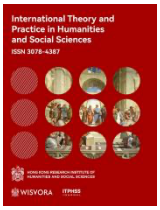
WISVORA

International Theory and Practice in Humanities and Social Sciences
2025 Volume2,Issue2 ISSN 3078-4387



The Influence of Music Training on the Lexical Richness of English Writing: A Study Based on Self-built Corpora

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Article Info

Accepted:5 January 2025

Keywords:

music training; English writing; lexical richness; self-built corpora

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http://doi.org/10.70693/itphss.v2i2.249

Abstract

This study aims to explore the influence of music training on the lexical richness of English writing. The method of this study is both qualitative and quantitative. Through a nearly 8-week music and writing training, an experiment was conducted on 40 research subjects (20 in experimental group and 20 in control group), and self-built corpora were established for analysis. The results show that music training effectively improved the lexical variability, complexity, and density of the experimental group, reduced the use of high-frequency words, increased the use of low-frequency words, and increased the proportion of content words. The results of interview also indicate that the majority of research subjects generally believed that music training has a positive influence on the lexical richness of English writing, and improves writing and emotional expression abilities. This study provides theoretical and practical basis for integrating music into the teaching of English writing, points out the limitations of this research and suggests directions for subsequent research.

1.Introduction

Music and language, as treasures of human culture, both convey ideas and emotions in their unique ways. Language expresses precise meaning through words, while music brings people intuitive and profound experiences through melody, rhythm, and emotional resonance. Compared to language, music has more advantages in expressing emotions, which can transcend the boundaries of language, directly touch people's hearts, evoke resonance, and provide endless inspiration for language creation.

It can be seen that music not only enhances an individual's aesthetic and emotional expression abilities, but also promotes language output. From the perspective of Behaviorist Theory, the expressive power of music can provide students with intuitive stimuli. At this point, linking vocabulary with musical features can form conditioned reflexes, bring associative memory, help students improve their vocabulary mastery, and flexibly integrate learned vocabulary into writing, thereby enhancing emotional expression in writings, such as improving

the lexical richness in writing, making the use of words more vivid and expressive, and better conveying ideas and emotions. In view of this, this research aims to investigate the influence of music training on the lexical richness of English writing. Through an experimental research, the researchers established self-built corpora of experimental samples and used corpus analysis software to quantitatively analyze lexical richness. In addition, the researchers conducted qualitative analysis on the research subjects through interviews. Therefore, this research used a mixture of quantitative and qualitative methods to give a demonstration of the positive influence of music training on enhancing the lexical richness of English writing.

2.Literature Review

2.1 Research on the Influence of Music Training on Language Cognition

In recent years, with the advancement of neuroscience technology, many researchers have used EEG, fMRI, ERP and other related methods to explore the relationship between music and language in brain processing. They have found that there is a significant overlap between the two in brain processing, which exhibit certain similarities in the processing process (Sun, 2017; Rie et al., 2022; Liu et al., 2022; Wang et al., 2023). The "Shared Syntactic Integration Resource Hypothesis (SSIRH)" proposed by Patel (2003) suggests that the syntactic integration of language and music relies on common neural regions and operations that provide resources for syntactic integration and help people better understand the relationship between language and music. Patel (2011) also proposed the OPERA (Overlap, Precision, Emotion, Repetition, Attention) hypothesis to explain how music training affects speech processing, providing guidance for developing new music activities to improve language abilities. From the above neuroscience research, it has been found that music can serve as an effective auxiliary tool, bringing positive transfer effects to language processing and to some extent promoting language learning (Nan, 2017; Chang & Zhou, 2018; Deng et al., 2023; Zhang et al., 2024). Based on these neuroscience research findings, we can further explore the relationship between music training and language teaching. The focus of this research is on the influence of music on writing vocabulary, therefore the following is a review of relevant literature on music's influence on the teaching of English vocabulary and writing.

