The Research on the Forms and Advantages of VR in Physics Teaching

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Abstract. In traditional physics experiments, the process and results of experiments are often presented verbally by teachers and in books, which do not allow students to understand the nature of the experiments and the techniques used in the experiments, based on this , this paper investigates how to combine VR technology with physics teaching so that students can deeply understand their knowledge and improve their learning efficiency, and the development with the characteristics of VR , the application forms and teaching characteristics of VR in physics teaching, the advantages of VR and the design principles of VR in physics teaching are explored separately, and conclusions are drawn. The results finds that the application forms of VR in physics teaching are Demonstration Experiments, Measurement Experiments, and Investigation Experiments, and the design principles of VR in physics experiments include The Constructivist Theory, The Embodied Cognition Theory, The "learning by doing" theory, and there are six aspects of advantages in physics teaching. Through this paper, the research hope can make some contributions to those who do this related research in the future.

Keywords: VR, physics, teaching, application.

1. Introduction

VR technology refers to Virtual Reality, is a new practical technology in the twentieth century, mainly refers to the comprehensive establishment of high-tech based on computer technology, human-computer interface technology, simulation technology, and other technologies, by establishing a multi-dimensional space virtual environment, allowing users to personally participate in it, and good interaction with the environment [1]. Virtual Reality is a new practical technology developed in the twentieth century that allows users to immerse and interact with the environment by constructing a virtual space. Physics teaching is one of the most important science courses in schools, and one of the most important modules is the physics experiment, which allows students to understand more deeply the knowledge points taught in class through the process and results of doing experiments, and to improve their experimental skills and abilities. However, in the traditional educational environment, physics experiments are usually conducted only through the teacher's dictation and information from books, because some physics experiments are difficult to prepare and can be extremely expensive, making it difficult to demonstrate in class and impossible for students to conduct hands-on experiments. With the expansion of education, the traditional teaching model is no longer suitable for the current teaching environment, and VR technology can make up for the shortcomings of traditional teaching and further improve the quality and efficiency of teaching, so need to explore how to integrate education and VR technology and find the development path of VR teaching. This piece article is divided into two chapters respectively, including the form of VR in physics teaching references and characteristics, hoping to make a small contribution to those who do this related research in the future.

2. The Forms of VR in Physics Teaching

2.1. The Development and Characteristics of VR in Physics Teaching

VR refers to Virtual Reality, a new practical technology developed in the twentieth century, whose main feature is to combine reality and virtualization by creating a virtual space in which users can

immerse themselves and interact with the environment, giving them a more realistic experience in the virtual environment. In physics experimental teaching, the application of VR technology aspects have three typical characteristics, one is immersive, that is, through the construction of a simulation of the virtual world, allowing people to see and hear everything that happens in it, this authenticity can allow people to be immersed in this virtual world in all aspects. The second is interactivity, mainly through a variety of sensors, interacting with a multi-layered information environment to achieve openness in the environment and thus respond to the user's output. The third is conceptual, VR technology is based on the characteristics of physics experiments and teaching reality and involves the construction of a virtual world, students can through qualitative, quantitative, and other aspects of integrated physics experimental environment to obtain perceptual and rational cognition, thereby improving their understanding and mastery of the content of physics experiments [1]. The first advantage is the immersive experience. VR allows users to perceive everything in a virtual space by creating a virtual space that gives them a real feeling of being immersed in it. The second advantage is interactivity, VR can now be configured with a variety of sensors, when the user interacts with the virtual environment, the virtual environment will give feedback on the user's behavior, providing a good interactive experience. The third advantage is conceptualization, in physics teaching, students can easily change various variables, allowing students to make experiments that are difficult to achieve in reality so that students have a deeper understanding of physics knowledge.

2.2. The Forms of VR in Physics Teaching

VR Learning physics will require some experimental learning, but only rely on the text in books and teacher dictation is not able to let students understand the essence, and because some physics experiments require a lot of preparation and are expensive, it is difficult to show in the classroom, and VR technology can make up for this shortcoming.

