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VR-Based Innovation in University Music Practice Teaching: Exploration and Reflection

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Abstract: At present, university music education is facing the challenge of digital transformation and urgently needs to achieve upgrading and change at multiple levels by leveraging new technologies and new development concepts. Integrating virtual reality technology into the practical teaching process of music in colleges and universities is a new direction for exploring the construction of art courses and has certain value and significance. This paper, guided by national policies such as the "Opinions of the Ministry of Education and Other Nine Departments on Accelerating the Digitalization of Education", the "14th Five-Year" digital economy development plan, and the "Opinions on Comprehensively Strengthening and Improving Aesthetic Education in Schools in the New Era", starts from the current situation of practical music teaching in colleges and universities, takes virtual reality technology as the core support, focuses on the construction and exploration of innovative paths for practical music teaching, and at the same time explores practical problems and reflection points in the application process of virtual reality technology, and proposes relative optimization strategies to further promote the practical teaching of music in colleges and universities to a new stage.

Keywords: Virtual reality (VR); Information technology; University; Practical music teaching; Innovative paths

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1. Introduction

With the continuous development of science and technology and the constant advancement of the national digital education policy, integrating virtual reality technology into the music practice teaching system of colleges and universities promotes the deep integration of information technology and art education [1]. At present, developing digital teaching resources and building a new model of digital teaching are becoming important paths for the innovative development of music education and teaching in current higher education institutions. As the core carrier of digital education, virtual reality technology, with its characteristics of "multi-sensory interaction" and "spatio-temporal reconstruction", not only breaks through the limitations of

educational space, but also its strong interactivity and high operability are highly consistent with the demands of "contextualized experience", "personalized training", and "cultural inheritance" in the practical teaching of music in colleges and universities [2]. This can not only stimulate students' strong interest in learning and broaden their learning channels, but also provide strong support for teachers' teaching, implement policy requirements, and serve as a key technical support for upgrading practical teaching, thereby promoting the overall teaching to move towards a new stage of efficient and high-quality development.

2. The adaptability of virtual reality technology to university music education

At present, virtual reality technology has become a new educational means to promote the innovation of music practice courses in universities. By leveraging virtual reality technology, an "immersive" music practice scene can be created for students, and a visual "situational channel" can be constructed to deepen artistic aesthetics and cultural understanding [3]. Cultivate students' ability to actively perceive and explore musical skills in immersive experiences, and fully stimulate their enthusiasm for learning in various music practice courses. The immersive, interactive, and imaginative features of virtual reality technology are highly compatible with the perception, skills, and innovation demands of university music teaching, jointly forming a solid theoretical support.

3. The current situation of university music practice courses and the demand for the application of virtual reality technology

3.1. The current situation of university music practice courses

At present, some universities in China still follow a single traditional teaching mode in music teaching. This teaching mode not only makes it difficult to innovate in teaching but also lags behind the market demand for music talents. If in vocal music teaching, the emphasis is placed on the teacher's empirical demonstration and explanation, students will find it difficult to directly observe the movement trajectories of the vocal organs and have difficulty further understanding and applying the abstract explanations. In the piano practice courses of colleges and universities, there is a reliance on teachers' demonstration and explanation, lacking multi-angle and data-driven teaching presentations. Some students majoring in music performance, due to the lack of stage practice training, suffer from emotional tension, lack of self-confidence, and weak psychological quality during on-the-spot performances. In other music practice courses, such as choral conducting rehearsals, duets and opera rehearsals, and improvisational accompaniment, although the forms vary, the common demands are unified. However, under the traditional teaching mode, due to issues such as teacher allocation, experimental equipment, and rehearsal venues, the course teaching lacks innovation. The above-mentioned problems vividly reflect the urgency of the reform of practical teaching. By innovating music practice teaching through modern information technology means and developing virtual teaching practice venues, teachers and students can transform into each other in both teaching and learning, achieving comprehensive development of students in terms of professional skills and practical competitiveness.

3.2. Demands for virtual reality technology applications

In the comprehensive university music courses, in addition to professional skills, some professional elective courses can also use virtual reality technology for teaching reform. A virtual visualization system of vocal organs was developed to display the relationship between vocal movements and sound waveforms in real

time through 3D models. The virtual concert hall scene was constructed to simulate the acoustic feedback and visual pressure environment of different sizes of audience seats. Combined with motion capture technology, the teacher's standard finger-pointing was transformed into virtual cursor guidance and strength display, and the comparison of students' action trajectories was superimposed. A multi-track virtual ensemble system was designed to support students in controlling the volume of different voice parts independently and intuitively understanding the relationship between voice parts. A virtual instrument simulator is developed to build a multi-person synchronous virtual rehearsal room, which supports low-latency audio and video interaction and real-time music notation [4]. Modern information technology can make students have a better experience in the learning process, to improve the teaching effect.

