Promoting students' multiple intelligences through music education in the context of Chinese high schools

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Abstract. The development of students' multiple intelligence has been discussed worldwide. In China, the Ministry of Education released the Compulsory Education Curriculum Development Program and Standards (2022 Edition) in 2022, which sets out the requirements for developing students' core competencies. The content of core competencies emphasizes students' comprehensive literacy, which is highly associated with multiple intelligences theory. In the field of music education, the traditional form of single-discipline training is difficult to develop students' comprehensive literacy and therefore would not enhance their core competencies. Thus, whether and how music education could promote students' multiple intelligences development through the integration of multiple intelligences theory has attracted authors' attention. This study proposed two questions: 1) Can the application of multiple intelligences theory in music education promote the development of multiple intelligences in Chinese high school students?; 2) Which types of intelligence are promoted by the application of multiple intelligences theory in music education? This study used the quantitative data analysis method. The experiment divided the experimental and control groups through control variables for data investigation. Through convenient sampling, 84 high school students from Beijing, China, were invited as participants. Statistical methods were used for data analysis. The study found that: 1) The application of multiple intelligences theory in music education can promote the development of multiple intelligences in Chinese high school students; 2) The linguistic intelligence, visual-spatial intelligence, bodily-kinesthetic intelligence, musical intelligence, interpersonal intelligence and intrapersonal intelligence of Chinese high school students were facilitated by the application of multiple intelligences theory in music. Although this study has certain limitations, it provides a reference for music and multiple intelligence teaching.

Keywords: Music education; Multiple intelligences; Chinese high school students.

1 Introduction

Since entering the 21st century, global scientific and technological innovation has been unprecedentedly active. A new round of technological revolution and industrial transformation is reshaping the global economic structure. With the more and more

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in-depth development of science and technology, new requirements are put forward for future students, who need to have comprehensive skills, such as problem-solving skills, independent thinking skills, critical-thinking skills, etc. [1]

In the face of the urgent demand for comprehensive talent, education, as a critical field of talent training, has been proposed by researchers worldwide. China is not an exception. In April 2022, the Ministry of Education issued the Compulsory Education Curriculum Plan and Standards (2022 Edition), marking that compulsory education has entered the era of core competencies in an all-around way. The document emphasizes: "Strengthening the comprehensiveness and practicality of the curriculum, promoting the reform of education methods, focusing on the development of students' core competencies, highlighting the dominant position of students, paying attention to students' personalized and diversified learning and development needs, and enhance the suitability of the curriculum". Multiple intelligences theory emphasizes that students should explore their own intelligence and have more opportunities to experience meaningful, personalized and relevant courses[2]. It is believed that it can make up for the current problems of Chinese teachers and help people change their perspective on students[3]. The focus of students' development is no longer on how brilliant a student is but on what aspects. Multiple intelligences believe that every average person is born with various intellectual potentials. The difference between human individuals lies in the differences and combinations of their intellectual strengths and weaknesses[4]. It could be served as a framework allowing teachers to explore their teaching styles and assist them in making decisions about ways to structure teaching and learning experiences for students[2].

From the perspective of the application of the multiple intelligences theory in the context of China, Most studies mainly focused on language[5] and scientific fields, such as biology[6], physics[7] and chemistry[8]. As a student who majors in music discipline, I found that in the music discipline, researchers mainly focus on the formulation of educational goals[9], teachers' teaching ideas[10] and students' music achievements[11]. However, these researches fail to study the changes in other students' intelligence in the process of music learning, and few people prove their effectiveness in the form of data, especially in the context of Chinese high schools. Therefore, the author combines the theory of multiple intelligences with music to explore the development of students' multiple intelligences in the context of Chinese high schools.

2 Literature review

2.1 Multiple intelligences

Gardner proposed the theory of multiple intelligences[12]. The theory of multiple intelligences is firstly defined as the ability of individuals to solve problems or create products of value in a certain culture under one or more cultural backgrounds[12]. Later, in 2006, he further proposed that intelligence is an information computing ability derived from human biology and human psychology[13], highlighting that intelligence is the ability to process information. Multiple intelligences include 1)Linguistic

