Teaching and Talent Training Reform of Virtual Reality Course

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***Abstract*—With the rapid development of virtual reality technology, many industries have used the technology widely, and the demand for talent is multiplying. However, talent in virtual reality technology is scarce, and there are some problems in the current talent training. Because of the widespread problems in the present teaching, this paper first analyzes the three characteristics of virtual reality courses. It gives the teaching objectives of the design, application and algorithm of virtual reality talent training. Then, this paper puts forward the overall idea of training virtual reality talents in computer specialty and the teaching content planning of the course and gives the detailed prerequisite courses and follow-up courses. Finally, this paper provides the theoretical overview, knowledge points and experiments of the virtual reality courses at three levels of content organization. After years of practice, we have achieved good results in our teaching reform. Virtual reality teaching has promoted the cultivation of application-oriented talents in computer science.**

***Keywords*—virtual reality, curriculum reform, reform in education**

I. Introduction

Virtual reality is the future of human-computer interaction technology. It can provide people with multi-sensory stimulation, giving them a strong sense of immersion. It is expected that the way of interaction between people and computers is the same as that between people [1]. In recent years, with the breakthrough of software and hardware technology, especially with the rise of the metaverse in the second half of 2021, the upsurge of the virtual reality industry has been further triggered, and the research and application of virtual reality are becoming more abundant. As a high-level development product of virtual reality, the metaverse integrates emerging information technologies such as VR, AR, MR, 5G, cloud computing, artificial intelligence, and digital twin. It will become the latest form of the next-generation internet, ushering our human society into a new era of the internet [2]. At the same time, the United States, Europe, China, Japan, and other countries also attach great importance to developing the virtual reality industry. For example, the Ministry of Industry and Information Technology of the People's Republic of China has often issued white papers on virtual reality.

At present, the market demand for virtual reality talents has increased sharply. However, many companies are challenging to recruit qualified VR talents nowadays. Therefore, teaching virtual reality has become a significant problem to tackle.

Attention has been paid to VR in various countries with increased demand. Therefore, many colleges and universities have put more effort into improving the course of virtual reality [3−5]. Moreover, virtual reality can simulate scenes that cannot be seen, and many majors adopt this technology for professional teaching [6−10]. Enterprises have also launched various virtual reality application systems [11, 12]. Although VR courses have been set as an elective in many colleges and universities for a long time, it is not applicable for college students to be trained technically and professionally due to the complexity and comprehensiveness of courses resulting from the characteristics of the technology. These situations in virtual reality teaching are not accidental, but closely related to the features of virtual reality technology itself.

II. Characteristics of VR Technology

A. VR Is a Combination of the Art Design and the Development of Technology

Complete VR work not only requires code writing and algorithm design but also needs 3D modeling, graphics rendering, material design, user interface design, design, production, etc. The students who study virtual reality courses are mainly divided into two categories. One is the students majoring in computer. They are familiar with coding and algorithm design but are not good at art-related works, such as 3D modeling, graphics rendering, material design, and user interface design. The other is students majoring in art. They have the foundation of painting and are good at art-related works, such as three-dimensional modeling, graphic drawing, material design, and user interface design. But they don't know how to write code, algorithm design, etc. The VR works designed by the computer students we teach are poor in artistic effect due to the lack of creative foundation, such as painting.

VR courses must combine technology development and art design, so two different teaching contents must be set

Manuscript received August 9, 2022; revised December 23, 2022; accepted March 6, 2023.

doi: 10.18178/ijlt.9.3.186-190

in virtual reality teaching. The two contents are programming and multimedia designing, and how to combine programming and multimedia designing is an essential issue in VR teaching.

B. VR Courses Have both Breadth and Depth

Virtual reality curriculum system needs the support of many courses, including computer graphics, computer vision, programming, algorithm design and analysis, human-computer interaction, optics, acoustics, even physiology, psychology, and so on. In addition, virtual reality system has high requirements for the reality of a virtual environment, real-time interaction, and the comfort of user experience. Therefore, the virtual reality course has both breadth and depth. There is no way to comprehensively teach VR technology in limited class hours, requiring us to plan the virtual reality course's teaching content carefully. We should introduce a wide range of knowledge and select some knowledge points for crucial and in-depth explanation and practice.

C. Unity and other Virtual Reality Engines Reduce the Technical Threshold of Development

A virtual reality engine is a platform software that provides a development system framework of VR. It can give the developers various virtual software development and management systems. In recent years, the virtual reality engine has enabled developers to focus on material production and logic control without paying attention to many professional algorithms involved, which dramatically reduces the technical threshold of virtual reality development.

