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Application Research on Enhancing the Cognitive Ability of Art Appreciation of Senior High School Students in Chengdu through Virtual Reality Technology

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Abstract

The application of virtual reality technology in art appreciation teaching can effectively guide students to recognize and appreciate art works from the visual, auditory and tactile aspects. By simulating the reproduction of the real scene of art works, the students' cognitive ability and appreciation ability of art appreciation can be improved. This paper aims to apply virtual reality technology to art appreciation teaching, improve students' cognitive ability of art appreciation, and adopt the quantitative and qualitative modes of research. This quasi-experimental study uses pre-test and post-test, and uses two different methods of traditional teaching modes and virtual reality technology teaching mode to compare the test results of the cognitive ability of art appreciation two groups of students. The data were analyzed by mean and standard deviation, and the research hypothesis was tested by independent sample t-test and paired sample t-test. The hypothesis test results showed that the students in the experimental group achieved good results in the test of virtual reality technology applied to art appreciation. Finally, the qualitative data of face-to-face interviews reflect the positive evaluation of the technology and the satisfaction of improving the cognitive ability of art appreciation. The main survey structure shows that art appreciation learning combined with virtual reality technology is effective and could be considered as a useful technical tool. It gives students the opportunity to learn and practice more comprehensively in the art class, thus improving their cognitive and aesthetic abilities.

Keywords: Applied research, Art appreciation, Cognitive ability, Digital technology, Middle school students, Promotion strategies, Virtual reality technology.

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1. Introduction

Cognitive ability includes attention, thinking ability, imagination, evaluation ability, judgment ability and perception. Students' cognitive ability of things directly affects the effect of classroom teaching. Modern teaching focuses on how to improve students' cognitive and understanding ability and cultivating students' cognitive ability. Senior high school is an important stage at which to cultivate students' cognitive ability. Art appreciation teaching plays an important role in students' aesthetic cognition [1]. Students' cognition and aesthetic ability of beauty are of great help to students' future work and life.

Nowadays, compared with traditional art classes, virtual reality technology can provide students with a more realistic and wonderful visual, auditory and tactile learning experience [2]. With its unique perception, interaction, symbiosis and other technologies, virtual reality technology can break through the cognitive mode of traditional art, take advantage of the opportunities created by modern technology to improve the art discipline and to expand the new space for the development of art discipline [3]. At present, China's high school students are facing great pressure to study and enter higher education, but what they have learned, seen and experienced at this stage has a great effect on their future development [4]. An art appreciation course is an important part of high school education in China. It mainly affects students by improving their aesthetic quality and cognitive ability.

Aesthetics often comes from cognition, and the level of cognitive ability determines the level of aesthetic quality to a certain extent. However, the current teaching effect of art appreciation course is affected by the presentation effect of art works, and virtual reality and artificial intelligence promote the development of education and teaching. As a new teaching tool, virtual reality appears in the classroom. It can effectively generate experience and make the learning form of traditional art clearer [5], so as to improve students' cognitive ability and appreciation ability.

There is still a lack of research or cases on the application of virtual reality technology in art appreciation courses in international and Chinese related research. This study is to improve students' cognitive ability through the application of virtual reality technology in art appreciation courses. It is different from most traditional art appreciation courses, which teach knowledge through pictures, books and slides, so it has certain creativity and uniqueness.

With the advent of the digital age, the application of virtual reality technology in the appreciation of art in the classroom breaks through the constraints of time and space through multi-dimensional experiences such as viewing, listening and touch, transmits more information to the audience, widens the historical value of traditional art works, and enriches the experience of art appreciation and learning. It helps to improve students' cognitive ability to appreciate works of art [6]. According to the research, the application of virtual reality technology in art appreciation teaching contains great potential and broad prospects. It has multiple advantages such as stimulating learning motivation, enhancing cognitive ability, creating learning situations, enhancing the learning experience and to realize the interaction and integration of digital technology in education. It provides a new teaching method for art appreciation course and breaks through the form and limitations of the traditional art teaching mode [7]. At the same time, it has achieved a new leap in the development of educational means, which helps to improve the cognitive ability of senior high school students in art appreciation learning [8].

1.1. Research Questions

1. What are the students level of judgement ability, inductive ability, observational ability, divergent thinking ability, and evaluation ability improvement after using the virtual reality.
2. What are the differences between students in art appreciation virtual reality technology and traditional teaching?

1.2. Research Objectives

1. To determine students level of judgement ability, inductive ability, observational ability, divergent thinking ability, and evaluation ability improvement after using the virtual reality.
2. To determine the differences between students in art appreciation virtual reality technology and traditional teaching.

1.3. Significance of the Study

1. The developed virtual reality technology applied to the teaching mode of art appreciation will be a tool to improve students' appreciation and cognitive ability of works of art.
2. This study narrowed the gap between traditional teaching and technical teaching.
3. The application of virtual reality technology in art appreciation model not only supports classroom teaching, but also can be used as a guideline for curriculum implementation and curriculum and teaching design, to improve students' cognitive ability of art curriculum learning. At the same time, it also puts forward a new form and direction for art teachers to adopt the teaching mode of art appreciation.
4. The application of virtual reality technology in the teaching mode of art appreciation makes up for the defect of being too abstract in art teaching, effectively solves the key and difficult points of teaching and realizes the improvement of teaching quality.

1.4. Research Hypotheses

The following are the list of hypotheses and literature that supports the development of hypotheses in the study. As shown in [Table 1](#).

Table 1.

List of hypotheses in the study.