4. The innovative path of music practice teaching based on virtual reality technology

4.1. Innovative path of vocal music practice teaching empowered by virtual reality technology

Virtual reality technology, with its characteristics of immersion, interaction, and conception, provides a new possibility for vocal music practice teaching. To promote the development of teaching personalization through data analysis. Focusing on the actual situation of students, virtual singing scenes with simulated acoustic effects are built. With the help of the atmosphere created by different singing environments, singers are inspired to actively adjust the softness of the timbre, so that the voice is more delicate and appealing, and the scene empowers the voice [5]. At the same time, with the help of virtual reality technology, the idea of visual and tactile feedback is integrated to realize a multi-dimensional sensory experience and strengthen the three-dimensional nature of artistic perception. For example, through the innovative integration of virtual reality technology and opera works, multi-dimensional interactive scenes are built through multi-sensory channels, and art scenes that fit the opera plot are built independently in the virtual scene. At the same time, lighting and sound effects are adjusted accurately with the help of digital technology to achieve an emotional resonance experience. Virtual reality technology can also combine with AI technology to analyze students' performance in the process of vocal singing in real time, such as intonation, rhythm, and phonation position, and give timely, targeted feedback, customize exclusive practice content, personalized guidance and appropriate practice content, and effectively mobilize students' learning enthusiasm, to achieve accurate and efficient teaching.

4.2. The innovative path of piano practice teaching is supported by virtual reality technology

Virtual reality technology teaching breaks the limitations of the traditional piano classroom, takes students' hands-on practice as the core, fully releases students' perceptual thinking, and stimulates creativity. Virtual disassembly and assembly of piano parts, familiar with the internal and external form of the instrument from multiple angles, the corresponding working principle, guide students to experience the immersive scene, feel the real visual effects, and stimulate students' interest in learning. At the same time, the virtual reality technology can create diversified teaching scenarios, according to the different ages and styles of work to build different music scenes, such as a virtual concert hall, an ensemble rehearsal room, different styles of play stage, overall layout, and details of these virtual scene spaces, scene environment highly consistent with

reality. When students play the piano ensemble in the virtual concert hall, they can not only hear the real echo of the ensemble sound, but also observe the immediate reaction of the virtual ensemble players. Under this experience, students can subjectively feel the atmosphere of piano performance and the synergy of the instrument ensemble. In addition, in the process of piano classroom teaching, teachers combine virtual reality technology teaching to cultivate students' comprehensive music literacy. The construction of virtual reality technology spans the historical "situational channel" and guides students to "enter" the composer's era context, and truly feel the social environment and cultural trend of the work creation.

4.3. Innovation path of virtual reality technology to help other music practice courses

Virtual reality chorus rehearsal simulation successfully breaks through the traditional rehearsal in time and space restrictions, and also solves the dependence on hearing. With the help of virtual technology to visualize the acoustic atlas, the abstract intonation is transformed into intuitive visual signals, which effectively help to improve the efficiency and accuracy of intonation and voice training. The application in the teaching process of duet and opera rehearsal realizes the interaction between students and opera characters in the virtual environment, provides a more realistic visual and auditory experience, a multi-sensory experience of the richness of opera, an in-depth understanding of the characteristics of opera characters, and promotes collaboration between students. Students can continue to carry out virtual concerts after class, wear VR headsets, experience the singing scene in an immersive way, develop a new performance cooperation mode, and obtain the experience of stage performance. Virtual reality technology has also achieved remarkable results in the teaching of improvised accompaniment. Through this technology, students can experience various musical environments, simulate the performance scenes, enhance their ability of music perception, and carry out relevant evaluation and feedback. Teachers can adjust teaching methods in time and solve problems in a targeted manner. It can be seen that the application of virtual reality technology in the teaching of music practice courses has greatly improved students' autonomous learning ability and exploration ability, and made forward-looking exploration for music practice teaching.

