Exploration and Implementation of the Blended Teaching Model of "Five Steps, Four Integrations, and Three Characterizations" — Taking the Course of "Virtual Reality Technology" as an Example

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ABSTRACT
Virtual reality (including augmented reality and mixed reality), as an important frontier direction of the new generation of information technology, has received support from relevant national departments and developed rapidly. Many digital media technology majors in application-oriented undergraduate colleges and universities have offered courses related to "Virtual Reality Technology" to cultivate applied talents in the field of virtual reality. Aiming at solving the problems existing in virtual reality courses for digital media technology majors, and based on years of practice, the article has explored a "five step, four integration, and three characterizations" blended teaching model of implementing a seamless five step connection of "online self-learning, independent practice, classroom research and learning, internalization reflection, and personalized learning" through the combination of online and offline, constructing a four integration teaching content of "competition-education integration, skill-art integration, integration of ideology and politics with project, and production-education integration", and cultivating applied talents with "knowledge compounding, ability engineering, and faith firming", and designed a "multi-stage + multi-dimensional + multi-subject" score evaluation method to continuously deepen curriculum teaching reform.

Keywords: *Virtual reality technology, Digital media technology, Blended teaching.*

1. INTRODUCTION

Virtual reality (including augmented reality and mixed reality), as an important frontier direction of the new generation of information technology, is not only a key frontier field of the digital economy, but also will lead a profound change in human production and lifestyle.

In October 2022, the Ministry of Industry and Information Technology, the Ministry of Education, the Ministry of Culture and Tourism, the State Administration of Radio and Television, and the General Administration of Sport jointly issued the "Action Plan for the Integration and Development of Virtual Reality and Industry Applications (2022-2026)", which proposes development goals: By 2026, the overall scale of China's virtual reality industry (including related hardware, software, applications, etc.) will exceed 350 billion yuan, cultivate 100 backbone enterprises with strong innovation capabilities and industry influence, create 10 agglomeration areas with regional influence and leading the development of virtual reality ecology, and build 10 industrial public service platforms. Breakthroughs should be made in key areas of virtual reality applications such as industrial production, cultural tourism, integrated media, education and training, sports and health, commercial and creative industries, and smart cities.

And corresponding safeguard measures have be proposed to support higher education institutions in strengthening the construction of virtual reality related disciplines, encouraging industry-university-institute cooperation, promoting precise talent

cultivation through joint efforts between colleges and universities, research institutions, and enterprises, strengthening talent introduction, expanding targeted training, and cultivating a group of interdisciplinary talents.

Virtual reality technology belongs to the emerging technological field and requires the support of talents. For Chinese undergraduate colleges and universities, there are relatively few reports on the systematic construction of virtual reality talent training programs, curriculum systems, experimental and practical training conditions, series of textbooks, and teaching staff, which are in the exploratory stage and lack prior experience for reference. Currently, there are very few undergraduate colleges and universities in China that offer virtual reality technology majors. Virtual reality technology is mostly offered as a course in a certain major in computer science colleges. (Wang Han, 2020) Taking Shandong Women's University as an example, virtual reality technology is offered in the digital media technology major of the School of Data and Computer Science. Therefore, as a profession, digital media technology undertakes the task of cultivating virtual reality technology talents and needs to provide talent support for the development of virtual reality.

2. INTRODUCTION TO DIGITAL MEDIA TECHNOLOGY

As one of the three women's regular undergraduate universities in China, Shandong Women's University is a public applied undergraduate women's university in Shandong Province. Our undergraduate program in Digital Media Technology began enrollment in 2016 and currently includes three forms of enrollment: Digital Media Technology (regular undergraduate), Digital Media Technology (school-enterprise cooperation), and Digital Media Technology (college to undergraduate). There are already 328 graduates in four terms and 420 students on campus. Although this major was founded relatively late, it has accumulated years of experience in digital media art education in the early stages, gradually forming a dual-base cross-border talent cultivation concept of "new engineering (digital technology) + new liberal arts (artistic creativity)". In 2021, the digital media technology major was approved as a first-class undergraduate major construction site in Shandong Province. In the same year, the school level Digital Creative Industry College based on this major was approved as one of the first modern industry colleges in Shandong Province.