Hypotheses (Null and Alternative)	Statement	Literature Support
H ₀ 1	The application of virtual reality technology in art appreciation teaching cannot improve students' judgment ability in cognitive ability.	Haifeng and Wensheng [9]
Ha1	The application of virtual reality technology in art appreciation teaching improves students' judgment ability in cognitive ability.	
H ₀ 2	The application of virtual reality technology in art appreciation teaching cannot improve students' inductive ability in cognitive ability.	Hong, et al. [10]
Ha2	The application of virtual reality technology in art appreciation teaching improves students' inductive ability in cognitive ability.	
H ₀ 3	The application of virtual reality technology in art appreciation teaching cannot improve students' observation ability in cognitive ability.	Dianling [11]
Ha3	The application of virtual reality technology in art appreciation teaching improves students' observation ability in cognitive ability.	
H ₀ 4	The application of virtual reality technology in art appreciation teaching cannot improve students' divergent thinking ability in cognitive ability.	Hettinger [12]
Ha4	The application of virtual reality technology in art appreciation teaching improves students' divergent thinking ability in cognitive ability.	
H ₀ 5	The application of virtual reality technology in art appreciation teaching cannot improve the evaluation ability of students' cognitive ability.	Limei [13]
Ha5	The application of virtual reality technology in art appreciation teaching improves the evaluation ability of students' cognitive ability.	
H ₀ 6	There is no difference in the improvement of cognitive ability between students who participate in traditional art appreciation and students who participate in the application of virtual reality technology in art appreciation.	Carlson and Lintott [5]
Ha6	There are differences in the improvement of cognitive ability between students who participate in traditional art appreciation and students who participate in the application of virtual reality technology in art appreciation.	

2. Literature Review

2.1. Significance of Art Appreciation Teaching

For students, through the study of art appreciation content series, they can not only appreciate some famous art works at home and abroad, but also stimulate their association, analysis and judgment of works of art, to go deep into art works and obtain spiritual resonance and aesthetic enjoyment and to better understand and grasp the expression intention of art works [14]. Then, the significance of art appreciation course is:

1. To meet students' aesthetic needs and improve their aesthetic ability.
2. To cultivate students' ideology and improve students' spiritual quality.

3. To help students broaden their horizons and expand their fields of knowledge.
4. To help students cultivate their sentiment and improve their mental health.

2.2. Virtual Reality Technology

The main components of a complete virtual reality system are shown in Figure 1:

- (1) The 3D virtual environment generator and its display part are the basic parts of the virtual reality system [15].
- (2) The signal acquisition part is composed of various sensors and is the sensing part of the virtual reality system [16].
- (3) The information output part, composed of various external devices, is the part that allows the operator to feel in the virtual reality system, including hearing, touch, even smell and taste.

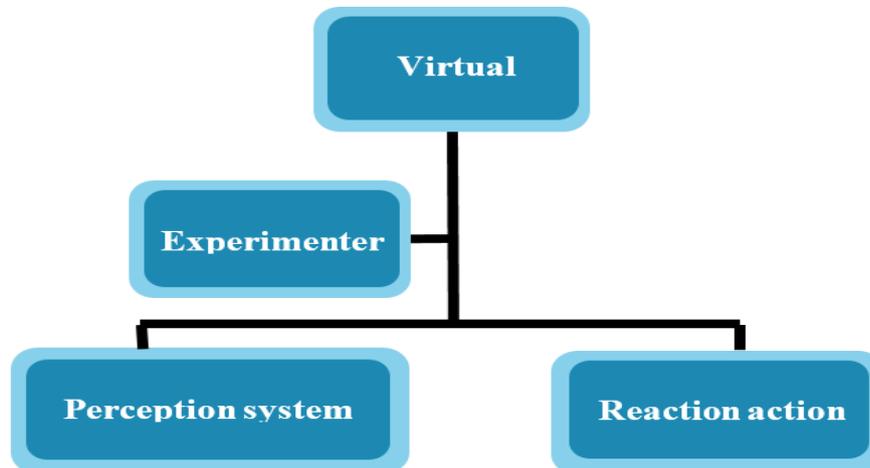


Figure 1.
Composition of virtual reality system.
Source: Zhong, et al. [17].

2.3. Characteristics of Virtual Reality Technology

2.3.1. Immersion

Immersion is the core feature of virtual reality technology [18]. Immersion refers to users being able to immerse themselves in the virtual environment generated by the computer system, in which the virtual objects can move autonomously [11]. Users can feel everything in the virtual environment through special devices, and feel as if they are on the scene, rather than staying on the external computer audio-visual or directly watching the results of computer processing [12].

2.3.2. Interactivity

Interactivity refers to that in the virtual environment, the user is no longer a passive feeling, and can change the content of the feeling through some special devices [19], that is, the user is no longer limited to simply processing information with the mouse and keyboard, but can use devices such as a sensor data glove or force feedback glove to interact with the objects in the virtual environment [20].

2.3.3. Conception

Virtual reality technology can not only reproduce the real environment, but also enables the experimenter to fly freely in a fantasy world with the wings of imagination. That is to say, the experimenter can freely conceive the objective environment that does not exist or even is impossible to occur [21] using virtual reality technology to realize the virtual scene in this field. For example, using virtual reality technology to simulate a human life scene on Mars to promote scientific research [22].

2.4. Advantages of Virtual Reality Technology in Art Appreciation Teaching

1. Virtual reality technology provides students with favorable conditions for autonomous learning. Depending on the equipment used, teaching resources can be saved in network operating platforms, desktop devices, mobile devices and paper books. Students can use different devices to call virtual reality teaching resources in different places and carry out autonomous learning at any time and from anywhere [23].
2. Virtual reality technology provides students with more realistic scenes. Using virtual reality technology to organize teaching, the presentation of three-dimensional effects can make up for the visual defects of two-dimensional planarization, and three-dimensional knowledge can be achieved, directly present unimaginable things in three-dimensional form. This disruptive technology may completely change the way students learn. It can analyze and refine the integrity of the work that many teachers cannot achieve by telling.
3. Virtual reality technology can improve students' interest in learning.

