Exploration of the Teaching Mode of the "Virtual Reality Technology" Course Based on the "One Center + Four Levels of Practice + Six Integration" Model

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Abstract. Virtual reality technology, as a cutting-edge technology with broad application prospects, has increasingly significant impact on the field of education. However, in traditional teaching modes, the teaching effectiveness and student engagement in the "Virtual Reality Technology" course are limited, manifested by three major disadvantages: abstract teaching content, monotonous teaching methods, and lack of professional competence. In light of these issues, this paper proposes a pedagogical innovation by utilizing tangible programming as a medium and creating an inquiry-based, interactive learning environment. This is achieved through the construction of a "One Center + Four Levels of Practice + Six Integrations" classroom teaching paradigm, aiming to revolutionize teaching model. Furthermore, a multidimensional evaluation model, encompassing "pre-class learning, in-class assessment, and post-class follow-up", is introduced to revamp the teaching evaluation system. Finally, the paper presents the innovative achievements in school-enterprise integration, competition integration, teaching-research integration, industry-education integration, research-education integration, as well as ideological and political education integration.

Keywords: Virtual Reality Technology; One Center; Four Levels of Practice; Six Integration

1 Introduction

Virtual reality technology has been widely applied in various fields, including education[1], healthcare[2], chemistry[3], and rehabilitation[4]. As a core course in the field of digital media technology, "Virtual Reality Technology" is offered in the third year of undergraduate students. The course has been established since 2018, and has been implementing a blended learning approach, combining both on-line and offline instruction since 2021. The teaching paradigm proposed in this paper, known as "One Center + Four Levels of Practice + Six Integration," has been implemented since 2021. And the teaching objectives of this course can be summarized in three aspects:

1. Acquiring a solid understanding of the course's relevant theoretical knowledge.

2. Cultivating well-rounded project development skills.

3. Connecting with social services.

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Regarding these aspects, detailed explanations will be provided in the subsequent sections of this paper, specifically in the "Four-level Teaching System" and " The effectiveness of the curriculum reform" sections.

2 Three major disadvantages in traditional teaching modes

2.1 Abstract teaching content

The course "Virtual Reality Technology" is a combination of art and technology that primarily focuses on programming, while also incorporating graphic design and creative aspects. The traditional lecture-based approach is a common teaching method widely used in programming courses. This teaching method typically involves instructors delivering knowledge through lectures, demonstrations, and concept explanations. However, the traditional lecture-based approach in programming courses tends to focus excessively on abstract theoretical knowledge, lacking practical hands-on experience and opportunities for application. Programming is a highly practical discipline, and passive listening and understanding of theoretical knowledge alone are insufficient. Students need to actively engage in writing code, solving problems, and debugging programs to truly grasp programming skills and cultivate the ability to solve real-world problems.

2.2 Monotonous teaching methods

The lecture-based teaching method and case-based teaching method are the primary instructional modes used in programming courses. In terms of the teaching process, these methods are generally classified into three categories: "theory first, then case study," "theory at the beginning and end, with cases in between," and "case study first, then theory." These teaching modes have become relatively mature in recent years. However, whether it is the theoretical instruction or the case explanations, this singular teaching approach prevents students from truly becoming the main participants in the classroom, as they passively receive knowledge or related skills. This is manifested in the following ways:

1) The classroom teaching and evaluation system neglects the student's role as the primary participant.

2) Students lack interest and have low engagement.

3) There is a deficiency in students' ability for independent exploration.

2.3 Lack of professional competence

The lack of professional competence is evident in the following aspects: disconnect from industry demands, disconnect from talent development and social services, and disconnect from ideological and political education. However, in the development process of a virtual reality project in an enterprise, the development of a project involves a series of complex processes, including project planning, project design (including UI design, character design, scene design, interactive function module design, etc.), implementation of interactive functions, code debugging and software testing, and subsequent program upgrades and maintenance. This requires project developers to gain experience in code debugging and software testing to handle different error solutions effectively.