The training objectives of the undergraduate program in Digital Media Technology are: to cultivate talents of comprehensive development in morality, intelligence, physical fitness, aesthetics, and labor, and mastering the basic theoretical knowledge of art and design, mathematics, and computer science and technology disciplines; to cultivate students that can master the basic theories, knowledge, skills, and methods of digital content creation and related technical tool development and application; to cultivate students that are capable of producing digital media content and developing related technical tools; to cultivate students that can possess good professional and technical qualities, certain artistic cultivation, and innovative spirit, and be high-quality application-oriented professionals who can engage in technology application and research and development in related fields such as film and television media, virtual reality, and gaming industry. The focus will be on cultivating talents in both virtual reality and data visualization directions.

3. THE CONSTRUCTION OF "VIRTUAL REALITY TECHNOLOGY" COURSE

3.1 Course Introduction and Objectives

"Virtual Reality Technology" is a compulsory course for digital media technology majors. Targeted at sophomore students with a certain professional foundation but weak self-learning ability, there are a total of 32 class hours. In the early stage, there is a foundation in program design and graphic image design as support. At the same time, a foundation in 3D modeling is offered. In the future, there are also courses such as virtual reality script design and virtual reality UI design.

This course supports the cultivation of talents with correct engineering ethics and values, solving complex engineering problems in the digital creative industry, and possessing collaborative innovation capabilities. Through the study of this course, students will be able to explain the relevant concepts and characteristics of virtual reality technology, and track cutting-edge technologies, be proficient in using common operations of virtual reality engines, be able to design virtual reality works with good experiential effects, and master basic virtual reality technology, physical systems, and special effects; students will be able to combine artistic design concepts with interactive design principles, and use the Unity3D engine for scene model construction, navigation settings, animation production, and special effects

processing with the goal of providing an immersive interactive experience. Combining virtual reality technology, in-depth analysis, model construction, and practical application development of various industry issues will be conducted in the teaching. In terms of quality: the course will cultivate students' spirit of independent learning and collaborative research, compare and evaluate different implementation plans, and be able to propose reasonable and effective evaluation and improvement measures. Students will be able to implement innovative solutions for complex engineering problems through team collaboration. In this process, they can shape correct values, outlook on life, and national emotions, and achieve cultural inheritance.

3.2 Teaching Content and Key and Difficult Points

The main content of the course is related concepts of virtual reality engines, basic interfaces of virtual reality engines, operation of virtual reality engine software, design methods of virtual reality applications, physical systems and special effects of virtual reality engines, etc. The teaching content is divided into 9 chapters, as shown in the "Table 1".

Table 1. Chapter content of "Virtual Reality Technology" course

Serial number	Chapter content	Online	Offline	Footing
1	Virtual reality technology fundamentals	2	2	4
2	Virtual reality scene production	2	2	4
3	Virtual reality roaming based on VR hardware	2	2	4
4	UI graphical user interface	2	0	2
5	Navigation system	2	4	6
6	Animation system	2	2	4
7	Illumination system	2	0	2
8	Particle system	2	2	4
9	Comprehensive experiment of virtual reality technology	2	0	2
Footing		18	14	32

- Teaching key points: Basic concepts of virtual reality technology (VR), basic VR technologies and principles, roaming, illumination system, animation system, programming implementation, and value shaping through the combination of ideological and political elements and projects.
- Teaching difficult points: following design principles such as three-dimensional composition, interactive design, and color composition, and combining with complex problems in scene design and roaming projects in the VR industry, design solutions and implement them.