The use of immersive experience stimulates students' enthusiasm and fun in learning about art works. It also provides learners with opportunities for subtle observation and cooperation with others, and helps improve students' ability to understand, analyze and evaluate learning content [24].

4. The application of virtual reality technology can promote the integration of high-quality resources.

At present, to promote the balanced development of education, the competent department of education will vigorously develop the application of virtual reality technology in teaching. This will be one of the specific ways to alleviate the polarization of educational resources, narrow the gap between urban and rural areas, and achieve educational equity.

In Figure 2, 3D modeling technology is the most important technology foundation in virtual reality. The authenticity of the model directly determines the authenticity of the 3D effect.

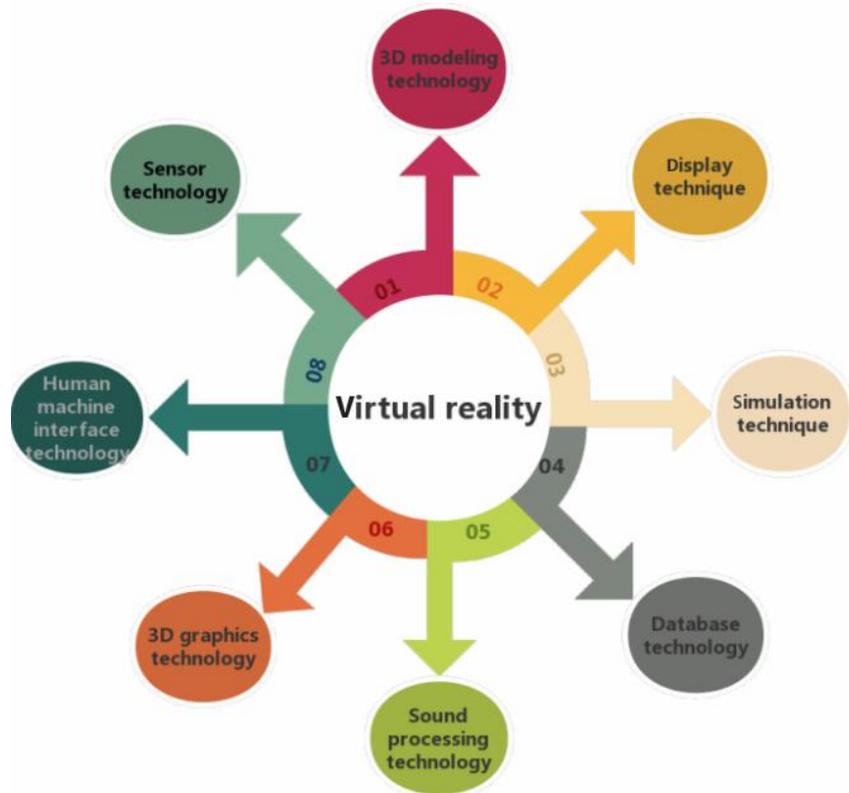


Figure 2. Technical basis of virtual reality

2.5. Cognitive Ability of Art Appreciation

The cognitive ability of art appreciation is the psychological condition that ensures the effective cognitive activities of art appreciation. It is an important part in ensuring the quality of art appreciation teaching [25]. The following are the specific ways to cultivate the cognitive ability of art appreciation:

1. Improve the cognitive and learning awareness of art appreciation.
2. Enrich the cognitive knowledge and experience of art appreciation [26].
3. Strengthen the cognitive operation guidance of art appreciation.
4. Create conditions and opportunities for feedback in art appreciation learning [27].

This series of keywords and their theoretical logic in Figure 3 promote the progress of aesthetic theory [28].

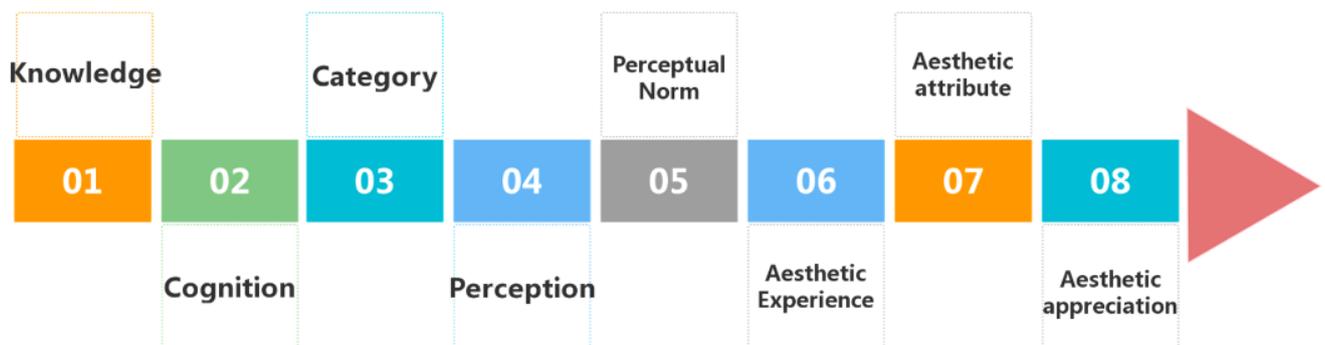


Figure 3. Aesthetic cognitive model.

3. Theoretical Framework

The purpose of this study is to determine whether virtual reality technology is suitable for teaching an art appreciation course to improve students' cognitive abilities.

