Research on Teaching Reform of New Energy Technology Based on Virtual Reality System

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Abstract. New energy technology is developing rapidly with the development of industry. In recent years, the demand for talents with new energy technology is increasing. In this paper, an innovative training mode of new energy technology based on virtual reality system is established to constitute an oriented training system from aspects of teaching and studying. The model formulation should cover the learned knowledge points. The research can provide a reference for building an education structure of advanced technology application and strengthening practical ability.

Keywords: New energy technology · Teaching reform · Virtual reality · Modern industry

1 Introduction

Energy is a key factor constraining the sustainable development of economy and society. With the gradual consumption of non-renewable resources (e.g. petroleum, ore, *etc.*) and the deterioration of ecological environment, it is urgent that a green and sustainable energy conversion and storage technology should be developed. Nowadays, with the rapid development of economy and science, too much energy consumption has led to energy depletion and environmental pollution seriously. Most people are advocating energy conservation and emission reduction. We should encourage automobile industry to reduce energy consumption and pollution, but it is more important that new technologies are developed to replace traditional energy. Therefore, new energy technology [1, 2] has become an effective way for overcoming the problem of energy shortage and environmental pollution. Under the general trend of the international energy transition, how to maintain the sustainable development of new energy is a major strategic issue. New energy technology is one of modern high technologies, including nuclear energy technology, solar energy technology, geothermal energy technology, ocean energy technology and so on.

The development and utilization of nuclear energy and solar energy have broken the traditional energy concepts that take oil and coal as the main body, and created a new era of energy. It is also one of the important directions for the cultivation of college students. However, there are some disadvantages for the education of new energy technology. For

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example, college students always face the abstract and conceptual cognition in paper textbooks. Then it causes the lacks of learning enthusiasm and practical ability.

Virtual Reality (VR) [3] was a useful technology for simulation field. The virtual environment established by virtual reality is made up of digital modeling and combination through real data, to establish the virtual scene in line with the design standards and requirements of engineering projects, and to truly reproduce the planning project. By using VR technology, teachers and students can expand space and compress time according to actual needs. VR can present virtual practical experiments that should obtain the results taking days and months in the real environment. This can give people an intuitive and visual display, which is the biggest benefit of VR education. VR can produce a full sense of experience and immersion. Therefore, we should introduce VR into the education of new energy technology which is designed to combine theory with practice. The research subject is to make positive contributions to the improvement of the talent training program and upgrade the quality of teaching in colleges.

2 Problems of New Energy Technology Teaching

Due to the short time of establishment for new energy technology, we lack the managing and education experience. Therefore, there are some problems in the teaching of new energy technology and its application. The problems are listed in Table 1.

2.1 Practical Teaching Problem

Teachers are unfamiliar with new energy technology, which leads to the focus of professional teachers' teaching work mainly on related theoretical knowledge points. For this teaching way, the practical teaching work will be neglected, resulting in students with more theoretical knowledge and lack of practical ability. Practical ability is an important aspect of training talents in higher colleges. It is difficult for higher vocational graduates without strong practical ability to meet the needs of enterprises [4, 5].

2.2 Assessment Method Problem

In the processes of the past teaching, the teaching assessment of new energy technology relied too much on the final exam. We can see the assessment method was too simplistic and single, which can not objectively and comprehensively evaluate the learning results of students. The single assessment method could not evaluate the real level of mastering the basic knowledge for students. It can not also measure the students' of ability learned for teachers' understanding of the learning effect of students. Another disadvantage is that the feedback of teaching effect is very late. Teachers cannot know the weak of teaching until the wrong answers are found in final exam. It is too late to remedy the teaching problems [6].

2.3 Experimental Safety Problem

In the process of experiment training, the safety of teachers and students is a key problem. For example, energy technology experiments always face inevitably high-pressure, high-temperature, toxic environments. For new energy technology, how to ensure the safety of the energy equipment in the process of new energy training. Meanwhile, some energy products can be harmful for the health of students without full training in the first time. So the safety methods should be improved as soon as possible. The three teaching problems of new energy technology are shown in Table 1.

Table 1. Three teaching problems for new energy technology.

No	Term	Description
1	Practical teaching	More theoretical knowledge teaching and less practical ability training
2	Assessment method	The assessment method was too simplistic and single
3	Experimental safety	High-pressure, high-temperature, toxic environments for experiment training

3 The Characteristics of VR Teaching Model

Virtual reality teaching is a new teaching model that allows students to have more autonomy and participate in a wider range of practical teaching and learning processes [7].

3.1 Realistic Practical Operation

For new energy technology courses, it is reasonable that the teaching of theoretical knowledge is relatively less and the practical application knowledge is more [8]. Cultivating practical ability in class is the key subjective to learn this course well. The teaching mode by VR system can simulate engineering cases according to the technical problems in actual engineering, so that students can get in touch with real projects and information. Students can not only observe the structure and shape of equipment through VR system, but also realize the energy production. At the same time, the software integration interface can be used to adjust the operating parameters of equipment in real time to realize the operation results.

