Research and Practice of Virtual Reality Technology in Vocational Education

Take Guangdong Innovative Technical College as an Example

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Abstract. As an emerging information technology, virtual reality technology has advantages of immersion and interactivity, which enable students to simulate the real training in the virtual learning environment and effectively improve students' vocational skills. The issues encountered in traditional skill training field of vocational education are discussed, includes high cost, high risk, low return rate, long training time, low efficiency, environmental pollution, difficult to reproduce and so on. It is explained that how the issues could be solved by integration of vocational education and virtual reality. Five different virtual reality modes are illustrated and demonstrated, which are multi-channel virtual reality technology, networked virtual reality technology, desktop virtual reality technology, panoramic virtual reality technology and wearable virtual reality technology. The application results in college shows that virtual reality technology enables students to explore in an immersive environment, inspire their enthusiasm for learning and innovation, cultivate their practical capability, and improve the average score and pass rate of courses.

Keywords: Virtual reality · Vocational education · Skill training

1 Introduction

Informatization is the requirement of education development and an essential way to realize education modernization. However, in the field of vocational education, there are few breakthroughs in informatization. For this reason, since 2012, the Ministry of Education in China has introduced policies to propose the development of virtual experiment and practical training projects, in order to improve the efficiency and effect of practical skill training in vocational education. With the arrival of the first year of virtual reality in 2016, various hardware platforms and resources related to virtual reality are gradually popularized in the market, bringing changes to the vocational education skill training mode [1].

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Because of its advantages of immersion and interactivity, the virtual reality technology enables students to simulate the training of the real environment in the virtual learning environment and improves the students' professional skills effectively. It also solves the problems of high cost, high risk, environmental pollution, difficult to observe, difficult to check, difficult to operate in traditional vocational education skill training field. So, the integration of theory, practice and virtual reality technology must be the direction of teaching reform and development of vocational education in future [2]. In 2018, an independent computer simulation research and development center was established in Guangdong Innovative Technical College, which was used to develop training software and support new training in virtual reality way. By using the center, the college can develop virtual reality practical training system to fit the relative courses and cultivate talents to meet social requirement.

2 Virtual Reality Solves the Issues in Skill Training Field of Traditional Vocational Education

2.1 Issue1, High Cost, Low Rate of Return on Investment

The real training cost are high for some majors, like petrochemical equipment maintenance, automobile testing and maintenance, building and so on. Take major of automobile testing and maintenance for example, which traditional training require to be practiced in real environment. That means it must purchase cars, automobile spare parts, detect and repair equipment, which cannot be afforded by most of the colleges.

By using virtual simulation environment, the trainer doesn't need to own cars, auto spare parts and other detect equipment. It not only reduces the investment of fixed assets and future maintenance, but also meets the demand of skill cultivation.

2.2 Issue2, Low Learning Efficiency and Long Practical Training Time

Some programs are designed to train students in one special skill, but it requires several other supporting skills. In order to complete this training, both trainer and trainee take a long time to make preparations, which lead to very low efficiency. For example, in program of circuit design practice, it requires to go through all kinds of welding. But due to welding skill levels of most trainees are low, many students have to spend a lot of time on it and just leave little time in circuit design, which leads to low quality in main skill training of the program [3].

By using virtual reality training software, students only need to click the mouse to weld the object to complete the preparations, so they can focus on circuit design, which means greatly improvement in efficiency of main skill training.

2.3 Issue3, Unsafe or Difficult to Reproduce Scenarios in Training

Some skill trainings involve unsafe factors such as explosions and toxic substances, which cannot be executed in training course, but can only be performed in virtual reality

way, such as ethylene separation process or catalytic cracking process in petrochemical major.

Some skill trainings need to be carried out under specific conditions, which are difficult to reproduce, such as automobile fault detection and maintenance. In this type of training, it is difficult to set a variety of faults, but it can be solved and reproduced by virtual simulation technology.