Intelligence (Linguistic Intelligence is related to the sensitivity to spoken and written language. It is the ability to acquire and use language to achieve certain goals. It refers to the ability to listen, speak, read and write"); 2)Logical-mathematical intelligence (Logical-mathematical intelligence refers to the ability to logically analyze problems, perform mathematical operations and scientifically investigate issues. It is susceptible to various relationships between things, such as analogy, contrast, causality and logic); 3)Visual-spatial intelligence (Visual-spatial intelligence refers to the identification and manipulation of patterns in space. It is mainly manifested in its extreme sensitivity to structure, line, colour, shape and spatial relationship); 4)Bodily-kinesthetic intelligence (Bodily-kinesthetic intelligence refers to the ability to use the whole body or some part the body to solve problems or create products. It is mainly manifested in the ability to control the body's balance, strength and speed); 5)Musical intelligence (Musical intelligence involves performance skills, the creative capacity of music works and the ability to appreciate music works. It shows its sensitivity to music and ability to express music by composing, playing and singing); 6)Interpersonal intelligence (Interpersonal intelligence means a person's ability to understand the intentions, motives and aspirations of others and therefore cooperate effectively with others. It is usually embodied in the ability to consciously observe and feel others' emotions, distinguish different interpersonal relationships through changes in facial expressions, sounds and actions, and make positive and appropriate responses to them); 7)Intrapersonal intelligence (Intrapersonal intelligence involves self-understanding, effective handling of self-desire, and the ability to use this information to regulate personal life effectively); 8)Naturalistic Intelligence (Naturalistic Intelligence refers to the ability of individuals to distinguish and utilize the characteristics of different environments)[14][15].

2.2 The Relationship between Music Education and Multiple intelligences

Music education is an educational form with music as the medium and aesthetics as the core[16]. Music education is not only related to a single music discipline but also involves a lot of content. For example, starting from the goal of music teaching, students should learn to sing and appreciate, compose and perform. From the perspective of art, it also includes the integration of music and poetry, dance, drama, film and television, art and other different art categories. In addition, there is also a close relationship between music and other disciplines besides art, such as music and history, geography, physics and other fields[17]. More specifically:

2.2.1. Linguistic intelligence.

Music education is believed to promote students' linguistic intelligence. Both music and language use sound to express emotions. Many elements of language can be connected with those of music. For example, the intonation, words, sentences, and speed of speech in a language match the pitch, volume, and speed in music. In addition, although music and literature are two different forms of artistic expression, they are connected and inseparable in the development of history. Combining the two,

more forms of musical works have been produced, such as opera, title music, symphony, and ballad. Therefore, music learning is also the process of developing students' linguistic intelligence. According to the discussion in the previous discussion, linguistic intelligence includes vocabulary. According to an experiment's evidence, a year of music lessons can improve vocabulary tests and understanding of prepositions. Researchers assume that music-based listening training causes vocabulary increases[18]. Therefore, music education might promote the development of linguistic intelligence.

2.2.2. Logical-mathematical intelligence.

The relationship between music and math achievement has been debated for many years. One common belief among the public and some scholars is that music is inherently linked with mathematics[19]. Pythagoras, the originator of mathematics, discovered the subtle relationship between music and mathematics. He used mathematics to explain music and used strings to calculate the degree of intervals. He divided intervals into consonance and dissonance. Researches also show that music can enhance spatial-temporal reasoning skills[20]; such spatial-temporal are vital for learning concepts in proportional reasoning and geometry. Moreover, many famous scientists are also very good at music. For example, Einstein is very good at playing the violin and can also play the piano skillfully.

2.2.3. Visual-spatial intelligence.

Music education is believed to promote students' visual-spatial intelligence. In music, the melody is the trend of the ups and downs of the pitch, expressed as straight lines, curves, stretches, or ups and downs. Some artists have also compared the tonality and colour of music. For example, Rimsky Korsakov thought that C major was white and G major was yellow[21]. Therefore, music is believed to promote visual-spatial intelligence. Research shows that musicians perform better on visual-search tasks that require them to detect "embedded" figures in line drawings than ordinary people[22]. Some experiments also show that compared with non-musicians, musicians seem to have less laterality bias[23]. According to the previous discussion, visual-spatial intelligence includes sensitivity to structure and line. Therefore, music education might promote the development of visual-spatial intelligence.

2.2.4. Bodily-kinesthetic intelligence.

Music education is believed to promote students' bodily-kinesthetic intelligence. Many famous music education systems advocate the integration of body kinesthetics into music education. The Swiss music educator Darkroz advocates the integration of body, music and emotion in music education and supports the experience of music through body movement to promote the coordinated development of hearing, kinesthetics, thinking and feeling. The Orff music education system also pays attention to the combination of music, dance, movement and language[24].

2.2.5. Musical intelligence.

Music education includes singing, appreciation, instrument performance, music composing and other music activities. Through listening to music, singing songs, playing instruments and other ways, students can participate in music, experience the melody and rhythm of music, and express their feelings with music. Some experimental studies suggest that people in early childhood have an innate ability to calculate and distinguish pitch[25]. This fully proves that musical thinking is an independent way of thinking, like mathematical, logical thinking. It does not belong to any intelligence but exists relatively independently. Development can only be achieved through music activities.

2.2.6. Interpersonal intelligence.

Music education is mainly characterized by emotion[16]. Music is an expressive art. Therefore, given the natural interconnection between music and emotion, music education enhances emotional expression[26] and emotional self-awareness[27]. In addition, music education allows students to develop intrapersonal skills while acquiring professional skills. According to the previous discussion, intrapersonal intelligence includes self-understanding and effectively regulating personal emotions. Therefore, music education is considered to promote students' intrapersonal intelligence.