3.2 Process Assessment with Interaction

A highly interactive teaching and learning process is important for process assessment. The interaction between teachers and students happens with ease during the teaching

process with VR system, because communication is the main way in teaching, replacing the traditional teaching focusing on knowledge points. In each teaching step, the progresses of students are recorded in VR system. Teachers can evaluate the learning results of students in real time and they can revise the Teaching content and progress, according to the actual situation [9].

3.3 Safe Operation Environment

The practical operations of students are realized on VR system, and they can not be exposed to the high-pressure, high-temperature, toxic environments of the production site [10]. Then the safety is improved by using VR system. At the same time, the functions and structures of devices provided by VR system are similar to that of real devices, but the VR cost is much lower than the actual devices. We can effectively reduce the cost of teaching. With the application of VR technology, the damages of experimental and practical training are reduced [11].

4 Design of VR System

The overall system architecture is designed based on the combination of B/S mode and C/S mode to realize the teaching training of new energy technology (see Fig. 1). The system includes the five main modules, virtual experiment, on-line communication, quality evaluation, virtual classroom, and material database etc.

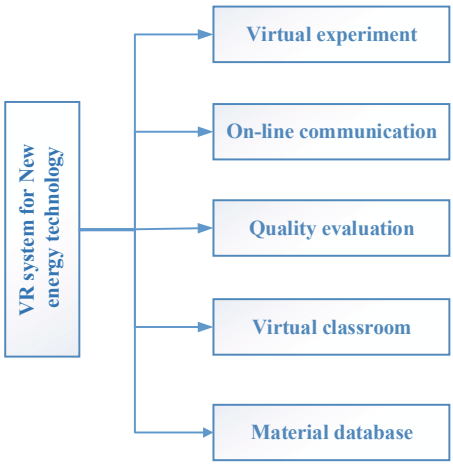

Fig. 1. The overall VR system architecture for new energy technology

4.1 Virtual Experiment Module

Virtual experiment module is an Internet or local virtual experiment platform, which is developed for experimental courses of new energy technology. The system can simulate the equipment used in the real experiment, provide an experiment environment similar to the real experiment, and provide the functions of experiment information management and progress monitoring.

4.2 On-line Communication Module

This function of on-line communication module is clear at a glance. It can provide a communication channel for students and teachers. The module is formed in the Internet era. How to let students and teachers more convenient feedback and receive information is the main design basis of the module [12].

4.3 Quality Evaluation Module

The design of the quality evaluation module is mainly divided into two roles: a manager role and a candidate role. The manager can add, delete, modify and view candidate information, can query statistical results and manage test questions; Candidates can view my information and upload profile information. The module can also evaluate the results of experiment operation in every steps for practical ability training. Some factors of the performance assessment for students are used in the module. The general evaluation of Gaussian is used as

$$f(x) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{(x-\mu)^2}{2\sigma^2}} \tag{1}$$

where μ is the mean of performance set, and σ is the variance of performance set.

4.4 Virtual Classroom Module

Classroom teaching based on VR is combined with engineering application, practical innovation and the latest research progress [13]. Students are encouraged to participate in the classroom according to their own interests. For some contents, which cannot be understood by traditional teaching methods, they can be helped to understand them by combining practice view. As shown in Fig. 2. The module can provide real-time interactive classroom, local courseware production, online-demand knowledge, students' learning behavior analysis.

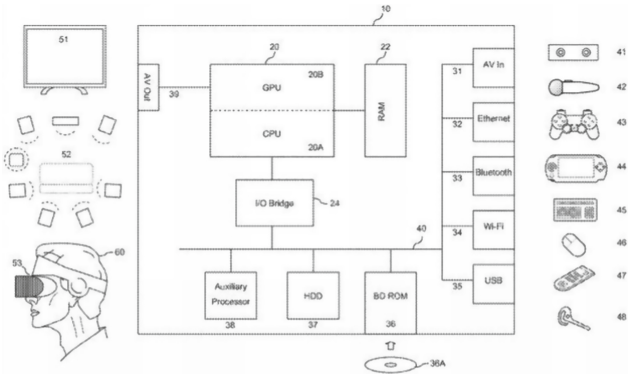

Fig. 2. VR system

4.5 Material Database Module

Database can consult and learn new energy technology papers, drawings and technical documents. It becomes the essential content during the training of students. The knowledge base contains new energy technology documents and multimedia materials. The whole knowledge is classified and sorted with graph method. Students can gain in-depth knowledge of new energy technologies by viewing the material database.

5 Overview of Virtual Reality

5.1 The Definition of Virtual Reality Technology

Virtual reality technology is the crystallization of scientific and technological progress since the 20th century, which embodies the latest achievements in computer technology, computer graphics, multimedia technology, sensor technology, reality technology, ergonomics, human-computer interaction theory, artificial intelligence and other fields. It is based on computer technology and exists in the computer. Some special input/output devices create a multi perception three-dimensional virtual world. In this virtual environment, users interact with things in the virtual environment through vision, hearing, touch and so on. All changes in the real world are vividly reflected in the virtual world, making people and things in the virtual world into a whole. People can directly experience the changes of the surrounding environment as if they were on the scene, and effectively realize human-computer interaction, including perceiving things and contacting the environment. Virtual reality has become an art in our life [14].