5. Practical reflection and optimization strategies of virtual reality technology

5.1. Reflection on issues arising during application

First, in terms of technical adaptation, the acoustic modeling of existing VR devices has certain differences in accurately restoring the subtle timbre of different Musical Instruments, easily leading to "timbre distortion" of virtual Musical Instruments and auditory cognitive bias. Due to the extremely high demand for "millisecond-level motion accuracy" for instruments such as pianos and bowed string instruments, ordinary VR motion capture systems have a delay of 50 to 100 milliseconds, which may cause the student's movements to be out of sync with the sound output. The adaptation design of the VR teaching system to "tactile feedback" and "force feedback" needs to be strengthened. Second, the teaching cost is relatively high. The VR teaching module requires the collaborative work of teachers, 3D modelers, acoustic engineers, etc. In the later stage, the instrument physics engine also needs to be continuously updated, which incurs high costs and is difficult for local colleges and universities or non-key majors to bear. At present, music colleges and a few universities have incorporated this technology and carried out teaching and interdisciplinary project exploration. Third, in terms of the acceptance of teachers and students, some teachers have "substitution anxiety" for VR technology,

fearing that the virtual system will weaken the value of teachers' "personalized guidance." Meanwhile, teachers need to learn additional VR equipment operation and content production, which increases the time of lesson preparation.

5.2. Path optimization strategy based on reflection

According to the reflection of current virtual reality technology in teaching, the following optimization strategies can be adopted. Development of music music-specific acoustic engine for technical adaptation optimization. Optimize VR acoustic models based on the characteristics of Musical Instruments. For instance, design an "action physical feedback system" for pianos to simulate the rebound speed of hammers when keys are pressed with different forces. Develop a "resonance cavity acoustic parameter library" for vocal music, and preset virtual resonance effects for different voice parts such as tenor and mezzo-soprano. Adopt a low-latency motion capture solution using "hybrid positioning technology." Basic motion capture uses a low-cost camera +AI algorithm, and uses dedicated sensors superimposed on core accuracy requirements (such as finger touch state in piano discipline) to reduce latency and ensure that core actions are synchronized with sound. Carry out a multi-modal interaction hierarchical design, and realize different sensory feedback such as auditory, visual, tactile, force feedback, and olfactory simulation according to the priority of course requirements.

According to different teaching objectives, the hardware configuration gradient controls the teaching cost. The basic version is suitable for a mobile phone VR box + ordinary camera, and lightweight contents such as "2D virtual teacher demonstration" and "simplified version of vocal organ animation" are developed. The cost of single equipment is controlled at a lower price, which is used for public elective courses or for beginners. The professional layout is oriented towards performance majors, equipped with headsets and motion capture devices, focusing on the high-precision demands of the discipline. In collaboration with multiple universities, a "VR Music Teaching Resource Alliance" was established, with a division of labor to develop modular content. Resources were shared through a cloud platform to reduce development costs. At the same time, an "open source community" mechanism is introduced to encourage teachers and students to upload self-made VR teaching materials.

The mechanism of "experience feedback-fast iteration" was established, anonymous feedback of teachers and students on the VR teaching system was collected regularly, and targeted optimization was carried out with the technical team to improve the acceptance of teachers and students. Launch "VR Teaching Workshops" to train teachers to independently design teaching scenarios using simple tools, enabling teachers to transform their roles from "skill transmitters" to "VR teaching designers." Transform teachers' "empirical knowledge" into "interactive teaching modules" in VR to strengthen teachers' leading position in the application of technology. The closed-loop student training system of "VR pre-training → real instrument practice → VR disk optimization "is adopted. The "action error report" is generated by correcting the basic action through the virtual system. Under the guidance of the teacher, the real instrument is used to verify the improvement effect in the class. The real performance video is recorded and compared with the VR standard action to generate the "virtual and real comparative analysis report."

6. Conclusion

Standing at the historical juncture of the digital transformation of education, virtual reality technology is

reshaping the genetic structure of music practical teaching. The application of virtual reality technology in college music practice teaching needs to break through the misunderstanding of "technology first" and return to the essence of "teaching demand as the core" [6]. By adapting customized technologies to solve the problem of "the particularity of music scenarios", lowering the threshold for implementation through gradient cost control, and resolving the resistance of traditional teaching habits through a teacher-student collaboration mechanism, the deep integration of VR technology and the laws of music education is ultimately achieved, making it a truly innovative tool that "empowerment rather than replacement." In the future, we should focus on the cross-research of musicology and VR: building the metaverse education ecology, developing distributed virtual scenes that support ten thousand people's concurrency; realizing real-time AI rendering of personalized teaching scenarios; integrating brain-computer interface technology to explore the possibility of controlling virtual Musical Instruments with thoughts. However, technology is always merely a means; the ultimate goal of education remains to cultivate a "complete and rich artistic personality." When the virtual and the real reach a perfect harmony in the symphony of education, people can truly play a new chapter in music education. This process will also contribute to the in-depth advancement of the modernization of university music education.

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