practical value. As far as virtual reality technology and environmental art design are concerned, the two are inextricably linked. They all emphasize the creation of the environment, and their fusion subverts the environment subtly. The most important thing is that in the technical support of VR, the waste of resources caused by repeated design is avoided; the change of design requirements and the real-time output of the computer, in order to observe the overall effect of the design, have quite high economic and social benefits.

On the one hand, VR technology makes up for the deficiencies in traditional ring art design. In traditional design, it may be restricted by space factors. For example, the design scheme exceeds the specific space range and has strong incompatibility. It has a great impact on environmental art design, but this problem can be solved by VR technology, so a perfect solution is obtained.

As mentioned above, virtual reality technology has the characteristics of high efficiency, high interaction, and high introduction, so its design problems are also predictable. After the computer is fine-tuned, it can better meet the design requirements. Compared to traditional design, VR opens up new ways of designing. On the other hand, VR technology effectively avoids some potential problems in environmental art design solutions.

Due to the slight differences between environmental art design and ordinary design, a lot of subject knowledge is required to complete the content of the design plan. If there are technical omissions in it, it may lead to the failure of the design plan. The introduction of VR technology in the design process and the use of table curves and legends for 3D modeling have shown great advantages in this issue. In the design process, if the design points are concentrated on a design platform, the problem will be clear at a glance, and the occurrence of design problems can be effectively avoided. In addition, the use of the database also greatly simplifies the designer's burden and foresees practical problems in construction, which greatly improves the efficiency.

3. Methodology

Grayscale conversion uses the mean formula:

$$\text{Grey} = \frac{(\text{red} + \text{blue} + \text{green})}{3}. \quad (1)$$

According to this principle, the Laplace operator is used to derive the image. According to the derivation formula:

$$f'(x, y) = -4f(x, y) + f(x - 1, y). \quad (2)$$

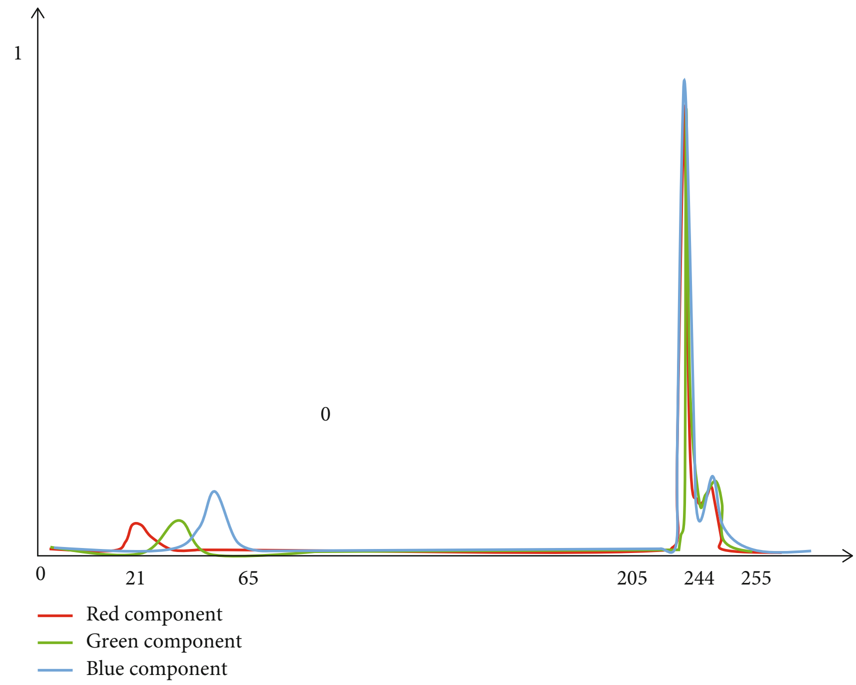

FIGURE 3: Histogram features of environmental design.

Extract coefficient matrix from derivative formula:

$$\begin{pmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{pmatrix}. \quad (3)$$

The general equation for a circle is:

$$(x-a)^2 + (y-b)^2 = r^2. \quad (4)$$

Figure 3 shows the statistical characteristics of the histogram of the designed visual marker. It can be seen from the histogram that the visual marker has a significant numerical increase in the range of 21 to 65 and 205 to 244.