2.2.7. Intrapersonal intelligence.

Music is an art form of social and nonverbal communication. It makes groups produce an emotional resonance, thus forming a network of emotional communication and mutual support. It connects each member not only from the surface but also from the inner level. In music therapy, music is often used as a tool to cure interpersonal communication problems[28]. In addition, music education also pays attention to cooperation. In music classes, many music activities take the form of team cooperation, such as chorus, band performance, musical performance, etc. Students communicate and exchange in the process of cooperation. Therefore, music education is believed to promote students' interpersonal intelligence.

2.2.8. Naturalistic intelligence.

Almost all art forms have described nature, and music is no exception. Composers constantly draw inspiration from nature, and there are many pieces with the theme of nature in music works. For example, taking rivers as an example, in Western music, almost every famous river in Europe has been written in music works, such as "The Blue Danube" by John Strauss, Symphony No.3 "Rhenish" by Schumann; In Chinese music, "Yellow River Chorus" by Xian Xinghai, etc. In addition, in the performance of musical instruments, composers also use various techniques to imitate natural sounds. For example, Schubert's art song "Der Erlkönig" uses the technique of piano homophonic repetitions to imitate the sound of horseshoe galloping. The ascending scale of the bass also imitates the dark wind blowing from the forest, creating a dark

and frightening atmosphere. Therefore, music is also closely related to the natural environment in naturalist Intelligence.

2.3 The Music and Multiple intelligences in the Context of China

Many studies have proved that music can promote multiple intelligences[20][29]. However, most of these studies are foreign, and the target groups have preschool children[30], elementary school children[31], undergraduate students[32], etc. In China, many researchers also pay attention to this topic. For example, Yi studied the innovation and discrete dynamic modelling of college music teaching mode. The research shows that applying the theory of multiple intelligences in colleges and universities can help teachers effectively analyze the diverse characteristics and changes of students in teaching activities, which is of great help to improve students' musical performance. Shen studied preschool children and found that musical training can promote children's inhibitory control, working memory, and cognitive flexibility[33].In the context of Chinese high school, Zhou paid attention to the high school stage[34]. Her research is about the influence and role of the theory of multiple intelligences in music teaching. Xu proposed the necessity of cultivating students' music intelligence from the goal of high school music teaching[35]. Sun analyzed the current music teaching situation in senior high schools and proposed the strategy of multiple intelligence theory in music teaching in senior high schools[36].

2.4 The current study

According to the above discussion, Music and multiple intelligences theory are associated. However, the role of music education in promoting multiple intelligences has not received enough attention. In addition, in the context of China, most of these studies are to explore the application of multiple intelligence theory in the music discipline from the theoretical level and focus on students' achievements in music. However, few people pay attention to the changes and development of other students' intelligence in the learning process, and few people use the data results to verify the effectiveness of music teaching. Therefore, I proposed the following research questions:

1) Can the application of multiple intelligences theory in music education promote the development of multiple intelligences in Chinese high school students?

2) Which types of intelligence are promoted by the application of multiple intelligences theory in music education?

3 Methodology

3.1 Research Method

The research used quantitative data analysis. Quantitative data analysis uses statistical analysis methods to quantify the data so that the development of students' intelligence can be described with more precise data, with high certainty.

3.2 Research context and Participants

The study was conducted in a Chinese high school in Beijing. The participants were 84 students from two classes in Grade Two. Each class has 42 students. This age group was chosen since I served as the music student teacher in Grade Two, and the students were more accessible. The sample selection strategy is based on convenience sampling[37]. The study lasted three months, from September to November 2022.

The research procedures and project were approved by the academic ethics committee of the author's school. They had written informed consent to students participating in the study. I obtained their parents' permission for 84 students under 18 years of age. They were told that their responses to the questionnaire would be anonymous and confidential, and the data collected would be used only for academic research.

3.3 Research design

The experiment divided the experimental and control groups through control variables for data investigation. The difference between the experimental and control groups is the teaching method. Under the same teaching content, Class X, the control group, used the conventional teaching method. In contrast, Class Y, as the experimental group, implemented the teaching method under the guidance of multiple intelligences theory. The content and objectives taught by the two classes were the same, and they were conducted according to the curriculum standards of high schools in China. The control group gave lectures according to the teaching procedures specified in the music teacher's textbook of the curriculum standards of high schools in China. Under the same teaching objectives and contents, the experimental group carried out teaching according to the theory of multiple intelligences. It combined the characteristics of multiple intelligences with the actual situation of students and teaching equipment conditions and showed them in the form of music activities. An overview of teaching is given in Table 1:

Table 1. The teaching design of the experimental and control groups

Catego-rize	Teaching design		
Group different	The control group	The experimental group	
Teaching	Non-Multiple intelligent music	Multiple intelligent music teaching activities	Intelligence

content	teaching activity		domain
Teaching method	Focus on the teacher's explanation, and students seldom make comments; Learn to sing songs directly; Sing directly according to the lyrics of the song.	·Focus on students' discussion, and the teacher only gives advice; ·Encourage students to describe their intuitive feelings about music in oral language after listening; ·Before learning to sing songs, read the lyrics with emotion; ·After learning to sing songs, encourage students to create lyrics according to the melody.	Linguistic
Way of thinking	Display the teaching content directly; Show the answer directly.	Pose questions and analyze, explore and solve questions with students; Draw a mind map or table.	Logical-mathematical
Equipment	·No multimedia: only can play music; ·Paper and pens: record class notes and knowledge content.	·Multimedia: can play music; show pictures and videos; search information online; ·Paper and pens: draw melody lines and staff notes; ·Paint: paint music emotion colour.	Visual-spatial
Class activities	·The teacher plays the piano and sings a demonstration, and the students sing and imitate; ·Listen to the teacher.	·The teacher plays the piano, and the students use percussion instruments to accompany songs; ·Walk or dance with music in the classroom; ·Play music game; ·Rehearse musical.	Bodily-kinesthetic
	·No group cooperation; ·Students study as an individual.	·Group cooperation; ·Group competition; ·Rehearse choir and orchestra.	Interpersonal
	·Watch the textbook illustration.	·Imitate the sounds of nature; ·Observe the nature.	Naturalistic
Learning songs	·Listen to a whole song ·Repeat looping	·Firstly, listen to music completely and grasp the overall emotion of music; ·Secondly, listen to music in paragraphs and phrases; ·Thirdly, listen to music elements, such as speed, melody, rhythm, etc. ·Finally, listen to music completely again.	Musical
Classroom summary	·Dismiss the class directly	·Write class reflection; ·Write self-evaluation.	Intrapersonal

3.4 Data collection

The research adopted the form of a questionnaire. The questionnaire adopted the Multiple Intelligence Developmental Assessment Scales (MIDAS) prepared by the Kentucky Education Bureau of the United States (http://www.kde. state. ky. us/oet/customer/mi/misurvey. Asp). It has been tested by many studies and translated into Chinese. Its adaptability in China has also been tested[38]. The questionnaire was issued in paper form. The control and experimental groups were given two questionnaires in the pre-test and post-test, respectively.

3.4.1.Data analysis.

SPSS (Statistical Package for the Social Sciences) program was used to analyze the data acquired in the study.

3.4.2.Reliability and Validity.

In this study, the reliability statistics of multiple intelligence developmental assessment scales were analyzed by Cronbach's Alpha. It can be seen from Figure 1 that the overall reliability of the questionnaire is α=0.893(>0.8). This indicates that the scale's reliability is within an acceptable range and meets the measurement requirements.

Cronbach's Alpha		Number
Linguistic	0.865	5
Logical-mathematical	0.839	5
Visual-spatial	0.852	5
Bodily-kinesthetic	0.89	5
Musical	0.911	5
Interpersonal	0.887	5
Intrapersonal	0.84	5
Naturalistic	0.834	5
Overall	0.893	40

Fig. 1. Reliability Statistics of Multiple Intelligence Developmental Assessment Scales(self-made)

In this study, the validity statistics of multiple intelligence developmental assessment scales were analyzed by KMO and Bartlett's Test. It can be seen from Figure 2 that the Sig. of Bartlett's test is p=0.000 (<0.01), and the KMO of sampling adequacy is 0.828 (>0.7). This indicates that the validity of this scale is good.

KMO Measure of Sampling Adequacy		0.828
Bartlett's Test of Sphericity	Approx. Chi-Square	3978.272
	df	780
	Sig.	0.000

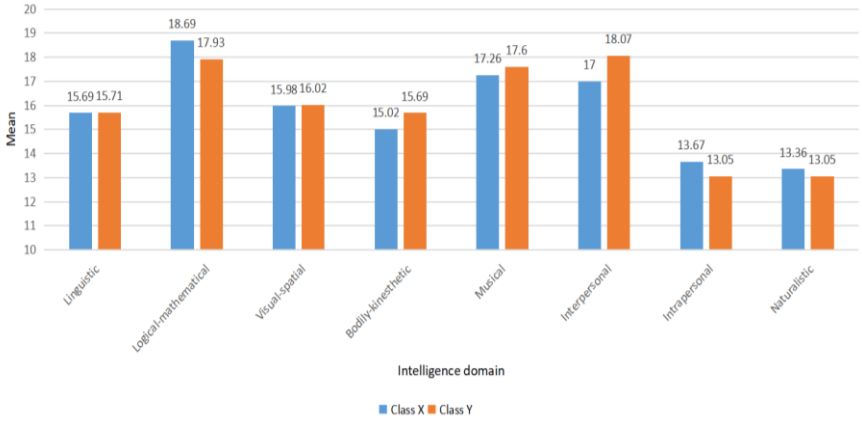
Fig. 2. KMO and Bartlett's Test of Multiple Intelligence Developmental Assessment Scales(self-made)