The definition of virtual reality technology can be summarized as follows: Virtual Reality (VR) is an advanced computer technology, which uses modern high-tech means to create a virtual environment, and enables users to “invest” in the environment through a variety of peripheral devices. This technology makes use of the natural way to interact with things in the virtual environment to achieve the purpose of human-computer interaction. VR technology allows users to use human basic skills to interact or operate objects in the virtual reality world, while providing visual, listening, touching and other intuitive and natural real-time perception [15].

5.2 Basic Characteristics of Virtual Reality

Virtual reality and users are interactive, which can make users feel immersive. Through the real-time interaction of vision, smell, hearing and other senses with nature, it greatly facilitates the user's operation and improves the user's work efficiency. It fully embodies the significant characteristics of immersion and interaction in the virtual world. In addition, the third feature of virtual reality system is imagination. In this way, immersion, interaction and imagination constitute the three characteristics of virtual reality technology [16]. American scientists burdeag and coiffet call it "the triangle of virtual reality technology", which concisely represents the three most prominent features of virtual reality technology, as shown in Fig. 3.

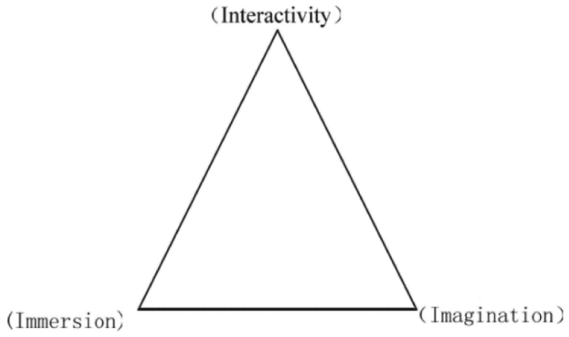

Fig. 3. Three "I" characteristic diagrams

Interactivity, there are people's participation and feedback in the virtual reality environment, people are an important factor in the virtual environment, people lead the change of things. At the same time, the reality in human-computer interaction is the premise and foundation, and the reality is completed through the effectiveness of other people's interaction. At the same time, human-computer interaction must be real-time. Real time refers to the virtual system can quickly respond to the various operations of users, human beings can use virtual reality technology, through natural skills, interact with the objects in the virtual environment [17].

Immersion, also known as temporary sensibility or immersion, is that users, as the main body, place themselves in the virtual world, let users change from the initiative of things to the participants of things, transcend the reality, and integrate themselves into the changes of the virtual world. It is considered to be the most important feature of VR, which is that the user's consciousness and illusion of real objects are mapped to the virtual environment. It has the characteristics of multi perception and autonomy. People have a variety of perception functions in the real world, and virtual reality should have these functions in the virtual environment. Multi perception means that virtual reality system should have all kinds of human perception functions. Autonomy means that all objects in the virtual environment have their own characteristics. The object can move independently in its own way and interact with each other. At present, our research on virtual reality is relatively late, and the major of technology is in its infancy. At present,

the research on the system is still limited to visual immersion, auditory immersion, tactile immersion, olfactory immersion, body sensation immersion, taste immersion and other aspects, and the development is not mature. In addition to the above, immersion is also used to collect the influence of the three-dimensional image field of view, depth information (whether it is appropriate to the user's life experience), whether the user is suitable for interactive devices, and whether the tracking time and spatial response are accurate.

5.3 Classification of Virtual Reality

According to different standards, virtual reality systems can be divided into four categories: desktop virtual reality system, immersive virtual reality system, distributed virtual reality system and augmented reality system.

Desktop virtual reality system (pcvr), also known as window virtual reality system, is a set of three-dimensional interactive scene of common PC platform. It uses low-level workstation and three-dimensional reality technology to produce virtual scene. Participants use input devices or location trackers to realize the important features of virtual reality technology. At the same time, participants can set up various virtual environments at will. Low cost, widely used.

Distributed virtual reality system (DVR) is a network-based distributed virtual environment that can be used by multiple users in different places at the same time. In this virtual environment, multiple users are located in different physical environment locations, and multiple virtual environments are connected through the network, or multiple users participate in a virtual reality environment, and the computer interacts with other users through sharing the virtual space. In the distributed virtual reality system, through the network, many users operate on the virtual world and communicate with each other in many ways. Distributed virtual technology has wide application prospects in the fields of distance education and telemedicine.

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Augmented reality (or hybrid reality) is a kind of system that combines real environment with virtual environment. Users can enhance their understanding of the real world with the information provided by virtual objects. It has the characteristics of real-time interaction, virtual reality combination and three-dimensional registration. It can also add virtual objects in the real environment, reduce the cost of complex environment in real things, and process things. At present, the system is widely used in medical visualization, equipment maintenance and processing, leisure and entertainment.

6 Summary

New energy technology is an interdisciplinary major involving natural science, technical science and social science. VR has been explored and discussed in many application-oriented colleges. The talent training method should be adjusted according to the development situation of economy. The VR sysem should be used for knowledge points of new energy technology. It is important that the training construction with VR will meet the need to further improve the teaching efficiency.

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