Improving the Effect of Education and Teaching with VR Technology

Hengwei Zhang(✉), Xiaohu Liu, and Yuchen Zhang

Henan Key Laboratory of Information Security, Zhengzhou, China
zhw11qd@aliyun.com

Abstract. Virtual reality (VR) technology utilizes computers to generate all kinds of realistic scenes, immersing users in virtualized and simulacra experiences. Advance in technology requires an equivalent breakthrough in practical education and teaching. Current practice education faces many kinds of problems no limited to lack of practice equipment and instructors, hidden security dangers, hard for students to preview and review. In this paper, we apply VR technology in practice education to explore a new area of teaching effect. First, we analyze the problems current practice education faces, and the advantages VR technology holds in practice education. Then, we refer to former VR practice education failures and come up with corresponding solutions to improve traditional education. Finally, we utilize VR technology in practice teaching, and the feedback of students verifies the improvement of effect in education and teaching.

Keywords: virtual reality · practice education · mechanic teaching · education improvement

1 Introduction

Practice teaching is an important part in higher education. Advance in technology requires students with higher engineering literacy. Current undergraduate education and part of postgraduate education mostly aim to enhance practical capability, while only few talents move to theoretical fields, let alone pupils and mid school students are required to master the ability to do many kinds of housework. Through education improvement with VR, the effect of practice education and teaching is further improved and students capability in manual dexterity and comprehensive quality is more adaptive to time development [1].

VR is a new digital media technology. By utilizing capable computers to model realistic scenes and construct diversely virtual 3-D environment, users experience realistic visual or auditory feedback. Besides, users in the virtual environment can also communicate with the outside world with the help of special equipment. VR technology has been deployed since the early 20th century. At that time, it was mostly displayed as a "show". The display effect was not satisfactory and did not have deep practical significance. However, with the continuous progress and development of science and technology, VR related practical applications have gradually emerged in all walks of life [2]. Since then,

X. Yuan et al. (Eds.): ICEKIM 2023, AHCS 13, pp. 275–282, 2023.
https://doi.org/10.2991/978-94-6463-172-2_30

VR technology has developed rapidly and has been gradually applied in various fields. In this context, it is the only way to realize the transformation of educational means from words to images, and from 3-D technology to VR.

Due to the rapid development of Internet technology, information network has gradually penetrated into all aspects of human life, and education has ushered in an era of online education. As one of the important modern teaching methods, VR technology is constantly promoting the development and innovation of education methods.

2 Drawbacks of Current Practice Education

2.1 Traditional Mechanic Teaching Out of Date

Most mechanic practice centers of high schools are transferred from former internship factories. Accordingly, the quality of engineering training instructors is uneven, and the teaching methods are single. Besides, the knowledge of some instructors is seriously aging, which has not kept up with the progress of the times [3]. In most teaching processes, the instructor has been used to demonstrate from beginning to end, including the operation of equipment, data input, etc. The students repeat this process, so that students do not need to think about the whole project training process, and can only repeat it monotonously, which makes the training process boring and it is difficult for students to really acquire the corresponding skills.

2.2 Lack of Equipment and Instructors

Adequate equipment and instructors are required to fulfill the effect of practice teaching. Lacking neither equipment nor instructors will descend teaching efficacy. However, with the expansion of students scale in colleges and universities and the continuous emergence of new technologies and processes, the number of engineering training modules is increasing. It is difficult to strictly meet the requirements of relevant standards when facing limited equipment or training instructors. This directly leads to students waiting long time in mechanic teaching [4].

2.3 Hard to Preview and Review

Limited by the nature of emphasizing operability in the mechanic practice course, students can only preview and review by reading books. However, it is difficult to provide on-site training resources of the Engineering Training Center for students to preview and review before and after the class, which makes the current engineering training and practice teaching usually just a “one shot deal”. And it is difficult to consolidate and improve through self-study [5].

The education products based on VR can provide great help to alleviate the above problems. Virtual space can provide a more vivid, broad and creative teaching space to cultivate students learning interest and expand their innovative thinking, using multi sensory channels to deepen key impressions and improve students autonomous learning ability [6]. Virtual interactive teaching is an important means in the future education. The virtual teaching realized by computer simulation technology can place students in the virtual scenes to provide an observable teaching environment, and show students many abstract knowledge structures, so that they can master knowledge more carefully and deeply. The main function of virtual interactive teaching is to create a virtual teaching model through a variety of electronic information technologies. This model can display a variety of knowledge modules, and express the way of thinking through special equipment [7].