The first kind is Demonstration Experiment, Demonstration experiments are the most commonly used method in theoretical teaching, and generally have high requirements for teaching aids, but for complex experiments and theoretical knowledge, traditional teaching can only be done through oral teaching methods, which is difficult to describe clearly. However, VR technology can be borrowed to create teaching simulation courseware, with a three-dimensional, realistic roaming screen to show the environment, scenes, and target objects, with only mouse and keyboard control, so that students can immerse themselves in the completion of the understanding and mastery of knowledge. For example, in the screen simulation teaching courseware of machining, students can activate the simulated object crane and control the crane to move, while inputting gravity, inertia, and other mechanical algorithms into the object, whose motion trajectory is the same as the real-life moving situation, and students can observe its changes in the control survey with the mouse to master this knowledge point [1]. Demonstration experiments are the most commonly used teaching methods, but due to the high requirements for equipment, often only use text pictures or oral narration, which is difficult for students to understand clearly. However, through VR technology, a virtual environment can be created by adding a variety of three-dimensional components to complete the experimental preparation, and then through the operation students can let students immerse themselves in the experiment and complete the mastery of knowledge. For example, in the gravitational acceleration experiment, people need to control the iron ball and feather in a vacuum environment while falling, in the VR virtual environment, students only need to input the gravity, mass, and other parameters, and people can observe the same results as the real experiment so that students can master the knowledge point.

Measurement Class Laboratory Physics Experiments is common types of experiments, the purpose is to test whether students can operate the experimental equipment flexibly, and these measurement experiments vary in complexity, if students can not personally test, will not be able to master this operation technique. In actual teaching, because of the limited physics laboratory teaching instruments, in a section of physics laboratory teaching, teachers can not ensure that every student personally involved in physics experiments. With the help of VR technology teachers can effectively

assist in teaching physics experiments, build a corresponding virtual experiment system, provide a variety of instrument models for physics experiments, and its parameters through the real thing consistent, which can maximize the safety and accuracy of students in the simulation of experiments [1]. In the measurement experiment, the purpose is to test whether students can flexibly use a variety of experimental equipment, and the degree of difficulty of these experiments. If students can not personally experiment, it is difficult to master the technology, and in the real experiment, due to the number of instruments, teachers often let students observe or take turns in the experiment, so it is difficult to let each student personally involved in the experiment, but through VR technology to create a virtual space for the experiment to construct a variety of instruments needed to model the parameters and the same as in reality, so that can ensure the safety and accuracy of students in the experiment.

The Investigative Experiment is also an important type of experiment in physics laboratory teaching, this type of experiment is "problem" oriented, guiding students to analyze, observe and explore the content of physics experiments, and finally reach physical conclusions, through this experiment, it can help students find the essence of physical knowledge, further strengthen students' ability to observe physical knowledge and investigate physical theories, and improve their scientific literacy, but such experiments are easily affected by external factors, and with the help of VR technology can make up for this deficiency [1]. The investigative experiment is also a common and extremely important experiment, this kind of experiment often lets students ask questions, and then let students analyze, observe and explore the content of physical experiments, this type of experiment can let students find the essence of physical knowledge, strengthen students' ability to observe experiments and inquiry theory, improve scientific literacy, but the biggest problem of this kind of experiment is easy to receive external but the biggest problem of this type of experiment is that it is easy to receive interference from external factors, and VR technology can circumvent this shortcoming. For example, in the "relationship between mass and gravitational acceleration" experiment, the teacher can first tell students the basic theory, the question "whether the mass of the object affects the speed of free fall", and then let students think freely, and then complete the experiment with the help of VR technology In this way, not only do we not have to spend a lot of money on experiments, but we can also avoid errors in experiments, and at the same time let students improve their observation skills through experimental scenarios to achieve a good learning effect.

3. The Features of VR in Physics Teaching

3.1. The Design Principles of VR in Physics Experiments

VR has the characteristics of immersion, imagination, and visualization, which can be used in physics experiments to enhance students' learning experience and efficiency. Some principles in physics teaching can be combined with VR to provide students with better help in physics learning. Students' physical learning activities supported by VR technology can be divided into principles through students' perception and interaction in the simulated real environment, and there are the following categories:

The Constructivist Theory believes that the construction of knowledge mainly comes from the experience of real life, and only in the actual situation can knowledge be truly understood and known, while teaching activities are to create a learning situation for learners, prompting them to know and understand knowledge in the experience of learning [1]. The constructivist theory believes that the main source of knowledge comes from real-life experience, and it is in the real context that knowledge can be truly understood. Teaching should create a learning context for learners so that they can understand the knowledge in learning. Students can immerse themselves in new knowledge by restoring life to the virtual environment created by VR.