4. EXISTING PROBLEMS WITH VIRTUAL REALITY COURSES

During the early teaching process, there are the following issues:

First, the course content is disconnected from industry applications, making it difficult to achieve the integration and cultivation of abilities, values, and higher-order thinking. Many virtual reality courses focus on theoretical knowledge and technical principles, but are disconnected from practical industry applications. Students may have learned the basic knowledge of virtual reality, but they lack the ability to apply this knowledge to practical projects and cultivate their creativity and innovation abilities.

Second, the digitization support for course teaching is insufficient, making it difficult to provide comprehensive real-time feedback to help optimize and adjust teaching in a timely manner. Virtual reality courses lack corresponding online learning platforms or educational management systems, which makes it difficult for teachers to collect student learning data and behavioral information, and also unable to provide timely feedback.

Third, the systematic design of course evaluation is insufficient, making it difficult to stimulate students' learning initiative. Traditional assessment methods are often limited to written exams, experimental reports, and other forms, lacking diversity and flexibility, and may not fully reflect students' learning performance and skill development in virtual reality environments. The evaluation method often lacks personalized consideration and

cannot fully consider the learning interests, ability levels, and learning styles of students. Lack of clear evaluation criteria can lead to students lacking a clear understanding of their learning situation, reducing their learning motivation and initiative.

5. REFORM PRACTICE OF VIRTUAL REALITY COURSE

In response to the problems existing in the early stage of the course, the course team has made practical efforts to reform and innovate in teaching model, teaching content, and evaluation methods. A blended teaching model of "five steps, four integrations, and three characterizations" has been designed with student output as the guide (as shown in the "Figure 1"). With the help of online teaching resources, it is necessary to implement a seamless five step linkage of "online self-learning, independent practice, classroom research and learning, internalization reflection, and personalized learning", construct a four integrated teaching content of "competition-education integration, skill-art integration, integration of ideology and politics with project, and production-education integration", and cultivate applied talents with "knowledge compounding, ability engineering, and faith firming". The teaching objectives of the course have always been implemented in the fundamental task of fostering virtue, with mutual efforts between teaching and learning, and mutual promotion between schools and enterprises.