3 VR in Practice Education Design

We design a VR based course, which is the optimization of a former equipment interactive course consisting of 30 credit hours and 1.5 credits. Students selecting this course are supposed to be capable of correctly identify different equipment we use in this course and interact relevant equipment to achieve a certain goal. The key factor is the connection between equipment. By introducing VR and replacing real objects, we get improved teaching effect and better experience according to students' feedback. Figure 1 shows the building of our VR course system. This system is developed from the basic support system and derived 4 sub-platforms. Besides, almost 200 students are supposed to select this course each semester.

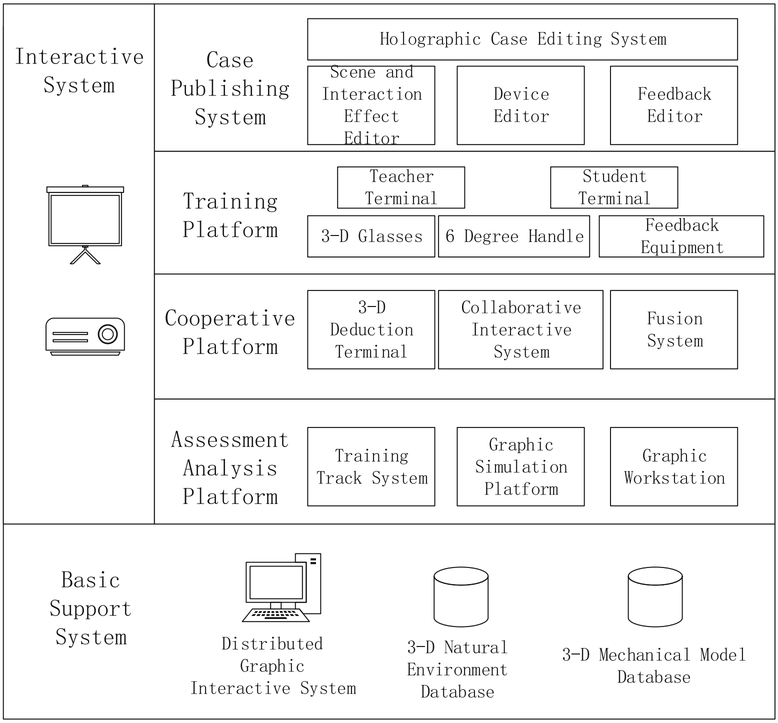

Fig. 1. Building of VR course system

3.1 Basic Support System

Basic support system is the bottom layer of our VR course. It provides hardware and data support for other system or platform, consisting of hardware and software.

Distributed graphic interactive system is the main hardware we use in this course, including capable CPU and GPU to run VR course program. Additionally, every student and teacher is distributed one of graphic interactive system.

Basic software is 3-D database to support mechanical and environmental interaction. It provides basic data exchange and teaching interactive deduction.

3.2 Interactive System

Interactive system is composed of 4 sub-platforms, likely case publishing platform, training platform, cooperative platform and assessment analysis platform. Those sub-platforms are designed by the typical course planning method. First, course instructors design training cases with case publishing platform based on course theme. Second, those cases are deployed to training platform for teachers to manage and students to train. Then, cooperative platform realizes multi-player interaction. Finally, assessment analysis platform evaluates students performance on the training course.

4 VR Effect on Practice Education

Through assessment analysis platform, we see the improvement of teaching effect between students in grade 2021 and those in 2020. The improvement is in many aspects apart from students score.

4.1 Device Cost

Device breakdown is a common incident during practice education. Before we improve practice training course with VR, we have 8 kinds of equipment and 20 pieces of each kind. Besides, we update and purchase new kinds of devices according to new teaching index every several years, which makes some devices scrapped or out of date, leading to unnecessary waste.

Figure 2 shows device breakdown in 2020 and 2021. Before introducing VR technology, there are 23 devices breakdown in 2020. Considering 23 devices belonging to all 8 kinds of equipment makes the fixing work even more difficult. After introducing VR devices, those equipment in all-time course stage before are put to exam stage, extending service life of those old devices. Moreover, fixing VR devices cost less than fixing old mechanical devices, for there are less people capable to fix old things.

Figure 3 shows maintenance cost in 2020 and 2021. Mechanical devices are easily to breakdown and cost more to fix. On contrary, VR devices are more homogeneous. Despite the update of teaching index, instructors edit old or create new training cases for this course, instead of purchasing new mechanical devices and scrapping old ones.