The literature review shows that virtual reality technology has been applied to various educational researches. This model should be considered and encouraged to improve students' cognitive ability of art appreciation. The realistic learning situation and flexible and diverse interaction methods created by virtual reality technology can improve learners' cognitive abilities and understanding of art appreciation courses.

4. Conceptual Framework

The conceptual framework of this study comes from the relevant literature review and theory, including the relevant literature of art appreciation at home and abroad, the content of virtual reality technology and its application in the field of education, and the cognitive ability of art appreciation.

In addition, Figure 4 attempts to describe the schematic diagram of the conceptual framework in the research, and determines the research design, teaching method selection and the application of virtual reality technology related to this research to improve students' cognitive ability and aesthetic awareness of art appreciation and to more effectively improve their learning ability in the course of art appreciation.

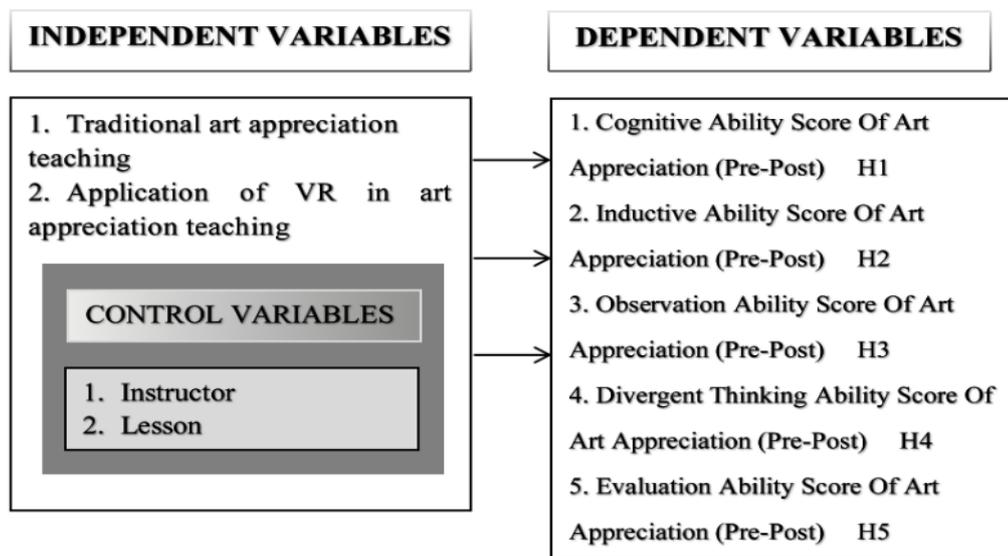


Figure 4. Conceptual framework.

5. Research Design and Methods

5.1. Research Design

The main purpose of this study is to develop a new teaching method of art appreciation using mixed methods for research and design. The quantitative part is to determine whether virtual reality technology can improve senior high school students' cognitive ability in art appreciation in the form of quasi-experimental research. In the qualitative part, the researcher will interview volunteers who can put forward their own experiences or views on the application of virtual reality technology in art appreciation courses. This study uses the quantitative research method to collect and analyze data, and compares the scores of cognitive ability of art appreciation after two different teaching methods: judgment ability, induction ability, observation ability, divergent thinking ability and evaluation ability. The Figure 5 illustrates the research methods of this study.

There are seven sessions in the teaching through the virtual reality. In the first session of class (60 minutes duration), the students received a brief history of the application of virtual reality technology in art teaching activities, the description of using virtual reality technology equipment and the content of art appreciation course. In addition, there were 120 minutes for participants to complete the art appreciation cognitive ability test (pre-test) based on the test questions.

In the second to sixth classes, the researcher released the learning materials and assignments of all art appreciation courses. The researchers used virtual reality technology equipment to teach the cognitive ability course of art appreciation. The tasks include making students understand the contents of art appreciation courses (such as oil painting, traditional Chinese painting, calligraphy, photography, design, architecture and other art works), whether students can distinguish the types of art works and check their judgment abilities.; Whether students can accurately classify and summarize all the elements in the picture mainly depended on their induction ability. Whether the students could distinguish the specific life objects with the same basic types according to the actual life, and investigate their observation ability. Whether students can analyze the creative intention of art works and investigate their divergent thinking ability. Whether students conduct comparative evaluation and intention analysis on multiple art works to investigate their evaluation ability. The purpose of

this assignment is to encourage high school students to use all the learning points of art appreciation to improve their cognitive ability in art appreciation.

In the seventh class (120 minutes duration), the students completed the summary and demonstration of the application of virtual reality technology to art appreciation. In addition, there were 120 minutes for participants to complete the art appreciation cognitive ability test (post-test) based on the test questions.

After that, all data were collected and analyzed after the virtual reality technology was applied to the teaching activities of art appreciation.

