Application of virtual simulation technology in experimental teaching of analytical instruments

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Abstract . As a new teaching mode, virtual simulation technology provides a new way of thinking for laboratory teaching. At present, there are some problems in the experiment teaching of instruments, such as small amount of equipment, lack of professional and technical personnel, and short time for students to receive training. With the unique characteristics of virtual simulation technology, such as real-time interaction, realism and immersion, diversity and flexibility, efficiency and cost advantages, data recording and analysis, and collaborative work across time and space distance, the application of virtual simulation technology to the experimental teaching of -scale instruments and equipment can promote the opening of -scale instruments and equipment to undergraduates and provide students with rich practical content and opportunities. Cultivate more high-quality talents with innovative consciousness and ability.

Keywords: virtual simulation; instrument; Experimental teaching

1 Introduction

In the era of rapid scientific development, cultivating students' innovative consciousness and ability and enhancing students' social competitiveness have become the focus of college talent training. Facts show that university laboratories are the basis for students to correctly understand and master theoretical knowledge and conduct scientific research independently, and are also an important carrier to improve students' practical ability and innovation ability. In particular, with some instruments and equipment, they can better cultivate students' innovative and practical spirit, which is also an important part of scientific research work and the main tool for experimental course teaching. At present, analytical instruments in colleges and universities, such as nuclear magnetic resonance spectrometer and high performance liquid chromatography-mass spectrometry, have problems in the process of experimental teaching, such as low student/machine occupancy and limited teaching time. [1-3]

With the development of computer technology and network technology, the role of computer aided instruction in the teaching process is more and more obvious. Virtual experiment is gradually playing an important role in teaching and training. The traditional experimental teaching method is also changing, and the limitation of equipment

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and resources makes the superiority of virtual laboratory prominent. [4-7] Through a variety of technical methods to simulate the experimental site, equipment, instruments and various reagents, to provide students with a pure virtual experimental environment, to build a visual display function, with interactive performance of the virtual laboratory. This method can solve the difficulties faced by experimental teaching and improve the quality and efficiency of experimental teaching. [8-9]

2 Current status of -scale analytical instrument experimental teaching

Analytical instrument experiment is a compulsory course for medical, pharmaceutical and related majors, which plays an important role in cultivating students' practical ability and innovation ability. Nuclear magnetic resonance spectroscopy, mass spectrometry, thermal analysis technology, fluorescence analysis, combustion heat determination technology, etc., play an important and irreplaceable role in the field of life science such as basic medical research, new drug research, Chinese medicine modernization. At present, the same problems generally exist in the teaching process of colleges and universities, and the main status quo is analyzed as follows:

2.1 The equipment is expensive and the number of experimental equipment per capita is low

Take a analytical instrument virtual experiment training system designed by a university as an example. The system consists of five experimental instruments, namely nuclear magnetic resonance spectrometer, high performance liquid chromatography-mass spectrometry, fluorescence spectrometer, thermogravimetric differential thermal analyzer, constant temperature microcomputer calorimeter, the total price of the above five instruments is about 8 million yuan. The number of students in each class is 30, and there is only one experimental instrument and equipment for each class. Under the actual situation of laboratory instrument management and instrument depreciation and maintenance, it cannot meet the requirements of each student to operate on the computer, which seriously restricts the cultivation of students' ability to use analytical experimental instruments.

2.2 The instrument is operated by a specially-assigned person and the demonstration teaching method is adopted

This is an unsolved problem in the experimental teaching of analytical instruments. Through auditing the experimental course and investigating the students, it can be learned that due to the high price of the instrument, the experimenter is usually responsible for the operation of the instrument. In the teaching process, the teacher adopts the form of demonstration teaching. In the whole learning process, the students have very limited opportunities to use the computer during the learning process, which is very unfavorable to the comprehensive training of students.

The mode of demonstration teaching directly leads to the situation that students cannot see and touch clearly in the process of observation. Therefore, in the experimental teaching of this kind of analytical instruments, students often have problems such as poor understanding and passive learning, and the teaching quality and effect are directly affected.