Comprehensively considering Fig. 2 and Fig. 3, we see after introducing VR technology, the breakdown and maintenance expenses descend by approximately 80%, greatly reducing course cost.

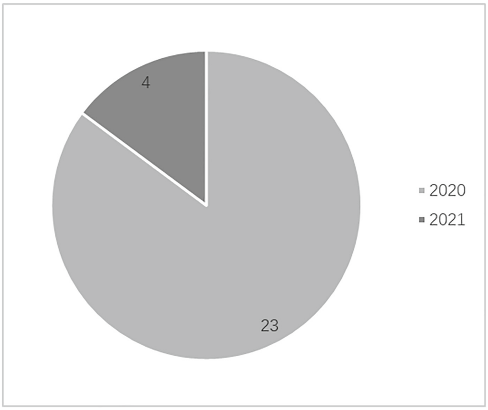

Fig. 2. Device breakdown statistics

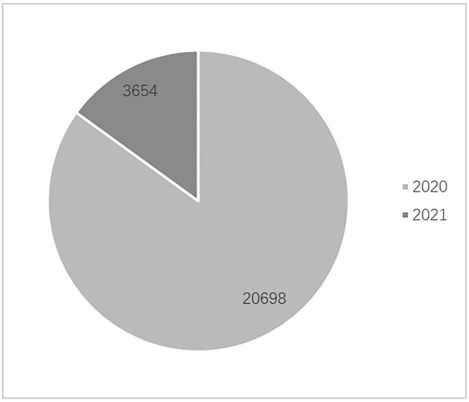

Fig. 3. Device maintenance cost

4.2 Queue Time

Due to lack of equivalent devices or instructors as we discuss in Sect. 2, back in 2020, 20 pieces of devices are distributed to nearly 200 students, leading 1 student operating while other 9 students waiting in line. Course instructors are supposed to supervise each student operating once, so that students waste most of credit hours wait and watch others operate and instructors tour around classroom circle by circle, let alone single device breakdown causing entire piece of device out of use.

VR devices are less easily breakdown, saving much time to fix and operate. Besides, VR devices occupy less room than mechanical devices, allowing more students operate in the classroom simultaneously. Actually, we place 50 VR devices in the classroom, so that only 3 students wait in line instead of 9.

As for preview and review, students still need to go through instructions before operating devices. But unlike mechanical devices, electronical devices need less maintenance and classrooms are always accessible for students, to give more space to prepare for final exam.

4.3 Joint Exam Score

Here, we mainly made statistics on the results of the joint examination of students in the past two years. In the final assessment process, students scores are divided into theoretical scores and practical scores. The total score consists of theoretical assessment score (30%), equipment cognition (10%), single person equipment assembly (30%) and multi person collaborative system construction (30%). The research object is the undergraduate students of our college in grade 2020 and 2021. The grade 2020 students use the traditional teaching and training mode, and the grade 2021 students use the teaching and training system based on VR system. 50 students were randomly selected from the two grades, and their scores in the final joint examination are shown in Fig. 4.

In Fig. 4, students' assessment scores are divided into five grades: A is excellent (>=90), B is good (89–90), C is medium (79–80), D is pass (69–70), and E is fail (<=60). Compared with students in grade 2020, the excellent rate of students in grade 2021 has increased from 15% to 23%, and the good rate has increased from 50% to 62%, rising 8 percentage points and 12 percentage points respectively. From the above data, it can be seen that the use of VR technology can effectively improve students' mastery of knowledge and improve the final assessment results. Under the traditional teaching model, students often train through physical settings. Because of the large number and variety of equipment, the management pressure of equipment also brings many inconvenience to the training work. In the new VR based training system, students can operate in a virtual environment, which greatly improves the training efficiency. According to the situation on the spot, students' manual ability and ability to deal with emergencies have been effectively improved.