The emergence of virtual reality engines in recent years allows developers to focus on material production and logic control without worrying about many professional VR algorithms. Thus, they sharply lower the technical threshold of virtual reality development. In recent years, engine software such as Unity has achieved outstanding accomplishments with widespread use in the virtual reality industry. In colleges and universities, students often use virtual reality engines to experiment and develop some VR works. The most commonly used one is Unity. The application of virtual reality engines in teaching helps students learn VR easily and quickly develop real projects. However, this method ignores the cultivation of fundamental algorithm theories, which is difficult for students to master the ability to create the core technology of virtual reality. Unity and other engine software have achieved great development and are widely used in the virtual reality industry. In college education, a virtual reality engine is often used for students to experiment and develop some virtual reality works. Unity is the most commonly used. Through the application of a virtual reality engine in teaching, the learning threshold of students is greatly reduced, and students can quickly contact the development of practical projects. However, this way lacks the cultivation of basic algorithm theory, and it isn't easy to enter the research and development of virtual reality core technology.

III. Hierarchical Analysis of Teaching Content of Virtual Reality

According to the characteristics of virtual reality technology analyzed above, we can divide virtual reality technology into three levels, as shown in Fig. 1.

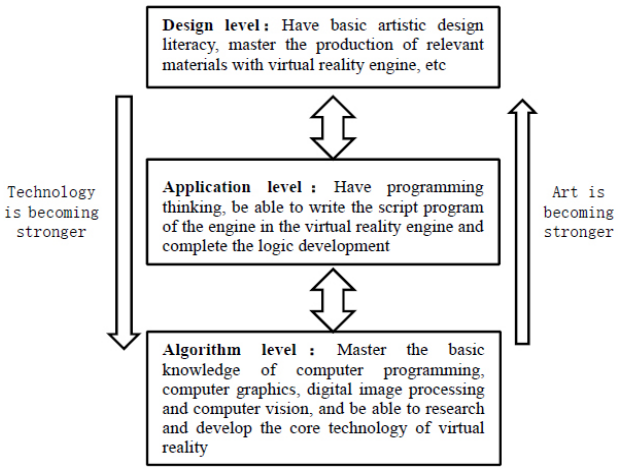

Figure 1. Three levels and basic contents of virtual reality technology.

In Fig. 1, the algorithm level is the bottom layer, the bottom core of virtual reality, and is most related to program and algorithm design. The design level is the top level, which needs design and production materials most related to art. The application layer is the middle layer, which refers to the engine application layer of virtual reality. It can be used to conveniently develop a virtual reality system, including the program development technology of engine script, which connects the algorithm layer and design layer. In these three levels, from top to bottom, the requirements for technology are more robust. In contrast, from bottom to top, the requirements for art and design are more powerful, and the virtual reality engine connects technology and art.

These three levels' teaching objectives and contents are quite different, and their applicable students are also different. Therefore, it should be cultivated at different levels according to the characteristics of teaching objects. First of all, we should plan the sequence of learning contents and teaching priorities according to the situation of students. For example, for computer students, we can focus on the cultivation of the underlying algorithm level; However, in teaching, we can start from the middle design level to guide students, and some art courses can be added appropriately. Art students can focus on the top-level design level and appropriately join the programming training to transition to the middle design level.

The students we have been teaching are computer students, so we mainly discuss virtual reality teaching for computer students.

IV. Content Arrangement of Virtual Reality Courses

A. Overall Idea

For computer students, the general idea is to cut in from the middle level and guide to the bottom. Starting from the

middle level means that after students learn the basic programming and design courses in their first and second years, the junior year can set up virtual reality courses and guide students to practice development based on the virtual reality engine. On this basis, combined with professional techniques such as computer graphics, digital image processing, algorithm design and analysis, teach the underlying and core technologies related to virtual reality, which is the so-called bottom guidance.

This arrangement has the following advantages. First of all, the basic concept of virtual reality technology is not difficult, but the application is rich and colorful. Students can first understand the relevant applications and cultivate interest. Secondly, the virtual reality engine reduces the development threshold of the virtual reality system, which can be mastered by students who have the relevant foundation. Through learning the engine, the students can master practical skills and further enhance their interest in developing virtual reality. Finally, the practical development process of using a virtual reality engine involves a large number of technical concepts in computer graphics, such as texture, model, illumination, shadow elimination, etc., which can guide students to understand these technical concepts and further guide them to understand the basic algorithms and related professional courses behind these technologies. Thus, students can intuitively see the practical use and application effect of these professional courses to generate interest and foreshadow the in-depth follow-up study of these professional courses.