4 Findings

Before the experiment, Class X and Y students were tested with the Multiple Intelligence Developmental Assessment Scales. The results are shown in Figure 3(a)(b):

Intelligence domain	Class	N	M	SD	T	Sig. (2-tailed)
Linguistic	X	42	15.69	6.014	-0.02	0.984
	Y	42	15.71	4.676		
Logical-mathematical	X	42	18.69	4.841	0.707	0.482
	Y	42	17.93	5.034		
Visual-spatial	X	42	15.98	4.77	-0.041	0.967
	Y	42	16.02	5.804		
Bodily-kinesthetic	X	42	15.02	5.598	-0.526	0.6
	Y	42	15.69	6.014		
Musical	X	42	17.26	5.592	-0.262	0.794
	Y	42	17.6	6.065		
Interpersonal	X	42	17	5.378	-0.943	0.348
	Y	42	18.07	5.029		
Intrapersonal	X	42	13.67	4.647	0.564	0.574
	Y	42	13.05	5.383		
Naturalistic	X	42	13.36	5.045	0.272	0.786
	Y	42	13.05	5.383		

(a)



(b)

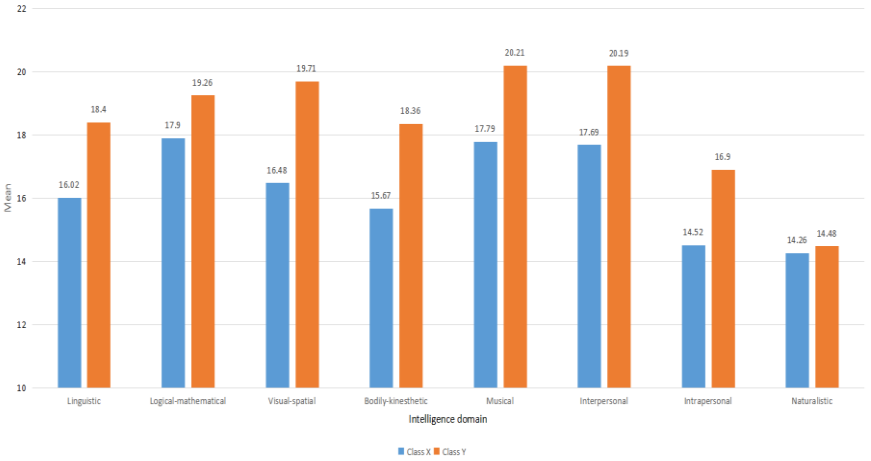
Fig. 3. (a)(b). Pre-test of control class(Class X) and experimental class(Class Y) (self-made)

It can be seen from Figure 3(a)(b) that before the experiment, there was no significant difference between the mean of students' intelligence in Class X and Class Y, which were basically the same. SPSS software was used to carry out the t-test for independent samples and at the column 'Sig. (2-tailed)', the results showed a statistically significant difference between the two groups - Class X and Class Y - because the significance level is higher than 0.05. According to statistical analysis, when $P>0.05$, there is no significant difference between the two samples. Therefore, it can be considered that the students' intelligence in the two classes is basically the same, which meets the requirements of reference and comparison and can be used as experimental objects. Class X was selected as the control class, and Class Y was the experimental class in this teaching experiment.

After the three-month teaching experiment, the students in control and experimental classes were tested with the same Multiple Intelligence Developmental Assessment Scales as the post-test. The test results are as follows:

Intelligence domain	Class	N	M	SD	T	Sig. (2-tailed)
Linguistic	X	42	16.02	5.804	-2.026	0.046
	Y	42	18.4	4.934		
Logical-mathematical	X	42	17.9	4.953	-1.241	0.218
	Y	42	19.26	5.071		
Visual-spatial	X	42	16.48	4.754	-3.098	0.003
	Y	42	19.71	4.825		
Bodily-kinesthetic	X	42	15.67	5.603	-2.306	0.024
	Y	42	18.36	5.079		
Musical	X	42	17.79	5.082	-2.232	0.028
	Y	42	20.21	4.887		
Interpersonal	X	42	17.69	5.101	-2.45	0.016
	Y	42	20.19	4.209		
Intrapersonal	X	42	14.52	5.209	-1.96	0.053
	Y	42	16.9	5.901		
Naturalistic	X	42	14.26	4.864	-0.195	0.846
	Y	42	14.48	5.186		

(a)



(b)

Fig. 4. (a)(b). Post-test of control class(Class X) and experimental class(Class Y) (self-made)