3 The "One Center + Four Levels of Practice + Six Integration" Model

To address issues such as abstract teaching content, limited teaching methods, and lack of professional competence, this paper proposes an educational model that upholds the principles of combining theory with practice, and the integration of knowledge and application. This is achieved through the construction of a "One Center + Four Levels of Practice + Six Integrations" teaching paradigm, aiming to revolutionize teaching concepts, as shown in figure 1:

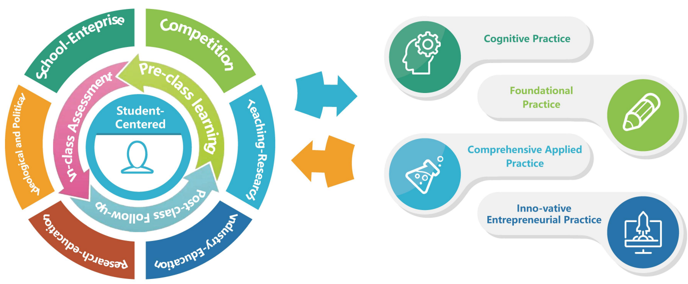

Fig. 1. The "One Center + Four Levels of Practice + Six Integration" teaching model

3.1 One center: Making students the main focus of the classroom

One center refers to making students the main focus of the classroom. To address the issue of "abstract teaching content" and "limited teaching methods", this paper proposes the use of tangible programming as a medium to create an inquiry-based and interactive learning environment, and adopts the project-driven teaching method[5], as shown in figure 2, which is sourced from a recorded classroom teaching session.

The development of a virtual reality project is the result of team collaboration in an enterprise, involving various stages such as project planning, design, programming, and maintenance. Thus, in a student-centered classroom, after students have completed the pre-course study of the relevant knowledge points for the on-line course, the teacher organizes the students into groups, with each team consisting of 3-4 students, to take on the roles of project planner, designer, and developer. The teacher plays the role of a project manager within each team, posing thought-provoking questions and providing appropriate guidance. This approach inspires the teams to engage in critical thinking, discussion, post-class data collection, and other activities. The teacher offers targeted guidance on key issues, provides feedback on student accomplishments and facilitates peer evaluations within the student teams. And based on the advanced materials collected by students after class, the teacher provides guidance for advanced subject competition preparation. This model comprehensively assesses students' performance and achievements throughout the learning process, not only focusing on knowledge acquisition but also emphasizing their thinking abilities, problem-solving skills, and teamwork capabilities.

As mentioned earlier, the teaching of traditional programming courses involves directly explaining highly monotonous and abstract content, such as concepts, syntax, and formatting, which often discourages many students. The presentation of tangible programming is completely different. It discards the dry shell of syntax and directly targets the core algorithms. The content on the cards, resembling algorithm flowcharts or even pseudo-code, allows students to rely on their creativity and freely explore without being restricted by syntax, making programming exceptionally interesting. Additionally, another major advantage is that within each team, through discussions, everyone can complete the algorithm design for their respective modules. By utilizing tangible programming, collaborative work becomes particularly convenient.

Figure 3 showcases a teaching case of tangible programming, which involves a simple interactive demonstration of a weapon model. This instructional example is based on a student's achievement for a subject competition, named virtual exhibition commemorating the 70th anniversary of the victory in the Korean War. By clicking the "Introduction" button, the introductory text alternates between being displayed and hidden. Additionally, by clicking the "Rotate" button, the weapon model alternates between a continuous 360-degree rotation and coming to a stop. It is evident that algorithm descriptions become clearer and more comprehensible for implementing interactions through tangible programming.