Our virtual reality course is offered in the 6th semester, with computer graphics and digital image processing as prerequisite courses. The algorithm is generally boring and challenging in the prerequisite, computer graphics, and other courses. The experiment is carried out through OpenGL. Only simple graphics and scene operations can be seen, and students easily lose interest. The practical development of virtual reality is relatively interesting, and with the virtual reality engine, it is relatively easy. In the process of virtual reality development, on the one hand, students can have a deeper understanding of the algorithms in the original computer graphics. on the other hand, they can experience the importance of these underlying basic algorithms and understand that they need more professional learning if they want to reach a higher development level. At this time, students will be more interested in professional courses and study more targeted.

B. Relevant Course Arrangement Sequence

Based on the above ideas, Fig. 2 shows the courses closely related to virtual reality and their sequence relationship planning. At present, we lack relevant courses based on art and design. Under the existing credit regulations, it is not good to add professional courses, and we can only let students learn through school-level quality elective courses.

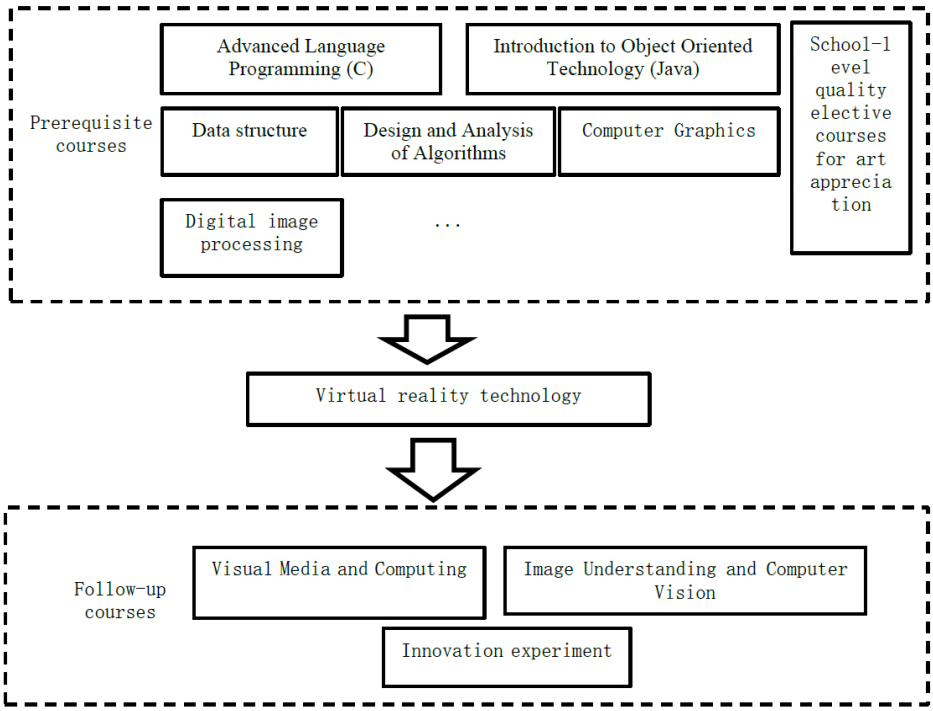

Figure 2. Prerequisite and follow-up courses in virtual reality technology for computer students.

C. Planning of Teaching Contents

According to the overall idea discussed in Section III.A, the course content of virtual reality is organized into three levels: theoretical overview, theoretical knowledge points and experiment, as shown in Fig. 3. Our curriculum consists of 18 academic courses and 36 experimental courses. The theoretical course teaches a theoretical overview and theoretical knowledge points. Undergraduates complete the experiments with the help of a virtual reality engine and panorama generation tool software in the experimental course.