2.2 The Influence of Music Training on Vocabulary Teaching

Regarding the influence of music training on vocabulary teaching, various empirical studies have shown that music training can significantly improve the vocabulary learning outcomes of children, adolescents, and adults. About children and adolescents, teaching English vocabulary through song activities has a positive influence on preschool children's learning of English as a second language (L2) vocabulary acquisition (Coyle & Remei, 2014), and can enhance their recall of vocabulary (Wallace, 1994; Good et al., 2015). Busse et al. (2018) explored the effectiveness of a language teaching method that combined songs and speeches for immigrant children to learn German as a second language (L2). They found that students made significant progress in vocabulary tests and sustained effects were observed in follow-up tests.

About adults, a research conducted by Ludke et al. (2014) pointed out that singing can better help 60 native English-speaking adult participants remember Hungarian phrases and demonstrate higher accuracy in the posttest. Somaye (2018) conducted an empirical study to explore the role of music in second language vocabulary acquisition. 105 college students were divided into a full-music group, a semi-music group, and a no-music group for the experiment. The findings revealed that in the posttest, participants in the full-music group showed notably superior scores compared to those in the other two groups. Zhang et al. (2023) conducted an empirical study and

divided 95 Chinese middle school students into two groups for song learning and poetry recitation learning. The results illustrated that the vocabulary acquisition effect of the song learning group was obviously better than that of the poetry recitation learning group. The above research indicates that using music can more effectively improve students' vocabulary acquisition, and can help increase learning motivation, reduce learning anxiety, enhance cultural understanding, and promote long-term memory.

2.3 The Influence of Music Training on Writing Teaching

Regarding the influence of music on writing teaching, existing research mainly focuses on the influence of background music on writing motivation and fluency. Researchers have found that allowing students to choose their favorite music can enhance their writing motivation and help them create a positive learning environment (Donohoe & McNeely, 1999), indicating that background music has a promoting effect on second language writing (Cho, 2015). Some researchers have also found a marginal significant relationship between music engagement and writing quality, but no significant relationship with writing fluency (Aryanto, 2016). However, some researchers have found that listening to background music while writing may have a certain hindering effect on writing fluency (Ransdell & Gilroy, 2001).

While research has investigated the effect of background music on writing motivation and fluency, the majority of these studies concentrate on the act of listening to music, with a scarcity of empirical evidence directly linking musical instruction to writing proficiency. However, in existing indirect research, Zhang (2018) has pointed out that music has the traits of “ambiguity” and “uncertainty of meaning”, which can surpass words in expression and provide unlimited inspiration for language creation. It also suggests that music training may have a potential influence on improving writing ability, which is worth further exploration.

2.4 Lexical Richness

After recognizing the promoting effect of music on second language vocabulary learning, it is necessary to explore how to enhance learners’ lexical richness of writings through music as an effective tool. Although there are currently no research results directly exploring the combination of music and lexical richness in literature, many studies on the lexical richness of writings can be found. Liu (2003) found that although vocabulary does not directly determine writing quality, it indirectly affects text length and thus has an influence on writing quality. In addition, students with richer vocabulary tend to use complex vocabulary rather than simple vocabulary in their writings. Bao (2008) analyzed the development trajectory of lexical richness in second language learners' writings. Through comparative analysis of timed compositions from three different levels of learners, it was found that there were no significant differences in lexical variability, lexical density, and lexical uniqueness among the different level groups, indicating a non-linear development path. However, lexical complexity is the most significant feature that distinguishes differences in lexical usage between different groups, and its development shows a linear trend.

In terms of lexical variability and complexity, studies have shown that with the improvement of English proficiency, there is an increase in lexical variability and complexity in writings (Wan, 2010; Zhu & Wang, 2013). Meanwhile, enhancing lexical richness and diversity significantly improves writing quality (Gregori-Signes & Clavel-Aroitia, 2015; Hye, 2019). Zhang (2020) found that English beginners have relatively weak vocabulary application ability and insufficient vocabulary, but this situation improves with the increase of grade, and the level of lexical development in various dimensions is not consistent. Yang et al. (2022) summarized the dimensions, methods, and indicators of lexical richness measurement, providing theoretical

guidance for studying lexical richness.