Fig. 2. Classroom teaching activities by using tangible programming as a medium and project-driven teaching method

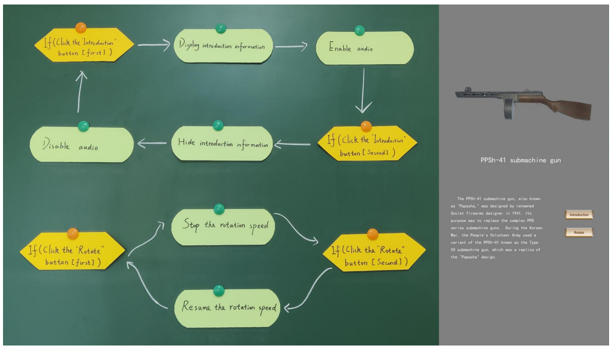

Fig. 3. A classroom teaching case based on tangible programming (using cards)

3.2 Constructing a teaching content system based on the "Four Levels of Practice

To address the issue of "lack of teaching competence," this paper proposes a "Four-Level" practical teaching content system that combines industry and education, based on cognitive practice, foundational practice, comprehensive applied practice, and innovative entrepreneurial practice, as shown in figure 4. It integrates enterprise cases into classroom teaching, aligns the curriculum with professional knowledge, industry, and enterprises, and fosters students' transformation from classroom practice to professional skills, cultivating them into professional and technical talents with the ability to develop virtual reality projects. The specific contents are as follows:

1) Through the Four-Level practical teaching content system of cognitive practice, foundational practice, comprehensive applied practice, and innovative entrepreneurial practice, projects are integrated into the curriculum, case resources are incorporated into classroom teaching, and the combination of professional knowledge with industry and enterprises is achieved through school-enterprise cooperation and the integration of industry and education. This enables students to transition from classroom practice skills to becoming professional virtual reality project developers.

2) Comprehensive cultivation of talents with full-range project development skills. Through the "Four-Level" practical teaching content system, students will acquire a comprehensive understanding of the entire process of developing virtual reality projects in an enterprise, including project planning, graphic design, implementation of interactive functions, code debugging and software testing, as well as subsequent program upgrades and maintenance. This ensures the alignment of classroom teaching with industry demands, producing professional and technical talents who possess specific virtual reality project development capabilities.

3) Engaging in social services. The developed virtual reality interactive products will be applied in areas such as innovation and entrepreneurship incubation, and the development of locally distinctive software products, thereby providing social services that cater to the needs of the community.

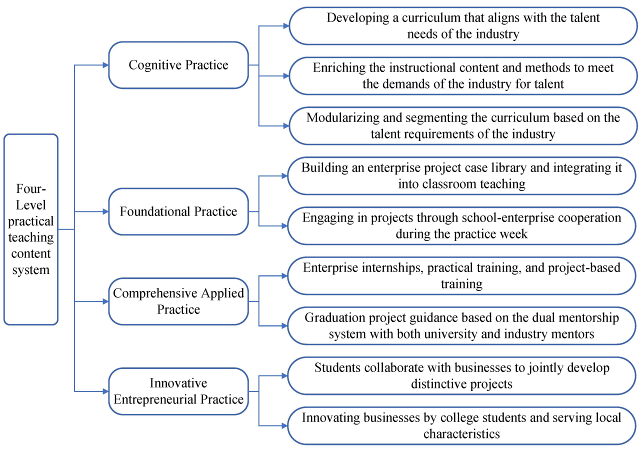

Fig. 4. Flowchart of the four-level teaching practice system

3.3 Developing an "OBE-based Six Integration" curriculum system

OBE, which stands for Outcome-Based Education[6], is a curriculum system that focuses on students and aims to achieve specific outcomes. This paper proposes the development of an "OBE-based Six Integration" curriculum system, which includes the following aspects: school-enterprise integration[7], competition integration, teaching-research integration, industry-education integration, research-education integration, as well as ideological and political education integration[8-10].