The Embodied Cognition Theory believes that human cognition is not only controlled by the brain but also obtained by one's perception of the outside world. First, one of the important factors affecting the human cognitive process is the body's perception of the external environment, and the human

brain is influenced by the body's perception in addition to the control of the body. Therefore, cognition, body, and environment are a dynamic unity [1]. When students learn the corresponding knowledge points through VR technology in the physics classroom, through observe and feel the process of the simulation experiment, the experimental results and the experimental space, the students can intuitively grasp the process of the physical experiment and the experiments involved in the experiment. The embodied cognition theory of VR in physical experiments can not only bring new experiences to students, but also enable students to clearly grasp the learning that is usually impossible due to insufficient conditions or difficult experiments in an immersive environment.

The last ons is the "Learning by Doing" Theory: The traditional teaching method of oral instruction by teachers tends to focus only on knowledge education. Students learn mechanically and passively, neglecting the cultivation of creative thinking. Dewey's theory of "learning by doing" emphasizes that learning is a by-product of action, and teachers can create a "doing" environment to guide students to think and gain knowledge. This teaching theory provides a solid theoretical foundation for the application of VR technology in physics laboratory teaching [1]. In traditional teaching, the teacher usually narrates the knowledge verbally for students to understand, but such education often focuses only on mechanical knowledge learning and does not bring students to develop creative thinking. However, the interactive nature of the VR environment allows students to practice in a realistic experimental environment, stimulating their interest in learning and improving their learning efficiency.

3.2. The Advantages of VR in Physics Teaching

The first one is stimulate students' learning motivation and enhance the learning experience: The interactivity of virtual reality can well enhance students' interest and attention to physics experiments. Its immersive nature gives students visual and auditory stimulation, allowing students to feel involved in real experiments through a "first-person" perspective, allowing them to learn and investigate physical phenomena [2].Virtual experiments and real experiments combined to enrich the teaching form. Real experiments have the advantage of experimental error analysis and trial and error of experimental operations, which is part of the VR experiment can not reach. VR experiments can make up for the shortcomings of real experiments in many aspects. In the current teaching situation, the combination of the two teaching advantages, more helps to improve the teaching effect, while enriching the teaching form of physics experiments [2].

The second is deepen knowledge learning and cultivate thinking ability: The experimental scenes built by VR technology break the limitations of space and time and expand students' cognition. It can also be used to enhance the interconversion of students' "explicit and implicit" knowledge [2]. Through the experimental scene built by VR technology, students can cultivate logical thinking ability in simulated real situations, grasp the physical knowledge they have learned through real and specific thinking, and can deeply understand and recall physics teaching when applying physical knowledge in the future.

The third is promote knowledge transfer and innovation: Using VR technology, experimental content can be visualized and visualized. Through the virtual context, it can promote the mutual transformation of students' explicit and implicit knowledge, and promote knowledge transfer and innovation [2]. When students only learn physical knowledge but can not truly understand the content, the technical support of VR in physics teaching enables students to deeply understand the presentation form of physical knowledge when simulating real experiments. Through real experience, it can also deepen the invisible knowledge, so that students' explicit knowledge and invisible knowledge in physics teaching can be transformed into each other, and they can truly master the key points of physics learning.

The forth is expand the content and space of experimental teaching. VR technology applied to physics experimental teaching can improve its effectiveness in two aspects: content and space. First, the virtual experiment platform built by VR technology can complete some dangerous experiments or high-cost experiments that are difficult to complete in traditional teaching experiments, solving the

problem of insufficient experimental equipment and instruments; second, traditional physics experimental teaching is mostly limited to a one-dimensional physical space, while VR technology can be expanded to a two-dimensional space that integrates physical experimental space and virtual space, in which teachers do not need to In this environment, teachers do not need to move the experimental equipment and can flexibly organize teaching, thereby improving teaching efficiency.