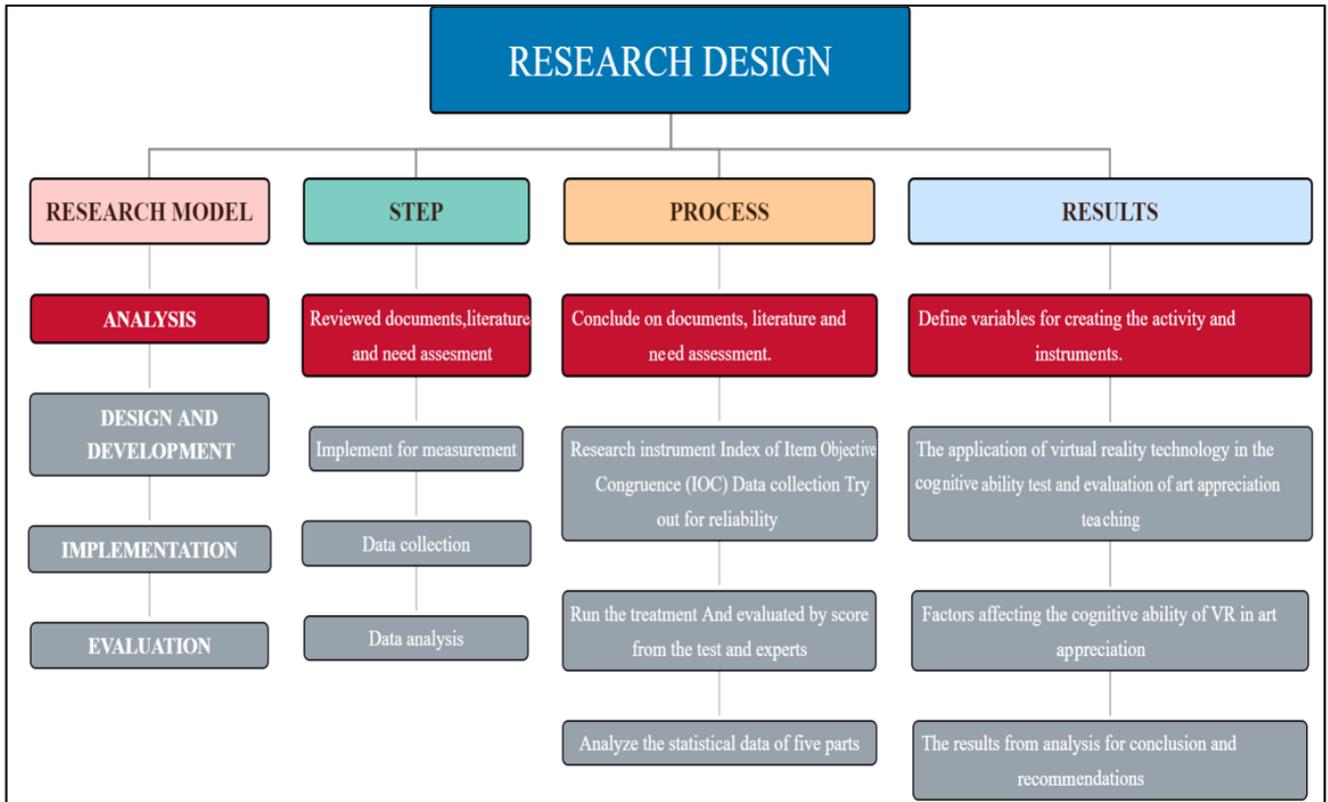


Figure 5. Diagram of research method.

5.2. Population Characteristics

The research team will be in the public high school students in Tianfu new area, Chengdu, Sichuan Province, China in 2022, especially the second year students of Taiping middle school, who have the ability and experience of art appreciation.

This school can provide 50 sets of available virtual reality technology equipment to use for learning and application of art appreciation.

The second grade students in the school comprise 68 boys and 52 girls, who are divided into three classes of 40 students. The students of the three classes must participate in the study of art appreciation. Therefore, all high school sophomores participated in the study. The researcher used purposeful sampling techniques to find the same characteristics in the population.

5.3. Sample Size

The sample group consists of 120 senior high school sophomores from Taiping middle school in Tianfu new area, Chengdu, Sichuan Province, China. They took an art appreciation course in the first semester of the 2022 academic year. One classroom was the control group of 40 students. The other two classrooms were the experimental group of 80 students. Before applying virtual reality technology to art appreciation teaching activities, both groups of students explored their cognitive ability through an art appreciation cognitive ability test.

5.4. Performance Tests (Pre-test / Post-test)

The quantitative part of this study is quasi-experimental research. The indicators to evaluate the cognitive ability of participants' art appreciation include five score dimensions, namely judgment ability, induction ability, observation ability, divergent thinking ability and evaluation ability. The cognitive ability test of art appreciation was divided into five parts and five groups. The total score of the test paper is 100. The following is the layout of the number and scores of specific questions in each section. The following figure shows the test contents of five parts of art appreciation cognitive ability in the quasi-experiment, as shown in Figure 6.

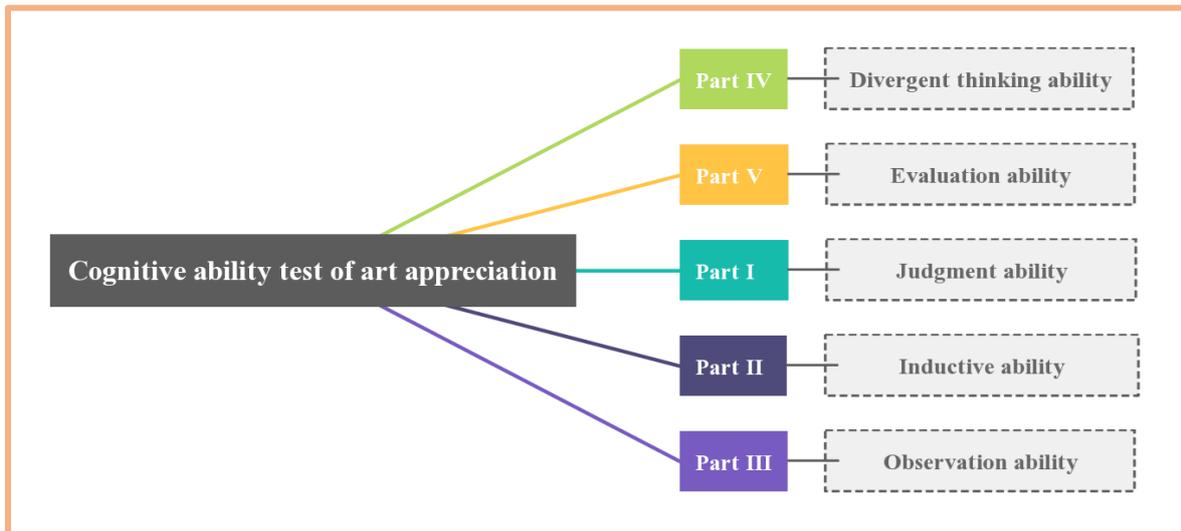


Figure 6.
Construction of cognitive ability test of art appreciation.