2.3 Students' learning time and space are limited

The analytical instrument laboratory is operated by the experimenter. In addition to the students' class time, all kinds of chemical analysis experiments are carried out. Therefore, students can only have access to the experimental instruments during the course. For such courses as experimental teaching, once students leave the laboratory learning environment, they will feel very difficult and abstract in the process of independent learning.

Therefore, in order to break through the limitation of time and space and provide students with an open learning platform, it is necessary to build a virtual laboratory. At present, virtual laboratory has been applied to the teaching field of many medical colleges at home and abroad. However, through literature research, it is found that there is no virtual laboratory or matching training software system for -scale analytical instrument experimental teaching. Therefore, it is necessary to develop a standard, systematic and effective virtual experiment training system for the experimental teaching of analytical instruments.

3 Characteristics of virtual experiment

Virtual simulation technology is a kind of technology that generates virtual environment by computer and simulates the real world or abstract concept. It is widely used in various fields, including games, training, medicine, engineering and so on. Virtual simulation technology has the following significant characteristics.

3.1 Real-time interactivity

Virtual simulation technology can provide real-time interactive experience. Users can interact with the virtual environment through various input devices, triggering actions and feedback. This real-time interactivity makes virtual simulation technology play an important role in training, simulation and entertainment. Flight simulators, for example, allow pilots to perform flight training in a virtual environment to improve their skills and reflexes.

3.2 Sense of reality and immersion

Another important feature of virtual simulation technology is its ability to create a sense of reality and immersion. With realistic graphics, sound and tactile feedback, virtual environments can give users a sense of being there. This sense of realism and immersion

is important for many applications, such as virtual reality games, medical surgery simulations, and architectural design. Users can explore and experiment in a virtual environment without the risks and costs of the real world.

3.3 Diversity and flexibility

Virtual simulation technology can simulate a variety of scenes and situations. Whether it is to simulate urban traffic flow, weather change, or to simulate molecular structure, planetary motion, virtual simulation technology can provide flexible simulation environment. Users can customize and adjust as needed to meet different needs and research objectives. This variety and flexibility makes virtual simulation technology a powerful tool for academic research, product design, and decision support.

3.4 Efficiency and cost advantages

Virtual simulation technology can improve work efficiency and reduce costs. Through virtual simulation, testing and optimization can be carried out at different stages, reducing the manufacturing cost of physical samples and prototypes. For example, in the automotive industry, virtual crash testing can help designers predict and improve the safety performance of vehicles to reduce the investment in costly physical crash testing. In addition, virtual simulation technology can also reduce the cost of training and education. Through the virtual environment, students can conduct practice and experiments, avoiding the cost of expensive physical equipment and field internships. This provides wider access and accessibility to education and training.

3.5 Data recording and analysis

Virtual simulation technology can provide detailed data recording and analysis functions. In a virtual environment, various parameters and events can be accurately recorded. This data can be used for analysis and evaluation to understand the performance and behavior of the system. By analyzing the data, users can find potential problems and optimize schemes, thereby improving the efficiency and quality of the system.

3.6 Collaborative work across time and space distances

Virtual simulation technology can also achieve collaborative work across time and space distances. Users in different locations can connect to a shared virtual environment through the network for real-time collaborative operation and communication. This is important for distributed team cooperation and distance education. Through virtual simulation technology, people can work and study together in different geographical locations, which promotes the sharing of knowledge and experience.

4 The role of virtual simulation technology in the experimental teaching of analytical instruments

4.1 Provide students with open learning environment and virtual experiment environment

Aiming at the current situation of expensive experimental equipment and low student equipment ownership, a virtual experimental training system is designed and developed to provide an open learning environment for students, so that students can learn independently on the computer through the desktop virtual laboratory provided by the computer. In the virtual experiment training system, there are many functional modules and learning resources, and students can choose different laboratories to perform virtual operation of analytical instruments. It is of great significance to provide an open learning environment to meet the requirements of students' autonomous learning.