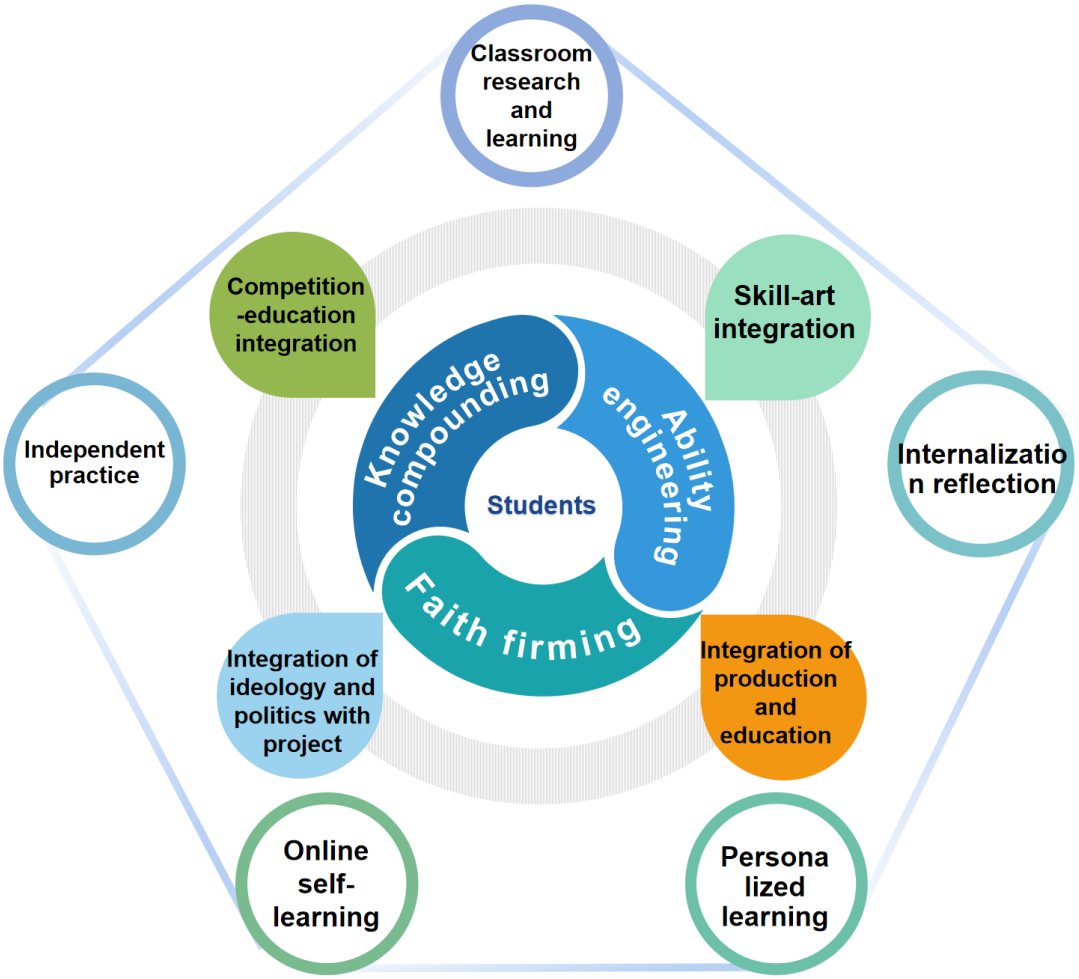

Figure 1 The blended teaching model of "five steps, four integrations, and three characterizations".

5.1 Clarifying the Course Objectives of the "Three Characterizations" Before Class

Virtual reality technology is actually a typical interdisciplinary field, covering knowledge structures that are very similar to digital media technology, such as computer graphics, digital image processing, computer vision, video and audio technology, interface interaction design, etc. (Anwei Hua, 2011) Therefore, the content of this course belongs to

compound knowledge, with a focus on cultivating students' engineering abilities, becoming confident technicians, designers who can program, and programmers who understand aesthetics. Therefore, the cultivation goal is determined to cultivate applied talents with knowledge compounding, ability engineering, and faith firming.

5.2 Organizing the Teaching Content of "Four Integrations"

It is necessary to organize teaching content, and integrate cutting-edge academic ideas, new industrial technologies, real enterprise application cases, and ideological and political elements into teaching. For example, in the first chapter of the virtual reality technology fundamentals, the development of virtual reality in China is explained, and the achievements of the State Key Laboratory of Virtual Reality Technology and Systems of Beihang University are introduced to provide a tactical drill system for China's military simulation training and exercises; The Institute of Digital Application of Cultural Assets at the Palace Museum has launched a series of large-scale virtual reality works such as "The Forbidden City: The Palace of the Emperor". By enabling students to understand the development status of the industry, inspiring their sense of professional honor and industry pride, and guiding them to focus on national strategic needs, teachers can inspire students to have a strong sense of patriotism and mission to serve the country, contribute to the country, and contribute to science and technology. For example, in Chapter 8, the particle system refers to the techniques used in computer graphics to simulate specific phenomena. They have unique advantages in imitating natural phenomena, physical phenomena, and spatial distortions, and can provide convenience for designers to achieve realistic, natural, and random effects (such as explosions, fireworks, and water flows). In the process of movement and development of anything in terms of speed, scale, etc., once a fundamental change occurs, it will also achieve a leap from quantitative change to qualitative change. It is necessary to combine the perspectives of quantitative and qualitative changes with the students' lofty ideals and the spirit of hard work in daily life, in order to enhance their sense of responsibility.