5.5. Interview Questions

1. Do you think the application of virtual reality technology to the study of art appreciation courses has improved your cognitive ability? If yes, how? In what aspect/way?
2. Compared with the traditional art appreciation teaching form, do you think learning and integrating new technologies can improve your interest in art appreciation? Why? What are the specific aspects?
3. Through the application of virtual reality technology, do you have a clearer understanding and experience of all parts of the cognitive ability of art appreciation? What did you learn specifically?
4. Do you think the application of virtual reality technology in art appreciation teaching can change your attitude towards art appreciation learning? Why?

5.6. Validity of the Performance Tests

The cognitive ability test of art appreciation is adapted with reference to the high school art appreciation test.

These test questions come from the national unified test and have a certain reliability and authority. The indicators used to evaluate the cognitive ability of participants' art appreciation include five score dimensions, namely judgment ability, induction ability, observation ability, divergent thinking ability and evaluation ability.

The Item Objective Congruence (IOC) Index is used as the basis for screening the item quality. Factor analysis of content validity was conducted using the project goal consistency index (IOC), which was used by experts from three professors who had at least ten years of teaching experience in art education or education management. Each expert was required to evaluate whether the project has measured the expected objectives and assigned IOC scores (1 = the expert determines that the project has actually measured the objectives, 0 = the expert is not sure whether the project has measured the objectives, - 1 = the expert determines that the project has not measured the objectives).

The pilot effectiveness of the study shows that the total IOC score of all five parts of the art appreciation cognitive ability test is = 1 (experts are convinced that the project actually measures the goal), as shown in Table 2.

Table 2.
Effectiveness of cognitive ability test of art appreciation.

Index of Item Objective Congruence Scores				
PART1 (Judgment Ability)	PART2 (Inductive Ability)	PART3 (Observation Ability)	PART4 (Divergent Thinking Ability)	PART5 (Evaluation Ability)
1.00	1.00	1.00	1.00	1.00

5.7. Validity of the Interview Questions

Factor analysis of content validity was conducted using the project goal consistency index (IOC), which was used by experts from three professors who had at least ten years of teaching experience in art education or education management, Each expert is required to evaluate whether the project has measured the expected objectives and assigned IOC scores (1 = the expert determines that the project has actually measured the objectives, 0 = the expert is not sure whether the project has measured the objectives, - 1 = the expert determines that the project has not measured the objectives).

The pilot of the study shows that the total IOC score of all interview questions is shown = 1 (experts are convinced that the project actually measures the goal), as shown in Table 3.

Table 3.
Effectiveness of interview questions.

Index of Item Objective Congruence Scores			
Question 1	Question 2	Question 3	Question 4
1.00	1.00	1.00	1.00

6. Collection of Data and Data Analysis

6.1. Quantitative Part

The pre-test and post test data of all experimental groups and the control group were collected and analyzed by SPSS (statistical product and service solutions). SPSS is data statistics and analysis software. The cognitive ability data of art appreciation were collected through the cognitive ability test of art appreciation.

In addition, after the completion of the cognitive ability test of art appreciation, the cognitive ability of art appreciation was divided into five parts according to the obtained data, which were analyzed by the following procedures:

1. Calculated the mean, percentage, standard deviation and other basic statistical data of the scores of judgment ability, induction ability, observation ability, divergent thinking ability and evaluation ability.

2. Hypothesis test statistics used the Pearson correlation coefficient, paired sample t-test to test the hypothesis and evaluated the interaction between the application of virtual reality technology in art appreciation teaching activities and cognitive ability.

6.2. Qualitative Part

This part summarized the main and important opinions of volunteers and analyzed the interview data through content analysis. All recorded interviews were transcribed into fluent written records. The subjects were analyzed using content analysis methods and converted into tabular format to show the results of their frequency and percentage.

7. Results

7.1 Quantitative Results

There are six hypotheses:

Hypothesis 1:

H₀₁: The application of virtual reality technology in art appreciation teaching cannot improve students' judgment ability in cognitive ability.

Ha1: The application of virtual reality technology in art appreciation teaching improves students' judgment ability in cognitive ability.

For hypothesis 1, the paired-sample t-test was performed to evaluate whether the scores of the pre-test and post-test were different. The results indicated that the mean of the post-test score (M=8.33, S.D.=3.05) was significantly better than the mean of the pre-test score (M=6.17, S.D.=2.48), $t(79) = -6.23$, $p=0.00$. That means the experimental group (the application of virtual reality technology in art appreciation teaching) was effective in improving their judgment abilities in cognitive ability. Therefore, the first null hypothesis was rejected. The detailed information is shown in [Table 4](#).

Table 4.
Means Summary for Pre-test and Post-test of Judgment Ability in Art Appreciation.

Test Item	Mean	S.D.	N
Pre-test	6.17	2.48	80
Post-test	8.33	3.05	80

Hypothesis 2:

H₀₂: The application of virtual reality technology in art appreciation teaching cannot improve students' inductive ability in cognitive ability.

Ha2: The application of virtual reality technology in art appreciation teaching improves students' inductive ability in cognitive ability.