1) School-Industry Integration: Our school has established a long-term and close partnership with leading industry company named Li Fang Group, and we have built an off-campus practical base for university students in our province. On one hand, we create a repository of industry case studies to incorporate enterprise case into classroom teaching. On the other hand, through activities such as company visits and student internships, we promote collaboration between the school and industry, as well as the integration of academic and industry practices.

2) Competition Integration: Academic competitions are an important means to assess students' professional abilities. By integrating the content of our courses with academic competitions, students' professional competence could be enhanced.

3) Teaching-Learning Integration: Teaching and learning go hand in hand. Our team of teachers actively participate in various teaching competitions and teacher training programs to improve their professional and pedagogical skills.

4) Academic-Industry Integration: Students apply the knowledge gained from this course to develop innovative entrepreneurial projects and contribute to local industries, thus bridging the gap between academia and industry.

5) Research-Teaching Integration: The course instructor's research focus is on pattern recognition and machine learning artificial intelligence. At the teaching level, the integration of Unity virtual reality and human-computer interaction is employed to merge teaching and research.

6) Ideological and Political Integration: This course is closely linked to ideological and political education. In addition to cultivating students' scientific literacy, craftsmanship, and patriotism in daily teaching, it also promotes the inheritance of revolutionary spirit through practical cases and learning from the older generation's revolutionary spirit.

4 The effectiveness of the curriculum reform

As previously mentioned, this course is offered in the third year of undergraduate students, and has been implementing a blended learning approach, combining both on-line and offline instruction since 2021.

The course has been established since 2018, corresponding to the students who will graduate from the year 2019 (namely, the class of 2019). And the teaching paradigm proposed in this paper, known as "One Center + Four Levels of Practice + Six Integration," has been implemented since 2021, corresponding to the students who will graduate from the year 2022 onwards (namely, the class of 2022, 2023 …) .

For simplicity, we refer to the teaching mode employed from 2018 to 2020 (corresponding to the class of 2019, 2020, and 2021) as the "traditional mode." Starting from 2021 (corresponding to the class of 2022 and 2023), the teaching mode proposed in this paper has been implemented, and we refer to it as the "innovative mode."

4.1 The effectiveness of course assessment and evaluation

Figures 5 present the data on students' on-line learning duration, it is evident from the graph that the average learning duration of students have been increasing generally. This growth can be attributed to several factors, including the intriguing case studies resulting from the continuous expansion of university-industry collaborations, the captivating showcases of achievements in discipline-related competitions, the emphasis on practical coursework under the new teaching model and so on.

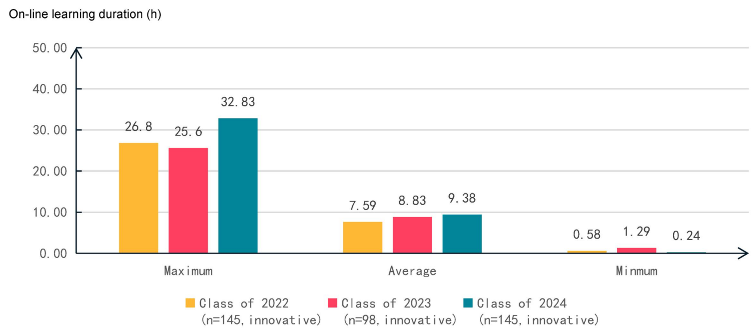

Fig. 5. Learning duration of on-line course

Regarding the assessment and evaluation system of the course, a multidimensional evaluation system and feedback mechanism of "pre-class learning + in-class assessment + post-class follow-up" has been established to conduct diversified course evaluations since 2021(corresponding to the class of 2022). Table 1 reflects the detailed assessment and evaluation modules of the course.

Unlike traditional methods of course assessment and evaluation, the proposed approach integrates students' rich learning activities throughout the semester, reflecting a student-centered teaching model. This model emphasizes the cultivation of practical skills, teamwork abilities, problem-solving and inquiry skills, as well as outcome-oriented innovation capabilities. The reformed course assessment and evaluation system fully reflects the comprehensive evaluation of students' abilities and qualities. Figure 6 illustrates the distribution of average course grades for students from the class of 2019 to the class of 2024, the error bars represent the slight variations in average grades among different classes. It can be observed that starting from the class of 2022, after the course reform, the overall average grades and the average grades in the course practice module have improved due to increased student engagement, enhanced practical skills, and a greater emphasis on course participation.