Some skill trainings need to be prepared in the early stage and students are not allowed to make mistakes so as not to damage the equipment. However, in real scenario, it is difficult for students to completely ensure that they do not make mistakes due to their inadequate capability. Through virtual simulation training, students can be allowed to make mistakes and simulate the serious consequences of mistakes, so as to cultivate students' awareness of safety and rule.

2.4 Issue4, Environmental Pollution

Some skill trainings will cause environmental pollution. In order to protect the environment and students' health, such vocational training can only be carried out through virtual simulation practice, such as electric welding, arc welding training programs.

2.5 Issue5, Large Space of Occupation

Some skill trainings require large space, either for bulky professional equipment or practical scenario, like logistics warehouse construction, building, etc. Most colleges cannot offer enough room, so it is very difficult for students to get adequate skill training in them.

Virtual reality vocational skill training can simulate the functions of actual equipment and provide a strong sense of immersion to trainees. Students can get sufficient skill training through virtual simulation training before they doing practice on real equipment, which help them to achieve the goal of skill training in an easier way.

2.6 Issue6, The Form Is Monotonous and the Participation Rate Is Low

Because limitation of resource, some traditional skill trainings just provide demo, without interaction and student participation. Virtual reality provides a funny way of interaction, which makes training more interesting. It can also provide enough resource for all participations, and even realize personalized guidance for each student, which means every student can choose relevant learning content according to his/her own interests and needs. By using virtual reality technology, all students can participate the training and conduct self-assessment anytime.

3 The Integration of Virtual Reality Technology and Vocational Skill Training

3.1 Mode1, Multi-channel Virtual Reality Technology

It refers to the multi-channel large-screen display technology composed of multiple projectors or LCD screens. Compared with ordinary display systems, the equipment

has larger display size, wider field of vision, more display contents, higher display resolution, and more impact and immersive visual effects. The technology can be used in large vocational training programs [4].

Guangdong Innovative Technical College introduced five channels immersive virtual simulation platform, used to carry out automotive machining, disassembly of motorcycle, disassembly and installation of automobile engine, disassembly and installation of automobile gearbox, vehicle dismantling, city planning, etc. In the platform, there are new technologies, e.g. infrared tracking system, data gloves, 3D glasses, which can provide a strong sense of immersion and simulate the real situation. It ensures students can get a good experience and develop their skills (Fig. 1).

Fig. 1. Multi-channel virtual reality system for city planning.

3.2 Mode2, Networked Virtual Reality Technology

It refers to the technology that virtual reality projects are released through the Internet and run directly through the web browser. Virtual reality training is carried out through the network, which is not limited by time and place. Students can attend the training at anytime anywhere.

In Guangdong Innovative Technical College, a variety of web-based virtual reality skill training resources are developed to support vocational education, includes generic cabling, art of catering, campus fire safety training, financial accounting, logistics and express practice and so on (Fig. 2).

Fig. 2. Networked virtual reality for logistics and express.

3.3 Mode3, Desktop Virtual Reality Technology

It is mainly aimed at the training projects that require complicated calculation and high precision. For example, three-dimensional model displaying requires so much calculation and memory that it must be run in the desktop computer or special server.

In Guangdong Innovative Technical College, two simulation software toolkits were developed for numerical control machine major and industrial robot major. Using these toolkits, students can complete pre-programmed debugging in numerical control area and simulate online operation in industrial robot area (Fig. 3).