For hypothesis 2, the paired-sample t-test was performed to evaluate whether the scores of the pre-test and post-test were different. The results indicated that the mean of the post-test score (M=16.58, S.D.=6.40) was significantly better than the mean of the pre-test score (M=11.06, S.D.=5.23), $t(79) = -4.371$, $p=0.00$. This means that the experimental group (the application of virtual reality technology in art appreciation teaching) was effective in improving their inductive abilities in cognitive ability. Therefore, the second null hypothesis was rejected. The detail information is shown in [Table 5](#).

Table 5.
Means Summary for Pre-test and Post-test of Inductive Ability in Art Appreciation.

Test Item	Mean	S.D.	N
Pre-test	11.06	5.23	80
Post-test	16.58	6.40	80

Hypothesis 3:

H₀₃: The application of virtual reality technology in art appreciation teaching cannot improve students' observation ability in cognitive ability.

Ha₃: The application of virtual reality technology in art appreciation teaching improved students' observation ability in cognitive ability.

For hypothesis 3, the paired-sample t-test was performed to evaluate whether the scores of the pre-test and post-test were different. The results indicated that the mean of the post-test score (M=27.80, S.D.=9.21) was significantly better than the mean of the pre-test score (M=19.04, S.D.=7.03), $t(79) = -10.51$, $p=0.00$. This means that the experimental group (the application of virtual reality technology in art appreciation teaching) was effective in improving their observation abilities in cognitive ability. Therefore, the third null hypothesis was rejected. The detail information is shown in [Table 6](#).

Table 6.

Means summary for pre-test and post-test of observation ability in art appreciation.

Test Item	Mean	S.D.	N
Pre-test	19.04	7.03	80
Post-test	27.80	9.21	80

Hypothesis 4:

H₀₄: The application of virtual reality technology in art appreciation teaching cannot improve students' divergent thinking ability in cognitive ability.

Ha₄: The application of virtual reality technology in art appreciation teaching improved students' divergent thinking abilities in cognitive ability.

For hypothesis 4, the paired-sample t-test was performed to evaluate whether the scores of the pre-test and post-test were different. The results indicated that the mean of the post-test score (M=25.06, S.D.=11.26) was significantly better than the mean of the pre-test score (M=14.22, S.D.=5.32), $t(79) = -3.60$, $p=0.00$. This means that the experimental group (the application of virtual reality technology in art appreciation teaching) was effective in improving their divergent thinking abilities in cognitive ability. Therefore, the fourth null hypothesis was rejected. The detail information is shown in [Table 7](#).

Table 7.

Means Summary for Pre-test and Post-test of divergent thinking Ability in Art Appreciation.

Test Item	Mean	S.D.	N
Pre-test	14.22	5.32	80
Post-test	25.06	11.26	80

Hypothesis 5:

H₀₅: The application of virtual reality technology in art appreciation teaching cannot improve the evaluation ability of students' cognitive ability.

Ha₅: The application of virtual reality technology in art appreciation teaching improved the evaluation ability of students' cognitive ability.

For hypothesis 5, the paired-sample t-test was performed to evaluate whether the scores of the pre-test and post-test were different. The results indicated that the mean of the post-test score (M=9.67, S.D.=3.23) was significantly better than the mean of the pre-test score (M=5.05, S.D.=1.64), $t(79) = -1.20$, $p=0.00$. This means that the experimental group (the application of virtual reality technology in art appreciation teaching) was effective in improving their evaluation abilities in cognitive ability. Therefore, the fifth null hypothesis was rejected. The detail information is shown in [Table 8](#).

Table 8.

Means Summary for Pre-test and Post-test of evaluation Ability in Art Appreciation.

Test Item	Mean	S.D.	N
Pre-test	5.05	1.64	80
Post-test	9.67	3.23	80

Hypothesis 6:

H₀₆: There is no difference in the improvement of cognitive ability between students who participate in traditional art appreciation and students who participate in the application of virtual reality technology in art appreciation.

Ha₆: There are differences in the improvement of cognitive ability between students who participated in traditional art appreciation and students who participated in the application of virtual reality technology in art appreciation.

For hypothesis 6, the independent sample t-test was carried out to compare the improvement of students' cognitive ability with the application of virtual reality technology in art appreciation teaching and traditional art appreciation teaching. T test is significant, $t(79) = 8.76$, $p=0.00$. The results show that virtual reality technology was effective in improving students' cognitive ability of art appreciation, because the process is different from the traditional teaching method of art appreciation. Therefore, the sixth null hypothesis was rejected. The detail information is shown in [Table 9](#) and [Table 10](#).

Table 9.

Average score of art appreciation cognitive ability test between students who use virtual reality technology teaching and students who do not use virtual reality technology teaching.

Test Item	Mean	S.D.	N
Traditional Teaching	62.42	25.17	40
Virtual Reality Teaching	87.52	34.03	80

Table 10.

T-test of the mean difference in cognitive ability of art appreciation between students using virtual reality technology and traditional teaching.

Participate in virtual reality teaching and traditional teaching	Mean difference	S.D.	N	N
	25.08	8.76	0.00	120

7.2. Conclusion of the Results

After the experiment, the data were analyzed by independent sample t-test and paired sample t-test. The results clearly show the following four points.

First of all, the two groups of art appreciation courses using different teaching methods have improved the students' cognitive ability of art appreciation.

Second, the control group used traditional art appreciation teaching, and the overall performance of students' art appreciation cognitive ability was statistically slightly improved.

Third, the overall performance of students' cognitive ability of art appreciation in the experimental group using virtual reality technology in art appreciation teaching is statistically significantly improved.

Fourth, compared with the control group using traditional art appreciation teaching, the experimental group using virtual reality technology in art appreciation teaching showed a more obvious score improvement in the five parts of art appreciation cognitive ability.