Set 80% of the training samples as the training set and 20% as the test set. The training set is used to train the neural network, and the test set is used to test and evaluate the trained neural network. The training set is represented as:

$$\left[\left(x_1^{\text{test}}, y_1^{\text{test}}, r_1^{\text{test}}, x_2^{\text{test}}, y_2^{\text{test}}, r_2^{\text{test}} .., r_n^{\text{test}}\right). \quad (5)$$

The activation function of the neural network is set as:

$$h(x) = \max(0, x) = \begin{cases} x(x \geq 0) \\ 0(x < 0) \end{cases}. \quad (6)$$

Each node weights the input data and adds the bias value:

$$a_j = \sum_i w_{ji} x_i + b_j. \quad (7)$$

The final output of the node needs to be processed by the activation function, and the above formula is brought into the activation function to get:

$$Z_j = h\left(\sum_i w_{ji} x_i + b_j\right) m_j. \quad (8)$$

The training errors are:

$$E_X = \frac{1}{n} \sum_i \left(X - X^{\text{train}}\right)_i^2. \quad (9)$$

$$E_Y = \frac{1}{n} \sum_i \left(Y - Y^{\text{train}}\right)_i^2. \quad (10)$$

$$E_Z = \frac{1}{n} \sum_i \left(Z - Z^{\text{train}}\right)_i^2. \quad (11)$$

The gradient of the error, that is, the partial derivative with respect to the parameter, where the mask parameter is a preset parameter, and the gradient calculation formula is:

$$\nabla_W \frac{1}{n} G_1(W, B, M) - X^{\text{train}}{}_2^2. \quad (12)$$

After the training is completed, the test samples can be brought in to verify the effectiveness of the neural network. The computational cost of depthwise separable convolution with a width multiplier α is:

$$M_\alpha = D_K \cdot D_K \cdot \alpha M + \alpha M \cdot \alpha N. \quad (13)$$

The second hyperparameter used to reduce the computational cost of neural networks is the resolution multiplier ρ. We use this hyperparameter to input the image, and its essence is that the representation of each layer is cut by the same multiplier. Actually, we use α by setting the input resolution. As the core layer of the network, the depthwise separable convolution with a width multiplier α and a resolution multiplier ρ, its computational cost can be expressed as:

$$M_{\alpha\rho} = D_K \cdot D_K \cdot \alpha M \cdot \rho D_F \cdot \rho D_F + \alpha M \cdot \alpha N. \quad (14)$$

The purpose of designing the tiled default border is to make the special feature map correspond to the special scale of the object. Each feature map is calculated as follows:

$$s_k = s_{\min} + \frac{s_{\max} - s_{\min}}{m-1}(k-1), k \in [1, m]. \quad (15)$$

Compared with extremely high-precision automated machines and equipment, social people are still the decisive factor in completing difficult and complex tasks. It can be seen that the future industrial design needs to be supported by basic scientific research led by human factors, and at the same time, with the construction of intelligent design scenarios and the continuous innovation of intelligent manufacturing technology, more and more intelligent clouds are equipped with human factors data. The product system will also be gradually applied to the industry.

4. Result Analysis and Discussion

Virtual reality technology is an advanced computer technology that can improve environmental art design. It can improve customers' multiperception, budget accuracy, and interaction with customers. The application of VR technology in the field of environmental art design has become an indispensable part. VR technology can be displayed more humanized in front of audiences and customers, and more richly show the charm of environmental art. This chapter will explore the effectiveness and feasibility of the entire problem-driven environmental design through human-computer interaction technology and virtual reality technology, in order to provide some practical insights for future research on the development of computational thinking across disciplines. Each round of teaching practice has gone through three complete stages: design, implementation, and evaluation. Design is activity design based on the design principles and strategies of interdisciplinary problem-driven environmental design.

4.1. Research Objects. The subjects of the study are students from East China. There are 32 students in total. The subjects in the study had basically no experience of using a computer or learning programming, as shown in Figure 4.

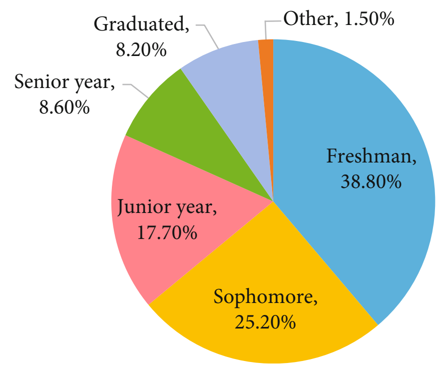

Figure 4: Data map of experimental research objects.