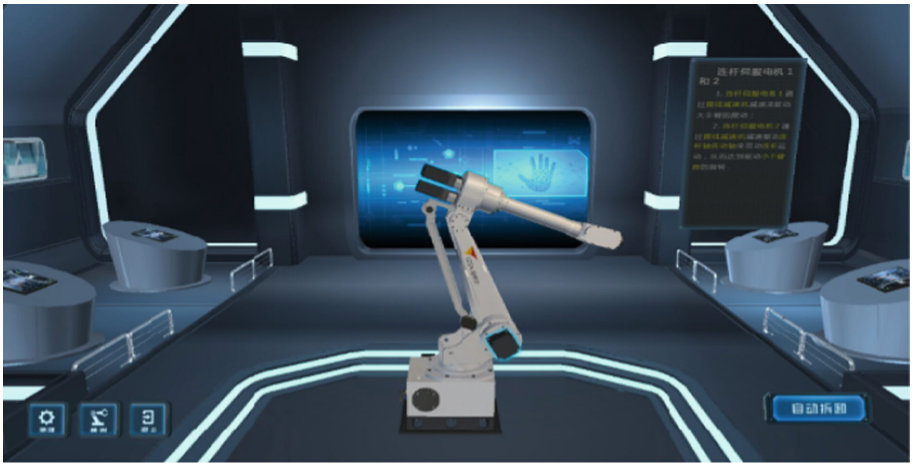

Fig. 3. Desktop virtual reality for industrial robot.

3.4 Mode4, Panoramic Virtual Reality Technology

It displays the real scene in the way of panoramic pictures or videos, which is widely adopted in tourist spot introduction or building introduction.

In Guangdong Innovative Technical College, 360° panoramic education software system was developed based in mobile platform. By using corresponding APP in mobile phone, user can take photos and join them together to create a simulation scene easily. After uploading to online system, everyone can browser and share the scene via Internet (Fig. 4).

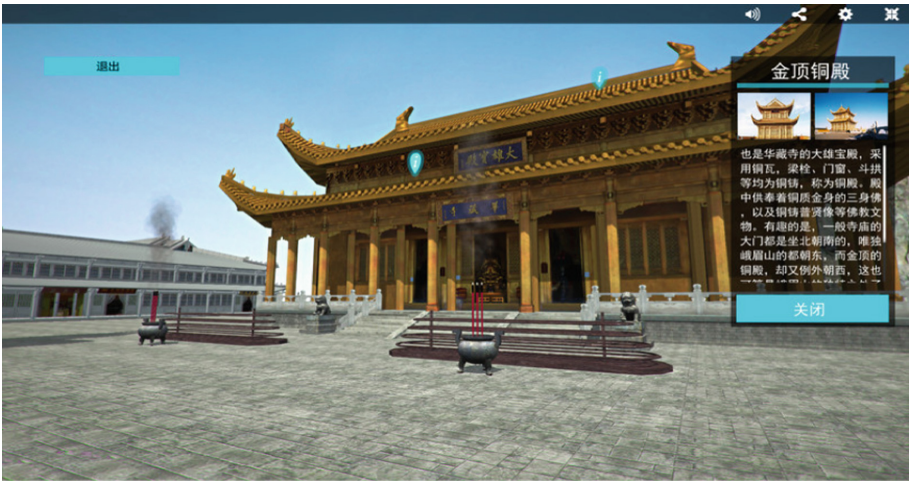

Fig. 4. Panoramic virtual reality for tourist spot introduction.

3.5 Mode5, Wearable Virtual Reality Technology

It refers to the virtual reality technology that realizes virtual reality immersive display with headset display device. Because it has better sense of immersion and interactivity, it become a popular manifestation form of virtual reality at present [5].

In Guangdong Innovative Technical College, a virtual reality vocational skill training software based on HTC helmet was introduced. It includes architecture design simulation subsystem, premises distribution subsystem, lighting art and space design simulation subsystem, etc. (Fig. 5).

Fig. 5. Wearable virtual reality for architecture.

4 The Effect After Applying Virtual Reality Technology in Vocational Education

Firstly, virtual reality technology improves the vocational skills of students significantly. On the one hand, Guangdong Innovative Technical College had participated in 21 provincial competitions in 2019–2020, won 11 first prizes, 17 s prizes and 12 third prizes. Compared to 2017–2018, the total number of awards increased by 36%. On the other hand, the satisfaction with graduates feedbacked from employer in 2019–2020 increased 23% compared to 2017–2018, which shown virtual reality technology improves the vocational skills of students and enhances their competitiveness.