7.3. Qualitative Results

One week after the post-test of cognitive ability of art appreciation, the researcher conducted a face-to-face interview with 15 students in the experimental group to understand their feelings and opinions about participating in this course and to understand their satisfaction with the improvement of cognitive ability of the application of new technology to art appreciation learning. The results show that students have positive views and attitudes about the application of virtual reality technology in art appreciation courses.

On the first question: *do you think the application of virtual reality technology to the study of art appreciation courses has improved your cognitive ability? If yes, how? In what aspect/way?*, eight interviewees believed and mentioned that using virtual reality technology is very beneficial to learning art appreciation, which can significantly improve their cognitive ability of art appreciation. Six of the respondents believed that it was better to learn art appreciation using virtual reality technology because they thought it was more interesting and realistic than traditional art appreciation courses. Another two students believed that using virtual reality technology in art appreciation courses could better stimulate their imagination and judgment.

On your second question: *compared with traditional art appreciation teaching forms, do you think learning and integrating new technologies can improve your interest in art appreciation? Why? What are the specific aspects?*, seven respondents believed that the art works generated by virtual reality technology were very real, and they could observe more details and parts in the art works to enhance their feelings and understanding of the art works. Five of them said that they prefer virtual reality technology to help them learn art appreciation courses, which is more interesting and dynamic than traditional art appreciation courses. All respondents liked virtual reality technology very much, and they were particularly satisfied with the improvement of their cognitive ability of art appreciation.

On the third question: *through the application of virtual reality technology, do you have a clearer understanding and experience of the cognitive ability of all parts of art appreciation? What did you learn specifically?*, ten interviewees believed that the use of virtual reality technology was very helpful and supportive for learning art appreciation courses, especially the judgment and observation abilities in cognitive ability were significantly improved in art appreciation classes, and they could more accurately understand and distinguish the composition and intention of different art works. In addition, seven respondents believed that using virtual reality technology would help them learn art appreciation, and hoped that virtual reality technology would continue to be used in the following art appreciation courses.

On the fourth question: *do you think the application of virtual reality technology in art appreciation teaching can change your attitude towards art appreciation learning? Why?*, eight respondents said that they had a stronger interest in the study of art appreciation courses, and the real scene of virtual reality technology helped them understand more about the creative intention of art works. Among them, three respondents believed that the application of virtual reality technology in art appreciation courses can bring them more perception than traditional art appreciation courses, including touch, hearing and vision. This makes them full of expectations for the follow-up study of art appreciation courses.

In short, the topics in the interview can be divided into two categories: first, helpfulness is defined as providing useful help, the tendency to help, giving or providing help or the characteristics of help; second, usefulness and learning are defined as practical, beneficial and beneficial qualities. It is effective to apply virtual reality technology to the study of art appreciation, and which is considered as a useful technical tool to enable students to appreciate and analyze art works

through the five aspects of cognitive ability of art appreciation, including judgment ability, induction ability, observation ability, divergent thinking ability and evaluation ability. In addition, students were proud to participate in the teaching resource project with virtual reality technology as a learning technology tool. This is beneficial for students, and all the answers show the benefits and value of this learning tool. The results of the qualitative part show a positive view of the application of virtual reality technology in art appreciation as a course learning tool, and support the quantitative research results.

8. Conclusion and Recommendations

Based on the results of the quasi-experiment, it was found that compared with the traditional art appreciation teaching, the application of virtual reality technology in the teaching of art appreciation is helpful to improve students' cognitive ability of art appreciation. The results show that the application of virtual reality technology in art appreciation has a significant effect on improving students' cognitive ability of art appreciation, and helps to enhance their ability to appreciate and create art works. It can be seen that virtual reality technology has certain application value in art appreciation teaching. At the same time, art appreciation learning combined with virtual reality technology is an effective tool to improve students' cognitive ability of art appreciation. The qualitative data from face-to-face interviews reflect the positive evaluation of the technology and the satisfaction of improving the cognitive ability of art appreciation. Art appreciation learning combined with virtual reality technology is effective and is considered to be a useful technical tool, which gives students the opportunity to learn and practice more comprehensively in the art classroom, so that they can give full play to their cognitive ability and appreciation ability and improve their aesthetic performance and aesthetic ability.

It is suggested that course developers consider integrating technology into the process of teaching and learning, and consolidate the application of this technology in art appreciation courses through a series of planning courses, content, activities and assessments. Therefore, in the subsequent art appreciation courses, researchers need to constantly improve the course structure and mode, improve and enrich the application of virtual reality technology in art appreciation courses. In addition, it is suggested that the use of virtual reality technology be promoted in teaching courses in more fields or disciplines, the teaching system of new technology is constantly optimized and the vigorous development of the teaching system to meet the needs of different learners is promoted.

9. Limitations and Future Studies

From the current hardware structure in the application of virtual reality devices, the visual contrast generated by the virtual reality interface and the delayed movement between device frames make the picture movement unable to follow and match the actual moving speed of the viewer thus showing the picture difference that often caused the viewer to feel dizzy due to long-term use of the device. On the other hand, in the student-centered learning process of art appreciation classroom using virtual reality technology, the communication between teachers and students was weakened, resulting in the freedom and randomness of students' autonomous learning, which increases the difficulty for teachers to control the classroom in classroom teaching.

Future research may focus on understanding the duration of students' participation in virtual reality classes, and comprehensively improving students' cognitive ability of art appreciation with the most appropriate learning duration, including qualitative data collection. At the same time, the use of virtual reality technology in other disciplines can be explored to assess whether these findings apply to another course. Future research can explore another art course, which corresponds to the course used in this study, and analyze the improvement of students' cognitive ability using the same research method.

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