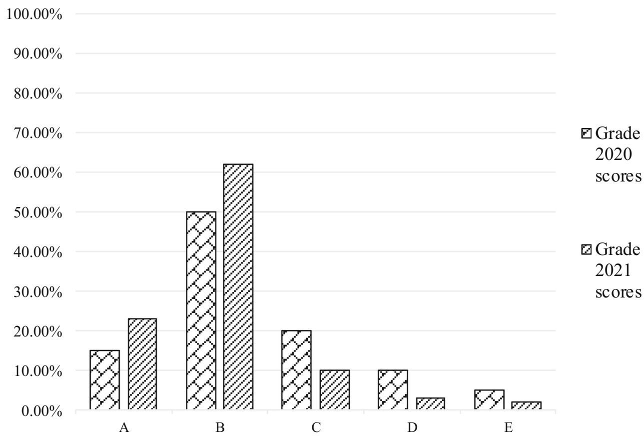

Fig. 4. Scores of final exam statistics

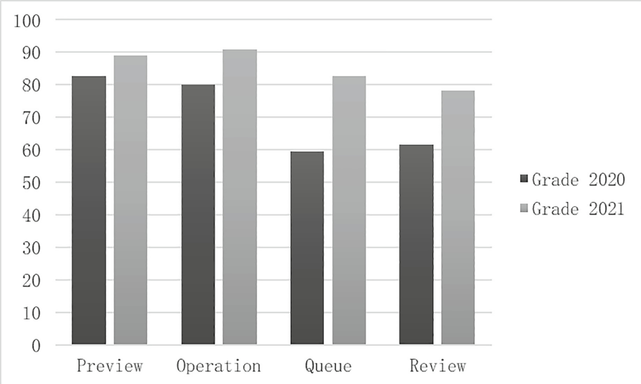

Fig. 5. Comprehensive satisfaction

4.4 Post Class Survey

After the class is over and before the final exam, we did a secret ballot to comprehend students satisfaction on this course. From Fig. 5 we know that after applying VR to this course, the comprehensive satisfaction has increased from every aspects, especially in queue time and post-class review. The average increase ratio is 14.22% and the queue experience increase most as 23.29%.

5 Conclusions

With closer integration of new media technology and education, the application of VR technology will be more and more extensive in the future. In order to meet higher educational needs, VR related technologies have developed rapidly in recent years, adhering to the principle of "lower cost, higher performance". The first is the breakthrough of dynamic environment modeling technology. The core of VR technology is to establish virtual environment. In order to obtain the three-dimensional data model of real things, dynamic environment modeling must be carried out. Second, real-time 3-D image and display technology has further developed. In VR technology, 3-D image generation and display technology has been relatively mature, but the generation and display of real-time 3-D images need further development. The key to future research and development is how to improve the refresh rate of images without reducing the quality of 3-D images to ensure real-time display and refresh. Thirdly, it is the research and development of more intelligent human-computer interaction equipment. Although VR helmets, data gloves and other devices can give users a strong sense of real experience, the current effect does not achieve the desired effect. In order to improve the authenticity and immersion of virtual interaction, the direction of improvement should be more like the natural interaction between people. Finally, web-based VR technology can connect different educators and learners into a virtual simulation space through their respective network terminals. The realization of web-based VR technology education application also requires the support of virtual sharing technology. The country has put forward a call to actively promote the construction of virtual education and teaching environment, and believes that the integration and application of education and VR technology will be more high-quality and effective in the future.

Acknowledgment. This work was supported by the National Key Research and Development Program of China under Grant no. 2017YFB0801900.

References

1. Jiang, Yan, and Kai Ma. “Blended Teaching Design in Higher Education Based on Deep Learning Model.” 2021 2nd International Conference on Information Science and Education (ICISE-IE). IEEE, 2021.
2. Ardiny, Hadi, and Esmaeel Khanmirza. “The role of AR and VR technologies in education developments: opportunities and challenges.” 2018 6th RSI International Conference on Robotics and Mechatronics (IcRoM). IEEE, 2018.
3. Sampaio, Alcínia Z., et al. “3D and VR models in Civil Engineering education: Construction, rehabilitation and maintenance.” Automation in construction 19.7 (2010): 819–828.
4. Markopoulos, Evangelos, et al. “Maritime safety education with VR technology (MarSEVR).” 2019 10th IEEE International Conference on Cognitive Infocommunications (CogInfoCom). IEEE, 2019.
5. Zhang, Qian, Ke Wang, and Sheng Zhou. “Application and Practice of VR virtual education platform in improving the quality and ability of college students.” IEEE Access 8 (2020): 162830–162837.
6. Park, Myunghwan, et al. “A study on the development direction of education and training system based on AR/VR technology.” Journal of the Korea Institute of Military Science and Technology 22.4 (2019): 545–554.
7. Wang, Chen, et al. “Application of VR technology in civil engineering education.” Computer Applications in Engineering Education 30.2 (2022): 335–348.