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The Exploration of the Application of Virtual Simulation in Physics Experiment Teaching

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***Abstract*—Due to the restriction and influence of various factors, it is difficult for many schools to set up enough experiments in physics teaching to meet the requirements of the new curriculum standard. Starting from the problems and difficulties existing in real experiments, this paper explores the effective application of virtual simulation experiments in physics experiment teaching.**

Keywords—Simulation, Physics experiment, Teaching, Application

I. INTRODUCTION

In physics teaching, experiment teaching is an indispensable part of physics teaching activities. Experiment teaching can help students master and understand knowledge points and cultivate their ability to analyze and solve problems. However, there are many difficulties in the current physics experiment teaching, such as the serious shortage of experimental instruments caused by insufficient investment in laboratory hardware, the difficult operation and high risk in real experiments, the uneven experiment level of teachers, the long maintenance period of experimental instruments, the insufficient depth of experiment teaching contents, and the short opening time of laboratories, etc. These problems are all factors that restrict the development of physics experiment teaching. In order to solve these problems, this paper uses information technology to improve the teaching mode of physics experiment, explore the characteristics and advantages of virtual simulation experiment, and further explore the new mode of virtual simulation experiment applied in modern physics teaching, so as to improve students' experimental ability.

II. THE MAIN PROBLEMS EXISTING IN REAL PHYSICS EXPERIMENT TEACHING

A. The Experiment Conditions are Backward and the Experiment Funds are Insufficient

With the continuous progress of modern technology and equipment, laboratory construction needs more funds, but many units have not increased the investment of laboratory funds. These equipment have serious aging and frequent failures, and have very slow detection, calculation and operation speeds, some of which cannot even meet the basic requirements for experiments. This does not only increase the management difficulties of managers in laboratories, but also makes laboratory users inefficient and seriously affects their enthusiasm for experiments.

At present, many basic research laboratories cannot be guaranteed funds. Some units have invested more funds in the research laboratories, and the basic research laboratories do not have a large amount of financial support, leading to the backwardness of basic laboratory conditions. With the continuous increase of research scale, many laboratory facilities cannot meet the experiment requirements, the number of experimental instruments is insufficient, and the updating speed is slow, which may lead to the long operation time of instruments and inaccurate experiment results. Experiment instruments lag behind the development of science and technology. Some laboratories have no relatively stable financial support and can only rely on undertaking some profitable projects to obtain funds to maintain the survival and development.

B. The traditional Teaching Methods are Difficult to Meet the Teaching Requirements of Comprehensive and Innovative Experiments at this Stage

Because of the particularity of the subject, physics needs a large number of experiments to assist teaching and verify the basic theory. With the rapid development of science and technology in the 21st century, the traditional physics experiment teaching can no longer meet the current social requirements for high-quality physics talents. At the same time, the traditional teaching methods and means of physics experiment are single, which is difficult to meet the needs of students for autonomous and creative learning. Therefore, the reform of physics experiment teaching is imperative. Its aim is to train high-quality innovative physics talents for the society to adapt to the development of modern science and technology. The reform of physics experiment teaching should first change the thinking and use modern scientific and technological achievements, improve the teaching mode and means, such as making full use of multimedia CAI and virtual simulation system, and create a diversified and open experiment teaching mode.

C. The Real Experiment Has the Problems of Difficult Operation and High Risk

In the teaching of physics experiments, some experiments are difficult to operate and dangerous to students, such as the determination of the electric quantities of the circuits used in daily life, the medium potential of high voltage, electromagnetic applications, nuclear reactions, etc. For these difficult and dangerous experiments, many schools can only teach students theories at present, but there is no way to further teach them by experimental methods. In the end, students can only have a little knowledge or can only learn by rote to cope with the exam without really mastering its essentials, let alone learning or even using it.

D. The Real Experiment is Obviously Limited by the teaching Environment and Time and Space

Real experiments are influenced by laboratories and experiment instruments, and many experiments can only be completed in laboratories. The simultaneous teaching of theory and experiment is the key in middle school physics teaching. However, due to the influence of real experiments, experiments can only be completed in laboratories. According to the investigation, in the teaching and learning of physics experiments, due to the limitation of experiment facilities, places and time, many experiments cannot be set up in many middle schools, and the teaching is mainly talking about experiments, which is very bad for students to master knowledge and improve their ability.