Secondly, virtual reality technology also greatly reduces the skill training cost of the school. Table 1 lists the comparison between some traditional skill trainings and virtual skill trainings, from which it can be seen that the cost of virtual skill training is lower than that of traditional skill training in terms of investment, consumable materials, maintenance fees and experimental time consumption.

Table 1. Cost comparison between virtual reality trainings and traditional skill trainings.

Training course	Mode	Investment (CNY)	Consumable materials (CNY)	Maintenance fees (CNY)	Time consumption(HR)
Chemical pump disassembly	Traditional	>200000	>35000	>15000	>4
	Virtual reality	<30000	0	0	<2

(*continued*)

Table 1. (*continued*)

Training course	Mode	Investment (CNY)	Consumable materials (CNY)	Maintenance fees (CNY)	Time consumption(HR)
Generic cabling	Traditional	>850000	>15000	>15000	>6
	Virtual reality	<35000	0	0	<2
Shadow and space design	Traditional	Infeasible	Infeasible	Infeasible	Infeasible
	Virtual reality	<20000	0	0	<4
Engine disassembly	Traditional	>350000	>30000	>15000	>12
	Virtual reality	<35000	0	0	<6
Catering art table design	Traditional	>600000	>30000	>15000	>8
	Virtual reality	<30000	0	0	<4

Thirdly, after the introduction of virtual reality technology, the students' learning enthusiasm had been inspired, and the quality of teaching had also been greatly improved. As shown in Table 2, compared with traditional vocational education, the evaluation indexes of skill training courses were improved a lot, includes students' interestingness, attendance rate, pass rate and average score.

Table 2. Quality comparison between virtual reality training and traditional skill training.

Training course	Mode	Interestingness	Attendance rate	Pass rate	Average score
Chemical pump disassembly	Traditional	56	71%	68%	67.8
	Virtual reality	72	85%	74%	72.7
Generic cabling	Traditional	61	79%	65%	74.6
	Virtual reality	78	89%	79%	78.9
Shadow and space design	Traditional	75	84%	89%	85.2
	Virtual reality	83	92%	93%	89.3
Engine disassembly	Traditional	73	87%	78%	76.3
	Virtual reality	89	93%	88%	82.7
Catering art table design	Traditional	80	91%	92%	83.5
	Virtual reality	92	98%	95%	88.4

5 Conclusion

The application of virtual reality technology in vocational education has brought great changes in the content and presentation of learning, enabling students to experience an immersive learning environment in the virtual world. By providing new mode and mechanism, it solves the issues of high cost, high risk, low return rate, long training time, low efficiency, environmental pollution, difficult to reproduce in traditional vocational practical training. At the same time, it enables students to explore in an immersive environment, thus cultivating students' practical capability, inspiring their enthusiasm for learning, and improving the level of vocational education. As a new type of teaching media, virtual reality has gradually caught the attention of educators by its advantages and potential. It is expected to play a more important role in vocational education in future.

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References

1. Shian, W.: Research on new form teaching of virtual reality vocational skills training. J. Southern Vocat. Educ. **8**(3), 72–76 (2018)
2. Jinjin, L., Tiantian, T.: Research on the co-construction and sharing of the information platform of higher vocational education core courses under the background of "internet + education." Farm Prod. Process. **4**, 109–113 (2021)
3. Chunping, D., Xiaoyuan, L.: Construction of practice teaching system of health vocational information technology specialty group. J. Guangzhou Open Univ. **21**(1), 44–47 (2021)
4. Huan, Z., Dequan, Z.: The logical framework of construction of vocational education's smart classroom in the new technological era. China Educ. Technol. **6**, 6–13 (2019)
5. Pengjun, Z.: The logic of practice and construction of wisdom classroom in an information technology era. J. Guangzhou Open Univ. **8**(1), 18–24 (2020)