Table 1. Multi-dimensional Course Assessment

Pre-class (10%)	Video Learning (5%)	Pre-class learning for flipped classroom approach on On-line course
	Discussion (5%)	Pre-class discussion for flipped classroom approach on On-line course
In-class (15%)	Interactive Quiz (5%)	Participation in interactive quizzes through voting, rapid response, etc.
	Group Discussion (5%)	In-class group discussions in project-based learning mode
	In-class Practical (5%)	In-class tasks in project-based learning mode
Post-class (25%)	Homework (10%)	Open-ended and advanced topics
	Unit Test (5%)	Theoretical foundations
	Competitions (10%)	Achievements such as participation in competitions (OBE mode)
Final (50%)	Final Exam (50%)	Final exam grades

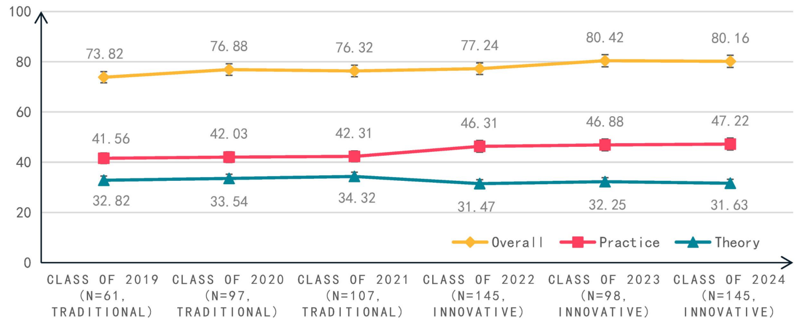

Fig. 6. The distribution of average course grades for recent cohorts of students

4.2 The radiating effects of course innovative achievements

This course has undergone multiple rounds of practice, and the achievements under the "Four Levels of Practice" and "Six Integration" course teaching system are significant. For example, figure 7(a) shows a case of Chengdu Lifang Group's collaboration with the university on the training project of 3D modeling and virtual reality roaming for Qatar Medical City.

At the level of industry-academia collaboration, students have completed projects such as the VR roaming of Mount Emei (as shown in figure 7(b)), effectively integrating and serving local characteristics.

In terms of teaching and research integration, Teacher Ma, who is engaged in the field of gesture recognition algorithms, has been applied the outcome of gesture recognition algorithms to teaching by combining Unity and motion-sensing devices. Figure 7(c) illustrates the student project guided by the integration of teaching and research: a rehabilitation training system based on gesture recognition and somatosensory interaction.

At the level of ideological and political education in the course, students have completed projects such as the virtual exhibition commemorating the 70th anniversary of the victory in the Korean War (as shown in figure 7(d)), where they learn from the revolutionary spirit of the older generation and understand the importance of staying true to their original aspirations, remembering history, striving hard, and fulfilling their missions.

Fig. 7. Examples of the radiating effects of course achievements

In terms of integration with competitions, both teachers and students actively participate in various discipline competitions, and have won numerous awards in the fields of game development, interactive media, and virtual reality.

Figure 8 illustrates the awards won by students in discipline-related competitions from 2018 to 2022. It can be observed that starting from 2021, after the adoption of innovative methods, the number of awards received by students has increased. The practical week teaching based on the collaboration between the university and the industry, the dual-mentor teaching approach for graduation design, as well as the students' innovation and entrepreneurship achievements, have all been utilized in discipline competitions. In the context of OBE, this teaching model has made a certain contribution.