4.2 Break the singleness of experimental teaching method and provide auxiliary teaching platform

At present, the vast majority of colleges and universities in China still adopt the traditional way of experimental teaching, that is, teachers explain, demonstrate, and then students do it themselves. Take the teaching method adopted in the experimental teaching of analytical instruments in a school of Pharmacy as an example. This method is a one-way transmission mode with teachers as the center and knowledge imparted. The teacher explains the experiment first, and then the students follow the existing experimental steps to carry out the experiment step by step, or the teacher explains the experimental principle first, and then the students watch the teacher demonstrate the experiment. The current teaching mode has to a extent formed students' passive and dependent learning habits, which is not conducive to the cultivation of students' innovative ability and "creative" talents.

In view of the singleness of demonstration teaching, virtual experiment training system can provide a new platform for teachers' experiment teaching. The design and development of the virtual laboratory in the virtual experiment training system is not to replace the traditional experiment teaching, but to provide a new development direction for the traditional experiment teaching and break the rigid mode of the traditional experiment teaching. This is of great significance for transforming and optimizing the teaching mode.

4.3 Solve the current situation of limited learning time and space

Aiming at the problem that students' learning is limited by time and space in the experiment teaching of analytical instruments, the virtual experiment training system provides a solution to this problem. In the virtual experiment training system, students can choose any time, any place, as long as there is a computer installed with a stand-alone version of the virtual laboratory training system, or a computer connected to the campus network, they can enter the virtual laboratory for experimental learning and operation

practice. The system has rich learning resources, including the content taught by the teacher in class, the teacher's demonstration teaching video, the animation of the working principle of the instrument, and the virtual operating platform. Through this system, students can preview before class, review after class, practice using instruments and test their own level.

Virtual experiment training system plays an important role in solving the problem of limited learning time and space in students' learning process, and provides direction and conditions for transforming students' learning style.

4.4 Improve teaching efficiency and quality

Most of the theories involved in -scale analytical instrument experiments are abstract and difficult to understand, and the experimental techniques are complicated, which makes students feel difficult to master and have little interest. There is also a contradiction between fewer class hours and the need to improve the quality of teaching. Through the combination of scientific teaching design and computer technology, the teaching difficulties and key points are highlighted, so that students can understand and master the experimental principle and operation more deeply. At the same time, virtual reality technology can simulate the use of laboratories and instruments, which can increase students' enthusiasm for experimental learning, increase practice and learning opportunities, and improve the efficiency and quality of experimental teaching.

In addition, a number of learning resources contained in the system can supplement and strengthen the content taught by teachers to a certain extent, which is meaningful for students to master the experimental principles, experimental steps and experimental methods.

4.5 Saving experiment teaching cost

In the process of experimental teaching, some experimental contents can not be carried out because of time-consuming or expensive experimental equipment. Most chemical analysis experiments have a long waiting time, because the class time is limited, and the students' time is limited, so they cannot be carried out smoothly, and they only skim through the teaching and explanation process. In addition, some of the experimental equipment or reagents required by the experiment are relatively expensive, taking into account the cost of the experiment, so it cannot meet the needs of each student's computer operation. The use of virtual experiment in the virtual experiment training system can avoid the consumption of drugs and equipment, so that students have enough time to practice through the operation of the virtual laboratory.

4.6 The development and application rules of training system in relevant experimental teaching are obtained

In the process of teaching application research, the data obtained through teaching experiments are analyzed and summarized to obtain the teaching application effect of

virtual experiment training system in experimental teaching, and further explore and conclude the development and application rules of such instrument training system.

5 Conclusion

The introduction of virtual simulation technology into the undergraduate experiment teaching of instruments can not only solve the problems of lack of instruments and equipment, too long experiment period, lack of professional and technical personnel, and waste of resources, but also promote the opening of instruments to undergraduates, improve students' instrument operation ability, strengthen students' comprehensive skills, and enhance students' competitiveness in future work or study.

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