E. Some of the teaching contents are abstract, making it difficult for students to master key knowledge points

In physics experiment teaching, there are many contents that are abstract, difficult for teachers to explain and difficult for students to understand, such as the teaching of current, magnetic field and electromagnetic effect, because these things are real, but they cannot be seen or touched.

III. ADVANTAGES OF VIRTUAL SIMULATION EXPERIMENT TEACHING

Simulation experiment is a virtual experiment platform that can realize experiment operation without instruments. Unlike traditional real experiment, simulation experiment completely simulates real experiment design. Compared with the real experiment, the simulation experiment platform has powerful functions and can solve the problems that cannot be implemented in the real experiment, such as sound propagation, circuit connection, high voltage control, electromagnetic field energy conversion, earthquake, nuclear explosion, etc. Compared with the real experiment, the physical simulation experiment has the following advantages:

A. It covers a wide range of experiments in middle school physics.

Because the simulation experiment is a high school physics experiment application software developed by using modern educational technology and other related knowledge, making full use of computer technology and corresponding software, the simulation experiment developed in the face of the shortage of the laboratory can include all the experiments of high school physics, including all the experimental contents such as electricity, mechanics, acoustics and optics.

B. Full simulation, realistic equipment and experimental process, from the beginning to the end of the experiment, fully simulate the real experimental environment.

Simulation experiment is a virtual experiment designed on the basis of real experiment. The original intention of the design is to replace the real experiment to a certain extent. Therefore, the simulation experiment is designed with full simulation of the real experiment and the closest to the real experiment is the goal.

C. Innovative experiment equipment cannot only complete the experiments required by the new curriculum standard, but also explore and learn according to the autonomy of the equipment.

When designing a simulation experiment, it can be designed as a complete operational experiment and a DIY experiment according to the requirements. DIY experiment is an innovative inquiry experiment, and there is no restriction on the operation process and experiment results in the laboratory. It can be innovated according to the knowledge learned and a new experiment can be designed.

D. Mobile laboratory.

Simulation laboratory is a series of educational virtual experimental platforms based on computers, tablet computers and mobile phones. They have broken away from the constraints of real experiments on the environment and appeared in front of us in a digital form and can easily do experiments on computers and mobile phones. The simulation experiment does not only support computer operation, but also supports mobile terminals such as tablet computers and mobile phones to truly realize multi-terminal operation and learning.

E. Break Through the limitation of Time and Space.

Compared with the simulation experiment, the real experiment is influenced by the laboratory and experiment instruments, and many experiments can only be completed in the laboratory. The simultaneous teaching of theory and experiment is the key in physics teaching. However, due to the influence of real experiments, experiments can only be completed in the laboratory, and due to the time limit, the time for teaching in the laboratory is very short. The simulation experiment belongs to the virtualization experiment and can be used through the virtual experiment platform. In the information age, mobile phones, tablets, computers and other tools can be seen everywhere around us. Using these tools, the simulation experiment can be operated without the influence of time and space and can be done anywhere and anytime.

F. Less Investment.

Simulation experiments are different from real experiments. Expensive experiment instruments are a major constraint to the establishment of physical laboratories. In some schools, due to funding problems, even a complete laboratory cannot be established. Simulation experiment is based on modern computer and network technology, and belongs to virtual experiment. It can be used by learners through terminal equipment such as mobile phones without experimental instruments and laboratories, so it is much less expensive than real experiment.

IV. THE APPLICATION OF VIRTUAL SIMULATION IN PHYSICS EXPERIMENT TEACHING

In physics experiment teaching, it is very important to cultivate students' interest in learning, while in physics teaching, what cultivates students' interest in learning is experiment, which is the foundation of physics teaching, and most theoretical knowledge in physics teaching is a summary of experimental phenomena. The design of the simulation experiment is to solve the problems existing in the real experiment. To a certain extent, the simulation experiment can be used to instead of the real experiment in the teaching process. Therefore, the design of the simulation experiment has high requirements.

A. The Design of Simulation Experiment Requires Scientific Rigor.

As an experimental platform that can replace real experiments, the experiment phenomena and conclusions obtained from simulation experiments should not only meet the experiment requirements but also conform to real experiments. The simulation experiment should be combined with the real experiment in the design process, and must be consistent with the whole process of the real experiment. The simulation degree should be high and the design should be scientific. In addition, the simulation experiment must be scientific and rigorous in the processing of experiment data. The experimental conclusion is the key to the experiment. The processing of the experiment conclusion that must be considered in the design of the simulation experiment should not only meet the requirements of teaching materials, but also be easy to handle, easy to understand and conform to the objective reality.