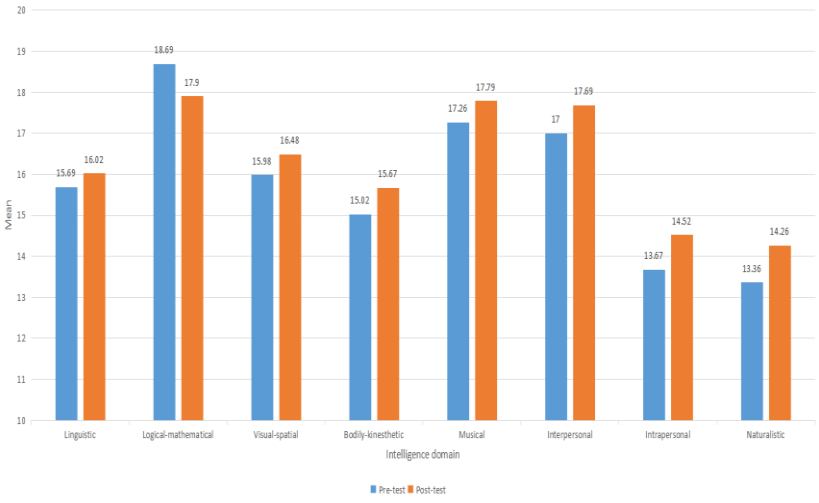
When the means of intelligence score according to Class X and Class Y were examined after the three-month teaching experiment, it is seen that in linguistic intelligence, the means of Class X is 16.02. The means of Class Y is 18.4. There is a statistically significant difference between the means of the two groups ($p = 0.046$). In logical-mathematical intelligence, the means of Class X is 17.9, and the means of Class Y is 19.26. There is no statistically significant difference between the means of the two groups ($p = 0.218$). In visual-spatial intelligence, the means of Class X is 16.48, and the means of Class Y is 19.71. There is a statistically significant difference between the means of the two groups ($p = 0.003$). In bodily-kinesthetic intelligence, the means of Class X is 15.67, and the means of Class Y is 18.36. There is a statistically significant difference between the means of the two groups ($p = 0.024$). In musical intelligence, the means of Class X is 17.79, and the means of Class Y is 20.21. There is a statistically significant difference between the means of the two groups ($p = 0.028$). In interpersonal intelligence, the means of Class X is 17.69, and the means of

Class Y is 20.19. There is a statistically significant difference between the means of the two groups (p = 0.016). In intrapersonal intelligence, the means of Class X is 14.52, and the means of Class Y is 16.9. There is no statistically significant difference between the means of the two groups (p = 0.053). In naturalistic Intelligence, the means of Class X is 14.26, and the means of Class Y is 14.48. There is no statistically significant difference between the means of the two groups (p = 0.846). It shows that part of the students' intelligence in the experimental class has been effectively developed after the experiment.

To understand whether there is any difference between the pre-test and post-test of the intelligence of the students in the control class (Class X), Figure 5(a)(b) compares the intelligence of 42 students in the control class before and after the experiment:

Intelligence domain		N	M	SD	T	Sig. (2-tailed)
Linguistic	Pre-test	42	15.69	6.014	-0.258	0.797
	Post-test	42	16.02	5.804		
Logical-mathematical	Pre-test	42	18.69	4.841	0.735	0.464
	Post-test	42	17.9	4.953		
Visual-spatial	Pre-test	42	15.98	4.77	-0.481	0.632
	Post-test	42	16.48	4.754		
Bodily-kinesthetic	Pre-test	42	15.02	5.598	-0.526	0.6
	Post-test	42	15.67	5.603		
Musical	Pre-test	42	17.26	5.592	-0.449	0.654
	Post-test	42	17.79	5.082		
Interpersonal	Pre-test	42	17	5.378	-0.604	0.548
	Post-test	42	17.69	5.101		
Intrapersonal	Pre-test	42	13.67	4.647	-0.796	0.428
	Post-test	42	14.52	5.209		
Naturalistic	Pre-test	42	13.36	5.045	-0.837	0.405
	Post-test	42	14.26	4.864		

(a)



(b)

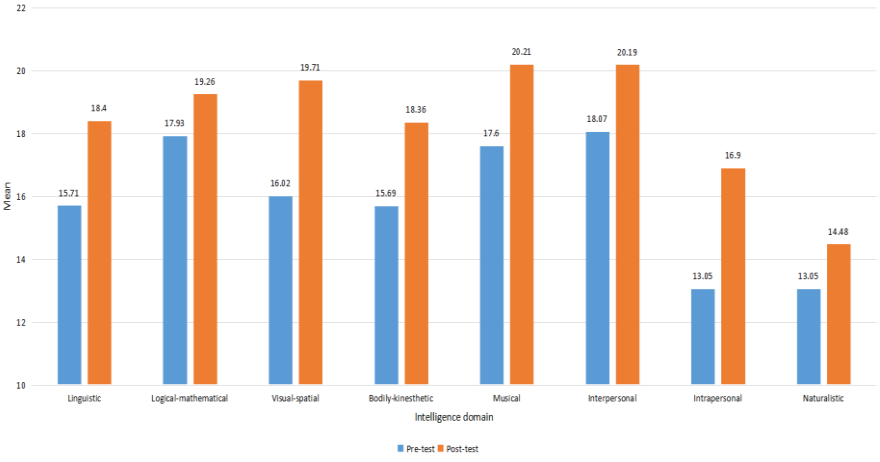
Fig. 5. (a)(b). Comparison of pre-test and post-test in the control class(Class X) (self-made)