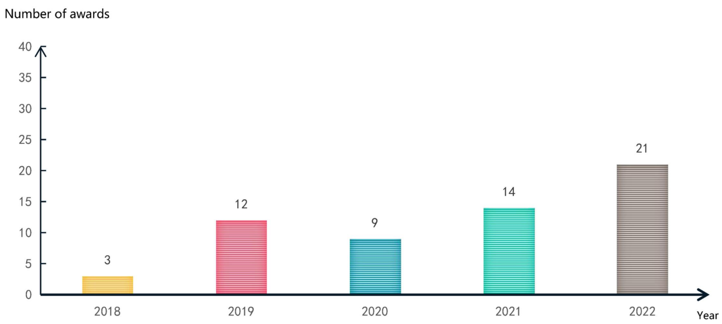

Fig. 8. Awarded in competitions related to the course from 2018 to 2022

Figure 9 depicts the achievement rates of recent cohorts of students in terms of the teaching objectives. It is evident from the graph that the graduation class of 2022 exhibited a significant improvement in the attainment rates of teaching objective 1 and teaching objective 3. This improvement is closely intertwined with the "One Center + Four Levels of Practice + Six Integration" framework of the course. Particularly in the aspect of social services, the close integration of the reformed teaching system with the students' innovation and entrepreneurship projects has led to a noticeable enhancement in the attainment rates of teaching objectives related to social services.

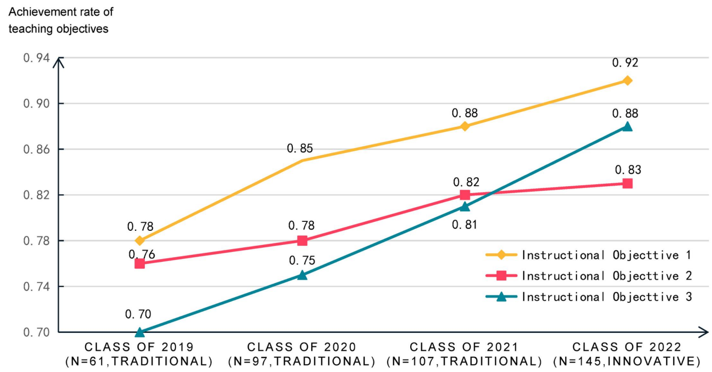

Fig. 9. The achievement rates of recent cohorts of students in terms of the teaching objectives

However, in the case of teaching objective 2, the innovative teaching model has not demonstrated superiority compared to the traditional teaching model. This is largely attributed to the limited amount of data currently available to support this conclusion. It will be necessary to wait for a few more years after students' graduation to gather sufficient data for statistical analysis. Nonetheless, the effectiveness achieved in this aspect is also worth anticipating.

5 Conclusions

This paper analyzes the current teaching status of the "Virtual Reality Technology" course and identifies limitations in the effectiveness of traditional teaching models and student engagement. To address these issues, firstly, this paper proposes a "One Center + Four Levels of Practice + Six Integrations" classroom teaching paradigm for the course. This paradigm enables students to be more actively involved in learning, thereby enhancing their understanding and application abilities in virtual reality technology. Secondly, this paper presents a multi-dimensional evaluation model, namely the "Pre-learning + In-class Assessment + Post-follow-up" evaluation system. Lastly, this paper introduces the evaluation and feedback mechanisms of the course and summarizes the innovative achievements in integrating industry-academia collaboration, competition integration, teaching-research integration, industry-education integration, teaching-research integration, and ideological and political education integration.

In the future, further exploration will be conducted to deepen the implementation of the six integrations in the "Virtual Reality Technology" course and expand the application of virtual reality technology in the field of education. Additionally, there is room for improvement in the evaluation system to more accurately assess students' learning outcomes and abilities. Ultimately, this paper hopes that the proposed teaching paradigm can become a widely adopted educational model and contribute to the cultivation of outstanding individuals with comprehensive abilities and an innovative spirit.

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