Implementing a combination of competition and education, integrating ideological and political education with projects, every year virtual reality technology course assignments are based on the theme of subject competitions, such as the China University Computer Design Competition. In recent years, the themes have successively been Chinese traditional culture series: Chinese characters, traditional Chinese medicine, traditional mathematics, etc. These ways can guide students to create, discuss, research, and reflect on ideological and political elements in a silent way, enhancing their participation, integrity, and teamwork ability, to construct the teaching content of four integrations, including "competition-education integration, skill-art integration, integration of ideology and politics with project, and production-education integration".

5.3 Implementing the "Five Steps" Blended Teaching

In 1946, American scholar Edgar Dell proposed the "Learning Pyramid" theory, which divides human learning into two levels: passive learning and active learning. The demonstration has the highest memory retention rate among passive learning methods, up to 30%; Traditional teaching only has a memory retention rate of 5%; Active learning is divided into discussion, practice, and teaching to others, with memory retention rates of 50%, 75%, and 90%, respectively. So active participatory learning is very important and crucial throughout the entire teaching process. Therefore, in virtual reality courses, efforts should be made to improve the active learning process for students and cultivate their habits of early learning, active learning, and continuous learning.

With the help of online teaching resources, a seamless connection of five steps can be implemented: online self-learning, independent practice, classroom research and learning, internalization reflection, and personalized learning. The online course "Virtual Reality Technology" developed by the course team was launched on the National Higher Education Smart Education Platform in 2020, and the supporting textbook "Introduction to Virtual Reality Development Tutorial" was published in 2021. The teaching cases are currently being promoted and applied in colleges and other domestic institutions. Since the course was launched four years ago, a total of 46 schools have been selected, benefiting 1,581 students, interacting 340 times, and browsing 5,031 times.

Teachers can use real cases as a guide, break down online tasks to drive collaboration, plan group tasks to promote collaboration, provide precise lectures, demonstrations, and analysis in class, and improving results to aid reflection after class,

promote the integration and innovation of industrial application practice, and motivate students to engage in self-directed, collaborative, and exploratory learning. Teachers can distribute guidance task sheets to students before class, and students will engage in online self-learning and independent practice, focusing on theoretical knowledge such as basic concepts and principles, as well as basic software operation skills. The teaching platforms collect student learning situations, intelligently analyze them, and generate self-learning feedback. In class, purposeful research and learning can be carried out. First, students report and share according to the guidance task list, and then they conduct group discussions and comments, which is the launch of a flipped classroom, and finally, teachers explain and summarize common problems. After class, students participate in enterprise practice projects, internalize reflection, create in groups, and enhance practical abilities. Finally, based on the knowledge gained, continuous improvement, summarization and organization, and testing of effectiveness are carried out to achieve personalized learning.

5.4 Implementing a "Multi-stage + Multi-dimensional + Multi-subject" Evaluation Method After Class

The course team designs a "multi-stage + multi-dimensional + multi-subject" score evaluation method. Multi-stage refers to the assessment of student learning effectiveness through pre-class learning, classroom learning, off class learning, and end of semester assessment, with multiple stages and the entire process; Multi-dimensional refers to the assessment of multiple dimensions of theory and practice, including the duration of online course viewing, online theoretical knowledge testing, offline work practice, classroom performance, and ultimately team collaboration; Multi-subject evaluation breaks the traditional way in which teachers are the final evaluators of grades. Students conduct self-assessments, group evaluations, and teacher evaluations. Multiple evaluators can objectively evaluate grades.

The final exam of "Virtual Reality Technology" mainly focuses on work assessment, and has undergone a reform in the assessment method, increasing the proportion of process assessment. Process assessment and achievement assessment each account for 50% of the overall score. Process assessment focuses on the student's daily learning process, examining their performance and progress during the learning process. Achievement based assessment focuses on the results of the final project, evaluating whether students have achieved the expected learning goals. Combining the two can provide a comprehensive understanding of a student's learning situation from multiple perspectives. These can reduce the unfairness caused by solely relying on performance-based assessments, and comprehensively evaluate the comprehensive quality and practical ability of students.