Individual differences were analyzed according to the research subjects. Because the experimental objects of this study are college students, college students are in the specific operation stage of Piaget's cognitive development stage theory, which is an important stage of thinking enlightenment. Its thinking is multidimensional and reversible, and its perceptual experience is mainly visualized. And with the growth of age, the process of understanding and thinking of college students gradually transitions from figurative to abstract. The information representation suitable for college students at this stage is visual content such as pictures and charts. Since the concept of computational thinking used in this research is in the context of computer programming, and the experimental objects are college students, it is necessary to use the support of visual programming tools, such as Scratch and Swift playgrounds.

4.2. Application Process. The application process is mainly divided into the course content of pretest, posttest, process evaluation, and environmental design. The pretest is mainly a numeracy test and a scale test of computational thinking. The numeracy test measures a student's level of prior programming knowledge. The course content of environmental design and design is the information technology course with redesigned mathematics and programming content, namely, visual programming Scratch and graphic drawing, panda kit and distance perception, and micro: bit robot and data management. Process evaluation is a qualitative evaluation based on classroom observation and formative feedback. Posttests are quantitative assessments of computational thinking, cognitive load, self-efficacy and mathematical knowledge, programming knowledge, and qualitative assessments of semistructured interviews and interviews. As shown in Figure 5.

Specifically, from the teaching method of designing cross-disciplinary real problems, the specific strategies are: (1) teachers use inspiring cross-disciplinary problems as the starting point of learning; (2) task-driven by pairing the problems in the programming manual; (3) problem records during student debugging.

From the cooperative interaction relationship of pair programming in the script support group, the specific strategies are: (1) clear roles and task assignments through the pair programming manual and checklist; (2) specific steps for subtasks exemplified by the pair programming manual; (3) regular role switching is carried out under the supervision of teachers, so as to ensure that students participate in

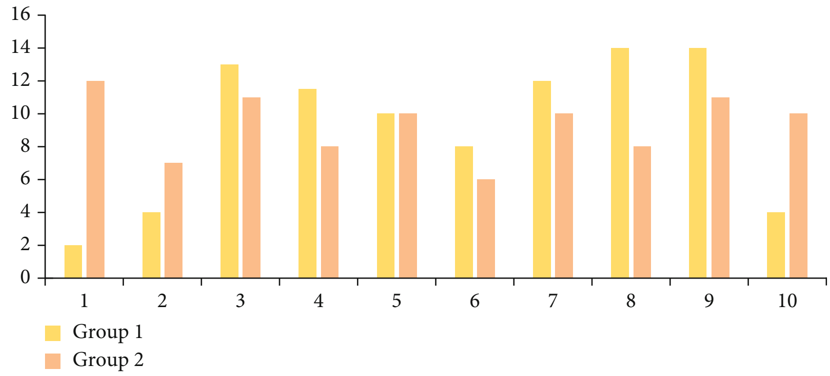

Figure 5: Quantitative strategy evaluation of the implementation process.

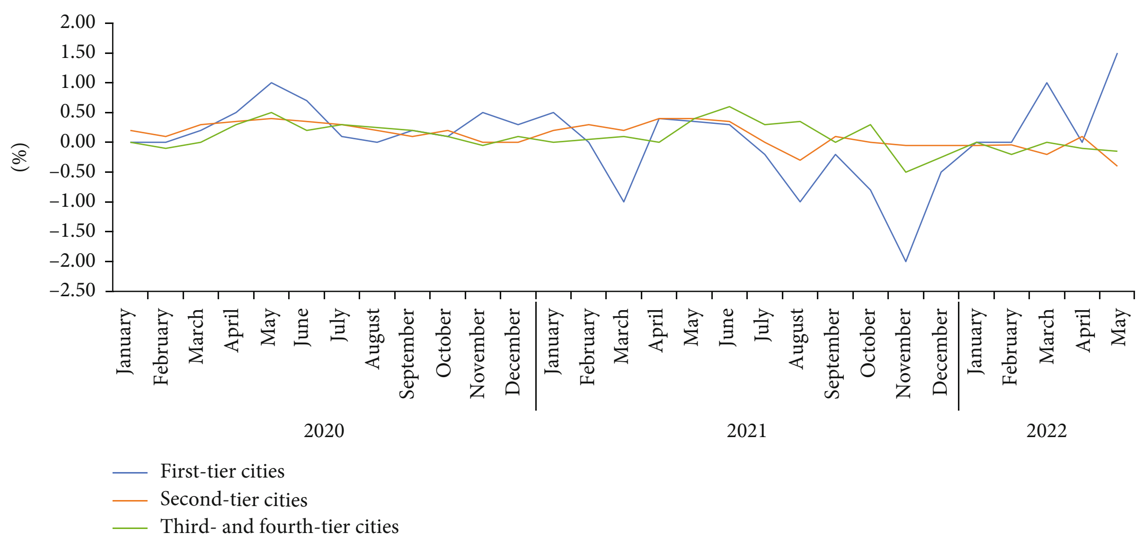

Figure 6: Data map of urban environmental design implementation.