It can be seen from the data comparison in Figure 5(a)(b) that after three months of a teaching experiment, the average scores of the students in the control class have both improved, except for logical-mathematical intelligence. Using SPSS statistical software, an independent sample t-test was conducted on the eight intelligent statistical data of the control class. Running along to each column 'Sig. (2-tailed)', we find that p >0.05. Therefore, the null hypothesis (there is no statistically significant difference between the means of the two groups) is supported. It showed that there was no significant difference in the intelligence development of the students in the control class before and after the experiment (P>0.05), and they did not develop effectively.

To understand whether there is any difference between the pre-test and post-test of the intelligence of the students in the experimental class (Class Y), Figure 6(a)(b) compares the intelligence of 42 students in the experimental class before and after the experiment:

Intelligence domain		N	M	SD	T	Sig. (2-tailed)
Linguistic	Pre-test	42	15.71	4.676	-2.565	0.012
	Post-test	42	18.4	4.934		
Logical-mathematical	Pre-test	42	17.93	5.034	-1.209	0.23
	Post-test	42	19.26	5.071		
Visual-spatial	Pre-test	42	16.02	5.804	-3.169	0.002
	Post-test	42	19.71	4.825		
Bodily-kinesthetic	Pre-test	42	15.69	6.014	-2.195	0.031
	Post-test	42	18.36	5.079		
Musical	Pre-test	42	17.6	6.065	-2.179	0.032
	Post-test	42	20.21	4.887		
Interpersonal	Pre-test	42	18.07	5.029	-2.094	0.039
	Post-test	42	20.19	4.209		
Intrapersonal	Pre-test	42	13.05	5.383	-3.13	0.002
	Post-test	42	16.9	5.901		
Naturalistic	Pre-test	42	13.05	5.383	-1.239	0.219
	Post-test	42	14.48	5.186		

(a)



(b)

Fig. 6. (a)(b). Comparison of pre-test and post-test in the experimental class(Class Y) (self-made)

According to the comparison of data in Figure 6(a)(b), after three months of teaching experiments, the average scores of students in the experimental class have both improved significantly. There is a significant trend in the development of intelligence. Using SPSS statistical software, an independent sample t-test was conducted on the eight intelligent statistical data of the experimental class. It can be seen that in linguistic intelligence, the means of the pre-test is 15.71, and the means of the post-test is 18.4. There is a statistically significant difference between the means of the two groups ($p = 0.012$). In logical-mathematical intelligence, the means of the pre-test is 17.93, and the means of the post-test is 19.26. There is no statistically significant difference between the means of the two groups ($p = 0.23$). In visual-spatial intelligence, the means of the pre-test is 16.02, and the means of the post-test is 19.71. There is a statistically significant difference between the means of the two groups ($p = 0.002$). In bodily-kinesthetic intelligence, the means of the pre-test is 15.69, and the means of the post-test is 18.36. There is a statistically significant difference between the means of the two groups ($p = 0.031$). In musical intelligence, the means of the pre-test is 17.6, and the means of the post-test is 20.21. There is a statistically significant difference between the means of the two groups ($p = 0.032$). In interpersonal intelligence, the means of the pre-test is 18.07, and the means of the post-test is 20.19. There is a statistically significant difference between the means of the two groups ($p = 0.039$). In intrapersonal intelligence, the mean of the pre-test is 13.05, and the mean of the post-test is 16.9. There is a statistically significant difference between the means of the two groups ($p = 0.002$). In naturalistic Intelligence, the means of the pre-test is 13.05, and the means of the post-test is 14.48. There is no statistically significant difference between the means of the two groups ($p = 0.219$).

5 Discussion

Based on the findings, in this section, I will discuss the research questions:

5.1 Can the application of multiple intelligence theory in music education promote the development of multiple intelligences in Chinese high school students?

It can be seen from Figure 3-4(a)(b) that after three months of teaching experiments, the visual-spatial intelligence of the students in the experimental class and control classes is significantly different ($P<0.01$). There were significant differences in linguistic, bodily-kinesthetic, musical, and interpersonal intelligence ($0.01<P<0.05$). However, there was no significant difference in logical-mathematical, intrapersonal, and naturalistic intelligence ($P>0.05$). It shows that part of the students' intelligence in the experimental class has been effectively developed after the experiment. The application of multiple intelligences theory in music education can promote the development of multiple intelligences in Chinese high school students.