Process assessment includes online learning performance, online assessment scores, offline classroom performance, and stage project scores. The achievement assessment consists of four parts: final project design, project defense score, group rating, and experimental report. The composition of the score ratio is shown in the "Figure 2".

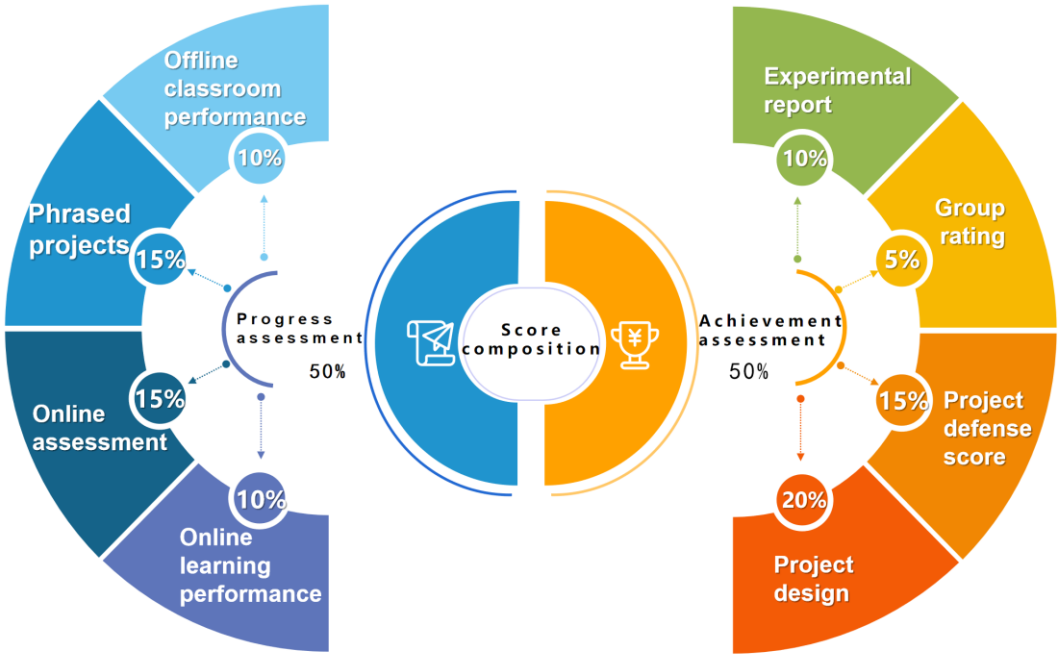

Figure 2 The grading method of "multi-stage + multi-dimensional + multi-subject".

6. TEACHING EVALUATION

The average score of student evaluation in the past three years is 98.5. The data shows that 83.7% of students have significantly improved their awareness of active learning and innovation ability, while 87% of students have significantly improved their interest and confidence in learning.

In terms of knowledge, students have mastered the concepts and basic VR development techniques related to virtual reality technology, and can combine artistic design principles to create VR works. In terms of ability, students are able to combine scene design and complex problem design solutions for roaming projects in the VR industry, and implement them. Students can have certain self-learning and team communication and collaboration abilities. In terms of quality, they have strong cultural and professional confidence, correct values and outlook on life, strong red genes and cultural inheritance ability.