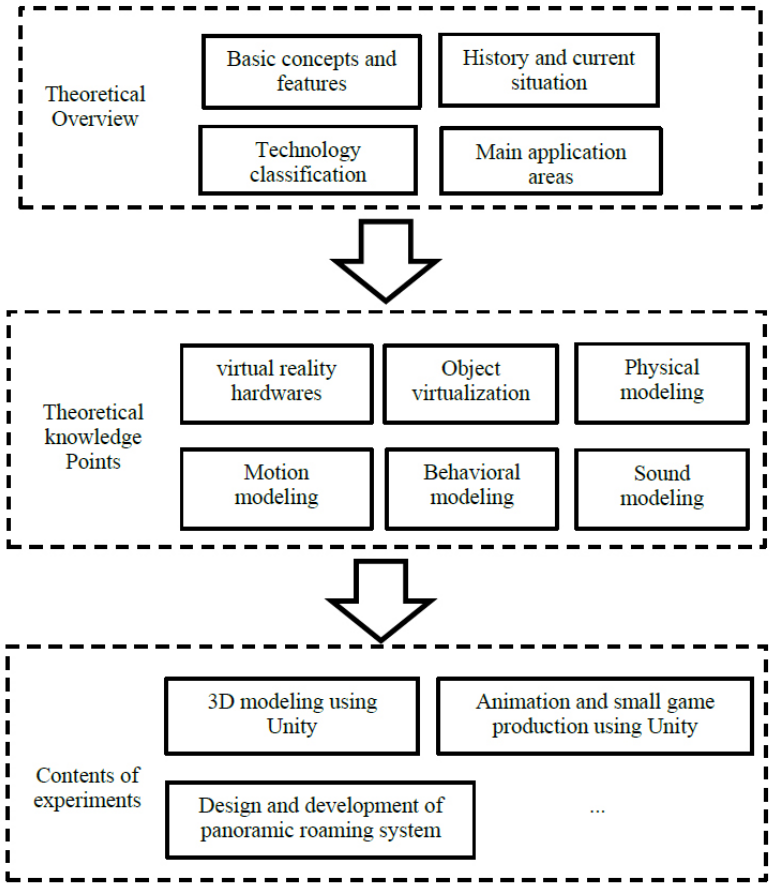

Figure 3. Knowledge module of virtual reality technology course.

Undergraduates learn the basic concepts and characteristics, historical development and current situation, technical classification, and main application fields of virtual reality at the theoretical overview level. They can understand virtual reality comprehensively and systematically.

The level of theoretical knowledge points more specifically introduces the knowledge points of virtual reality. It includes the hardware equipment of virtual reality, virtual object, physical modeling, motion modeling, behavior modeling, and sound modeling.

At the experimental level, undergraduates use unity3d to complete three-dimensional modeling, animation, and small game production, and use PtGui splicing software and pano2vr panoramic playback tool to complete the production of a panoramic VR system. At the experimental level, undergraduates can better understand the theoretical knowledge of object virtual, physical, motion, and behavior modeling through three-dimensional modeling and small-game production. This academic knowledge can also better encourage students to use the unity3d virtual reality engine skillfully.

Since the experimental course has only 36 class hours, unity's experimental teaching cannot include all of the unity's knowledge points but only preliminary knowledge. In the experimental contents, the first is to let students understand the basics and uncomplicated cases of unity. Then, start the introduction of some essential knowledge points. Finally, through a complete application of comprehensive cases, let students complete VR work in a team way. The specific arrangement of the unity experiment is shown in Fig. 4.

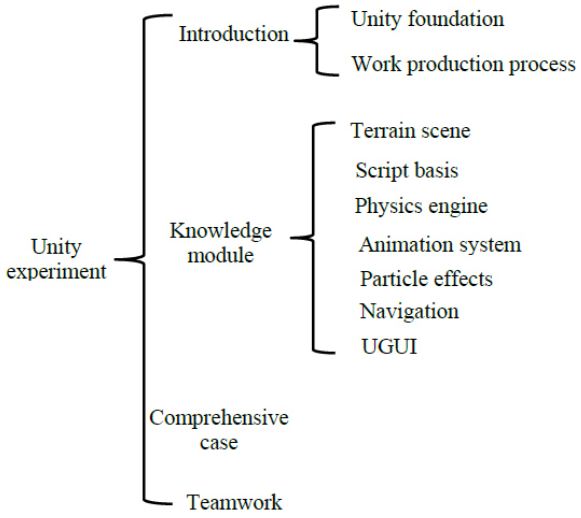

Figure 4. Unity experimental arrangements.

V. Conclusion

Virtual reality is the main development direction of human-computer interaction in the future, and it is also the best presentation form of artificial intelligence. The

development of virtual reality technology and industry is significant to China's scientific and technological innovation and economical construction. College educators need more effort to teach virtual reality courses and cultivate talents better.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Guowu Yuan and Jiliang Zong wrote the paper; Hao Wu, Wenhua Qian, Yuanyuan Pu, and Dan Xu revised the paper; all authors had approved the final version.

FUNDING

This work is supported by the College Reform Project of Education and Teaching in Yunnan Province (Grant No. JG2018015, JG20187023), the Training Plan for Excellent Engineers in Computer Science and Technology of Yunnan Province and the First-class Undergraduate Construction Project of Computer Science and Technology of Yunnan University.

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