This finding has been confirmed in other studies. For example, from the perspective of music textbooks, Sun analyzed the possibility of applying the theory of multi-

ple intelligences in Chinese high school music classes[39]. She believed that the eight types of intelligence were both reflected in the high school music textbook. Hence, music education has the basis for implementing the theory of multiple intelligences. This is consistent with the conclusion of this study that music education can combine with the theory of multiple intelligences to promote the development of Chinese students' intelligence; Luo learned about the current situation of multiple intelligences of students in a Chinese school and put forward the teaching strategies according to the current situation of students' types of intelligence[40]. However, the teaching design had not been implemented. This study implemented the teaching design on this basis. The results showed that music education is effective in promoting the development of Chinese high school students' types of intelligence; From the perspective of the teaching goal, Zhou analyzed the strategy of music instructional design[41]. She proposed that when setting teaching goals, it should reflect the characteristics of diversity and combine the students' knowledge level to design activities from the perspective of eight types of multiple intelligences. This study combined her teaching goal design method to construct and implement the teaching process. The result showed that the theory of multiple intelligences is feasible in the high school music curriculum.

5.2 Which types of intelligence are promoted by the application of multiple intelligences theory in music education?

It can be seen from Figure 5-6(a)(b) that after three months of a music teaching experiment, the students' visual-spatial intelligence and intrapersonal intelligence in the experimental class were significantly improved ($P<0.01$); There were significant differences in linguistic intelligence, bodily-kinesthetic intelligence, musical intelligence and interpersonal intelligence ($0.01<P<0.05$). However, there was no significant difference between logical-mathematical and naturalist intelligence ($P>0.05$). It shows that after a period of teaching experiments, some of the students' types of intelligence have been effectively developed in the experimental class. However, there was no significant difference in the intelligence of the control class ($P>0.05$) after the three months of the music experiment. They did not get effective development. Therefore, it can be concluded that the linguistic, visual-spatial, bodily-kinesthetic, musical, interpersonal, intrapersonal, and naturalistic intelligence of Chinese high school students are promoted by applying multiple intelligence theory in music education.

For the generalization of this finding in different disciplines, some researchers have reached similar conclusions in the field of sports dance. Some research shows that except for logical-mathematical intelligence, the progress of students' intelligence under teaching guided by the theory of multiple intelligence is significantly better than that of conventional teaching, especially in musical intelligence, interpersonal intelligence and intrapersonal intelligence[42]. This may be because there is a certain connection between sports dance and music. For example, sport dance is a two-person competitive sport that integrates sports and art. It requires that students not only accurately cooperate with music, but also express emotions through their body movements[43]. Therefore, the involvement of multiple intelligences in instructional design may not differ disciplinarily between the sports dance and music. However, whether

this finding differs from other disciplines requires further future argumentation; For the generality of this finding in different ages of students, Tao combined the theory of multiple intelligences with the situational approach in the music class of junior high school and reached a similar conclusion[44]. It promoted the development of linguistic, visual-spatial, bodily-kinesthetic, musical, interpersonal, and intrapersonal intelligence. Therefore, there might be no grade differences in the participation of multiple intelligences in music instructional design. This may be because there is little difference between the junior high school age stage and the senior high school age stage. The compilation of junior high school music textbooks and senior high school have a connection. The two parts are closely linked to form a complete music teaching system[45]. Therefore, it is considered that there might be no academic phase differences between junior high school and senior high school. However, the applicability of this finding at the primary and university levels remains to be demonstrated.

6 Conclusion

By comparing the pre-tests and the post-tests after three months, it was found that some of the students' intelligence in the experimental group were effectively developed. This can conclude that the application of multiple intelligences theory in music education can promote the development of multiple intelligences in Chinese high school students. Comparing the experimental and control classes after three months showed that the linguistic intelligence, visual-spatial intelligence, bodily-kinesthetic intelligence, musical intelligence, interpersonal intelligence and intrapersonal intelligence of Chinese high school students were facilitated by the application of multiple intelligences theory in music.

From the perspective of theoretical implication, this study proves that multiple intelligences theory can be applied to music education in Chinese high schools and also demonstrates the feasibility of shifting from unified teaching methods to diversified teaching methods in Chinese education. At the same time, the application of multiple intelligences theory in music also validates the relationship between music and other disciplines, which have commonalities with each other. From the perspective of practical implication, it provides music educators with new teaching ideas. Traditional music teaching usually teaches students mainly from a single auditory aspect. But combined with multiple intelligences, music can be learned from more sensory aspects and more activity forms. This study also provides references for researchers and educators in related fields.

This study also has some limitations. It may be difficult to observe changes in students' intelligence over time due to the short duration of the class. The study's sample size was also small, so the results may not be representative. The context is somewhat limited, and the study was conducted in Beijing only, which is difficult to cover the whole of China. Therefore, future studies can increase the sample size and investigate students in multiple classes or districts. Longitudinal research could also be attempted.

In addition, the course design is limited due to the time constraints of this study. It may be the reason why logical-mathematical and naturalistic intelligence was not improved significantly. In the future, I will further optimize the course design by adding an expert review or conducting action research.

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