The fifth is create simulation situations with the help of virtual reality technology. VR technology can create simulation situations with the help of a variety of technologies, the students will quickly exhaust the learning atmosphere, and then produce a sense of immersion, if use VR technology in physics experimental teaching, then students will be able to personally experience and explore the basic concepts and acquisition of knowledge in a simulation situation so that it is easier to grasp the experimental content and conclusions, and then deepen inquiry and accumulate experience for real experiments. At the same time, students can also find unforeseen problems from the practice process and continuously improve them, which can consolidate their mastery of knowledge and cultivate independent inquiry and innovative thinking.

The sixth is reduce the cost of trial and error and improve teaching efficiency. The policy experiment platform built based on VR technology can reduce the cost of error in physics experiments, allowing students to boldly try and experience situations that are difficult to achieve in life, helping students to find the differences and connections between theoretical knowledge and concrete practice, to better master the principles and content of physics experiments. At the same time, the intelligent search function of this simulation experiment platform can also solve the difficulties encountered by students in the experiment in time and improve their experimental efficiency [1].

VR technology can create a virtual environment to achieve the effect of real experiments, in real experiments, students may not be able to do experiments because of equipment problems only through the teacher's oral and text materials to understand the way the experiment, so students do not learn to bring the knowledge of these experiments, only mechanized understanding. With the help of VR technology, it is possible to create a virtual environment in which realistic experimental equipment can be created to get rid of the lack of equipment.

It is difficult to do some experiments in reality, such as some experiments with harsh environmental requirements such as vacuum environments or ideal experimental models proposed by some scientists such as the requirement of 0 friction of matter. Some experiments require changing one variable to compare observations, but it is often difficult to control without affecting the other changes. Many experiments have important pedagogical implications but for such reasons can not be shown to students, and VR technology can bring these experiments to life. For example, the "iron ball and feather at the same time from the vacuum environment drop" experiment, this experiment is the most basic experiment on the acceleration of gravity, reflecting the acceleration of gravity and mass-independent of this important concept, but for a large vacuum environment such conditions are too harsh, so the teacher can not let the students carry out experiments on the spot, however, by building a virtual environment with VR and inputting the required parameters, students can easily visualize the experimental process and conclusions, and many uncertainties can be eliminated to ensure the accuracy of the experiment.

4. Conclusion

In view of the cumbersome learning of physics theory, the complexity of experiments and the potential safety hazards in some experiments, this paper studies the teaching principles, application forms and advantages of VR technology in physics teaching according to the characteristics of physics teaching and strategies to improve the learning effect. Through the application form Demonstration Experiment, Measurement Class Laboratory Physics Experiments, The Investigative Experiment of different types of VR in physics teaching, and the teaching principles such as The Constructivist Theory, The Embodied Cognition Theory, The "learning by doing" Theory, and the application of VR in physics teaching mainly has 6 advantages: stimulate students' learning

motivation and enhance the learning experience,deepen knowledge learning and cultivate thinking ability,promote knowledge transfer and innovation,expand the content and space of experimental teaching,create simulation situations with the help of virtual reality technology,The sixth is reduce the cost of trial and error and improve teaching efficiency.

Through the conclusion, it can be found that VR technology can provide great help for physics teaching and can realize situational teaching. VR technology allows students to observe the experimental process and results through immersive observation, allowing students to understand experimental techniques and steps, and at the same time significantly improve experimental efficiency. Virtual reality technology can provide students with a deeper understanding of knowledge and skills based on traditional teaching. If future academics want to delve deeper into this aspect, they can pay more attention to how VR technology is presented in the classroom.

References

[1] Chunyan Sun, Analysis of Teaching Strategies for Physics Experiments Based on VR Technology [J], Science and technology vision, 2022(12):11-13. DOI:10.19694/j.cnki.issn2095-2457.2022.12.03.

[2] Xiaopan Chen, Research on the design and application of high school physics experiment based on VR technology [D], Shihezi University, 2021. DOI:10.27332/d.cnki.gshzu.2021.000528.