B. The Design of Simulation Experiment Requires Practicality and Beauty.

The design of the simulation experiment is for teaching. The real experiment plays an irreplaceable role in the experiment teaching. It cannot only cultivate students' practical ability but also stimulate students' interest in learning. The real experiment cannot be all-inclusive due to the influence of the environment. Practicality must be considered in the design of the simulation experiment. At present, most people study by mobile terminals, such as mobile phones, etc. The simulation experiment platform should be considered not only for use on computers, but also for use on mobile phones, tablet computers, etc. Similarly, the appearance design should also be close to nature, and the simulation experiment is designed according to the real experiment. Therefore, the experiment instrument and experiment platform should be close to the real object, and the interface design should also be neat, clear, beautiful and easy to operate.

C. The Design of Simulation Experiments requires a Wide Range of Coverage, Including all Experiments and Innovative Experiments in Middle School Textbooks.

The experiment in the textbook is a traditional experiment. The purpose of the design is to facilitate the experiment teaching. For the experiment that cannot be completed in the real experiment, the simulation experiment can be replaced to a certain extent. The experiment designed in combination with the textbook is conducive to the use of teachers and students. Innovative experiments are designed for DIY experiments in order to stimulate students' interest in learning and brain activity. Experiments in homework can also be completed through DIY experiments to achieve the popularity of experiments in physics teaching.

D. The Design of Simulation Experiment Requires the Experiment to be Easy to Operate.

The complex experiment operation of physics will make students who have just come into contact with this subject be weary of learning, thus giving up the subject of physics. In physics teaching, both theoretical and experiment teaching should follow the principle of simplification of complex things. The design of the simulation experiment should also follow this principle. The experiment should be easy to operate and can be completed independently even without the guidance of teachers.

E. Insist on the Principle of "Trying to be Reality and Combining Reality with Virtual"

The virtual simulation of physics experiment teaching is different from other disciplines and has a very strong reality. It must reflect the mapping relationship between virtual experiment and real experiment. The virtual simulation of physics experiment teaching must be based on a large number of authenticity tests and fully embody the application principle of "trying to be reality and combining reality with virtual". In teaching applications, if conditions permit to set up real experiments, real experiments must be set up to give students a chance to fully practice.

F. Combining Virtual Simulation Technology with Numerical Simulation Technology

Numerical simulation is an important means of physical experiment teaching research. With the rapid development of new technologies such as virtual reality, Internet, big data and cloud computing, virtual simulation technology integrates numerical simulation technology and provides a new virtual teaching platform for physical experiment teaching talent training. Through the construction of highly simulated virtual experiment environment and experiment objects, students are guided to study and explore in depth in the digital environment, master the process of data acquisition, conversion, processing and analysis in physics experiment teaching, and improve their innovative thinking, practical and scientific research ability.

G. The Fun of Training and Learning

As an excellent auxiliary teaching tool, virtual simulation technology can be used in teaching activities such as scenario creation and cooperative communication. The virtual simulation experiment teaching environment can create a variety of scenarios, adopt a three-dimensional animation model and add rich colors and music, so that the virtual simulation teaching environment can stimulate students' interest in learning. Because of its vivid image, strong interaction and real-time feedback, it can virtualize various hypothesis models proposed by students in the learning process, and can directly observe the results of hypothesis through the virtual system, so as to stimulate students' creative thinking and cultivate students' innovative ability. Therefore, virtual training teaching is beneficial for students to familiarize themselves with the real environment of training in advance, master professional skills and stimulate students' interest in learning.

V. CONCLUSION

The virtual experiment is only a simulation of the real experiment, and the experience and feelings brought to the users are still not completely real. The organic combination of virtual reality technology and simulation technology does not only realize the construction of the real world, but also uses some sensing tools or stereo display tools to enhance users' experience of all senses interacting with the real world. The introduction of simulation experiments into physics classes has changed the teaching characteristics of physics courses. Although simulation physics experiments are not affected by time and space and instruments, they also have their own shortcomings. The experiments cultivate students' practical ability. This point is incomparable with the real experiment. The introduction of the simulation experiment into the classroom is not a substitute for the real experiment, but must combine the advantages of the two to make up for its shortcomings in order to play a greater role in physics teaching.

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