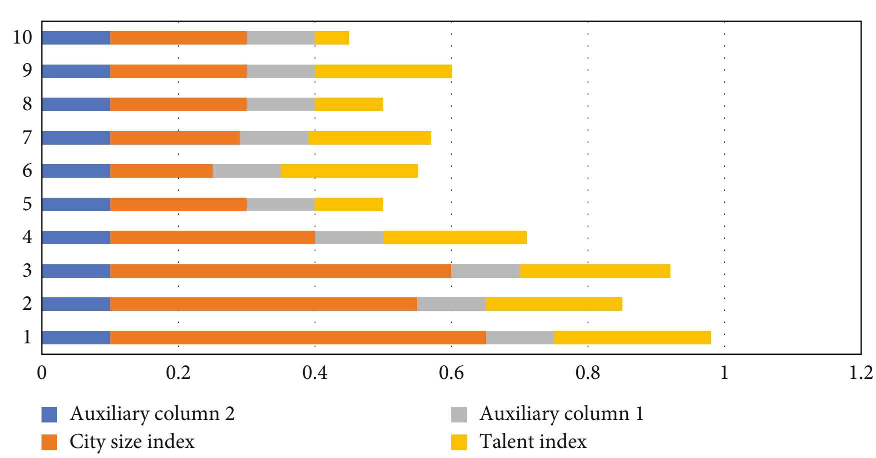

Figure 7: CAD data map of urban environment design buildings.

the classroom equally; (4) the works are exchanged and shared in the matching group.

From the technical environment that supports the visual representation of computational thinking, the specific strategies are: (1) visual programming tools for conceptual visualization (in this study, mathematical concepts and programming concepts); (2) problem-solving process thinking through problem scaffolding and task scaffolding; (3)

collaboration scripts visualize the collaboration process (pairing programming manuals and checklists).

Among them, the first round of teaching uses visual programming Scratch.

Quantitative data collected after the first round of the pre- and post-test includes the scores of the Computational Perspectives Scale and the Cooperative Perception Scale, and only the posttest is the mathematics academic performance and Bebras competition questions. Qualitative data are debug record forms, semistructured interview forms, and classroom observation records.

The specific implementation process of 3D virtual VR technology in urban environment art includes the following steps: when implementing 3D virtual VR in the urban environment, determining the overall design plan is the first priority, and after confirming the plan, it will be. After the model is constructed, import the model into the 3D virtual VR technology platform to adjust various details, and in the 3D virtual VR In the VR technology platform, the size, material, and other details of the objects are adjusted, and the application effects of different adjustment results are analyzed; finally, specific plans, 3D renderings, etc. are obtained for selection and use. Figure 6 shows the implementation data of the 3D virtual VR technology.

According to the overall design requirements of urban environmental art and the size of the area, the model constructed in this paper should have real spatial information and geographic information, and the texture of the details can accurately represent the specific characteristics of the model. In order to meet the detailed requirements of the model, the resolution of the image obtained by remote sensing should be above 0.5 m, and the requirements for point cloud data are more precise. The texture information of the surface is acquired by the SLR, as shown in Figure 7.

5. Conclusion

The application of virtual reality technology in the environment enables designers to use computers to scientifically process virtual reality technology systems, so that the scene designed by designers is not only a virtual reality technology, but also a real object model in real life. For example, before implementing an environment-based design approach, designers can use virtual reality technology to feel their own design, enabling them to discover deficiencies in their design, and report and discuss to the construction unit. At the same time, the designer can also modify the model according to the requirements of the builder, make it virtualized, more intuitively identify the problems in the design and model, and identify the change scheme according to the problems. This paper provides a good foundation and opportunity for the innovative development of virtual reality technology and human-computer intelligent interaction technology in environmental design and can effectively promote the overall improvement of the reliability, efficiency, and accuracy of environmental design. With the development of science and technology, virtual reality technology is becoming more and more mature, and its benefits are becoming more and more obvious. Designers should continue to tap the application potential of virtual reality technology, change the traditional complex design tools, use virtual reality technology to organize art, enrich design tools and innovative design concepts, and design more classic works.

Data Availability

The figures used to support the findings of this study are included in the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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