Based on this course, the course works have been transformed into over 40 high-quality VR projects, generating over 1 million economic benefits. In the past three years, students have participated in various subject competitions, such as the China University Computer Design Competition, the National University Digital Media Technology Works and Creativity Competition, and the National University Digital Art Design Competition. They have won more than ten national second and third prizes, nearly a hundred provincial awards, published 12 articles, initiated 10 academic projects for college students, and obtained 12 design patents. ("Figure 3")

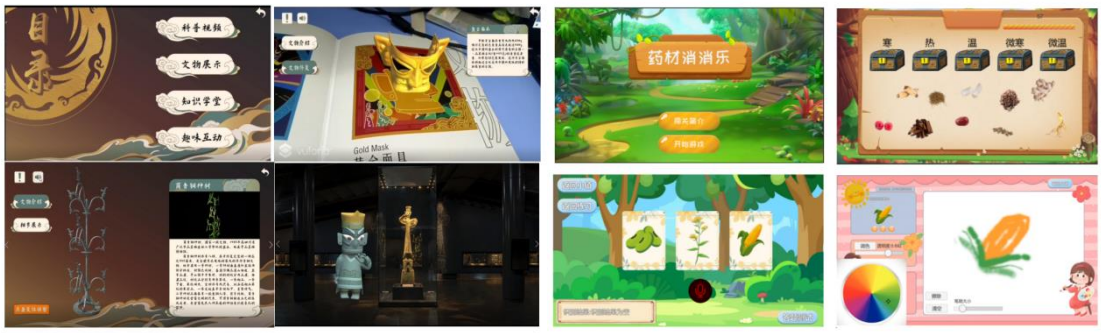

Figure 3 Virtual reality works "Walking into the Sanxingdui" and "Medicinal Herbs Match-3 Game".

7. CONCLUSION

Through preliminary practice, the teaching model of "five steps, four integrations, and three characterizations" has achieved good results. At the same time, the course team is constantly reflecting on existing problems, such as how to organically integrate and unify ideological and political elements with digital technology and artistic creativity in teaching content, how to further enhance the effectiveness of online learning for students and enhance the quality of blended teaching during the teaching process, and how to improve the accuracy of student portraits and effectively guide personalized learning in teaching evaluation. In the future curriculum reform practice, the team will continue to pay attention to the learning dynamics of students and enhance the practical effect of such teaching models in talent cultivation in colleges and universities.

REFERENCES

[1] Zhang Dandan, Wang Han, Exploration of the Training Model for Composite virtual reality Talents in Digital Media Technology Undergraduate Majors [J]. Journal of Chifeng University (Natural Science Edition), 2020: 36(4), 3. DOI:CNKI:SUN:CFXB.0.2020-04-028.

[2] Zhan Tianchi, Cao Jianqiu, Exploration on teaching reform of Smart Virtual Reality and Metauniverse course based on digital twin technology [J]. Journal of Heilongjiang Institute of Technology, 2023, (02), 73-77. doi:10.19352/j.cnki.issn1671-4679.2023.02.013.

[3] Feng Jianguo, Li Guihua, Gao Zongjun, Wang Min, Tian Hong, Chen Tao, Reform of Professional Course Teaching Mode Integrating Virtual Reality Technology - Current Situation, Problems, and Solutions Computer Knowledge and Technology [J]. Computer Knowledge and Technology, 2022, (36), 124-126+138. doi:10.14004/j.cnki.ckt.2022.2240.

[4] Yang Cheng, Exploring the Blended Teaching Model of Film and Television Majors under the Background of the Epidemic — Innovative Application Based on Boppps Teaching Method [J]. Journal of News Research, 2020, 11(23), 2.

[5] Feng Binlu, Bi Yanyan, Wei Chenming, On the Talent Training Standard for Application-oriented Undergraduate Universities [J]. Review of Higher Education, 2019, (02), 48-53.

[6] Ma Ben, Fu Hongxiao, Virtual Reality Course Teaching Reform Practice Exploration Based on Unity3D [J]. China Metallurgical Education, 2021, (05), 48-49. doi:10.16312/j.cnki.cn11-3775/g4.2021.05.012.

[7] Xue Yingying, Exploration of Virtual Reality Talent Training Model under the Opportunity of Industry Education Integration [J]. Journal of Social Science of Jiamusi University, 2021 (05), 175-177+180.