However, existing research mainly focuses on the influence of music training on memorizing vocabulary, but there is little exploration of the application of vocabulary in practical communicative situation, especially the related research on the influence of music training on second language writing. Besides, most existing research is related to songs, but there is little research on the influence of absolute music and specialized music training on English vocabulary (Cao, 2019). Therefore, this research aims to integrate existing research on the influence of music on second language vocabulary learning and lexical richness, and explore how music training affects lexical richness in English writing through a combination of specialized music training and the teaching of English writing vocabulary, with the purpose of helping students better understand and appreciate music, improving their emotional expression ability, enhancing their sensitivity to vocabulary, and strengthening their writing skills. Therefore, this research proposes the following 3 research questions:

RQ1:What influence does music training have on the lexical richness of English writing?

RQ2:What specific mechanisms of music training influence the lexical richness of English writing?

RQ3:How to effectively integrate music training into English vocabulary teaching to enhance students' lexical awareness of writing?

3.Methodology

3.1 Experimental Subjects

This research recruited a total of 52 potential research subjects through online recruitment, all of whom were freshmen of non-English majors from a college in Guangdong Province, China. After explaining the research purpose, procedures, and duration to all potential experimental subjects, 12 students decided to withdraw, and ultimately 40 students participated in the experiment.

Before the experiment began, a questionnaire was distributed through the online platform Wenjuanxing[1] to collect information on participants' age, gender, English learning experience, English proficiency, and music training experience. According to the questionnaire data, the participants' age distribution falls within 18 to 20 years (M=18.65, SD=0.77), with 8 males and 32 females. To ensure fairness, the participants were evenly distributed between the experimental group (n=20, M=18.55, SD=0.76) and the control group (n=20, M=18.75, SD=0.79) through drawing lots. Every participant began their English education in the third year of primary school and have not undergone any formal musical instruction. As freshmen, the English proficiency is based on the scores of National College Entrance Examination（NCEE） of China, which range from 105 to 115 points[2] (M=101.75, SD=4.74), indicating a mean level. The experimental group (M=108.15, SD=2.64) and the control group (M=108.65, SD=2.87) were included.

40 research subjects participated in the experiment anonymously. They were assigned to the experimental group (A1-A20) and the control group (B1-B20) according to their numbers (see Table 1). Every subject signed an informed consent form in the form of an anonymous questionnaire, confirming that their information is only used for experimental research and strictly confidential. All 40 research subjects completed the experiment throughout the entire research

1 The website of Wenjuanxing: WJX.cn.

2 The English score range for China's NCEE is from 0 to 150 (with 90 as the passing scores), and scores between 105-115 can be regarded as a mean level.

process.

After the experiment, all participants received compensation. To ensure fairness in the experiment, the researchers provided the participants of the control group with the opportunity for music training after the experiment, and all of them participated in the subsequent music training.

Table 1: Background Information of Experimental Subjects

Number	Age	Gender	Scores of NCEE	Number	Age	Gender	Scores of NCEE
A1	18	F	105	B1	19	F	105
A2	18	F	108	B2	19	F	109
A3	19	F	103	B3	20	M	109
A4	18	F	108	B4	18	F	114
A5	18	F	105	B5	18	F	110
A6	19	M	109	B6	19	F	108
A7	18	F	110	B7	18	M	105
A8	19	F	108	B8	18	F	109
A9	20	F	112	B9	18	F	105
A10	18	F	106	B10	20	F	111
A11	19	F	107	B11	20	F	109
A12	18	F	109	B12	19	F	107
A13	18	M	107	B13	19	F	106
A14	18	F	107	B14	20	M	110
A15	18	F	108	B15	18	F	115
A16	20	F	114	B16	18	F	106
A17	18	F	110	B17	18	F	105
A18	20	M	112	B18	18	M	111
A19	19	F	109	B19	19	F	110
A20	18	M	106	B20	19	F	109
M	18.55		108.15		18.75		108.65
SD	0.76		2.64		0.79		2.87

Note: About gender, M is for male, and F is for female.

3.2 Experimental Procedures

Taking into account the reasonable arrangement of participants' time, the experiment was scheduled to take place during the summer vacation of 2024. The experiment was conducted on the online platform Tencent Meeting. The researchers sent information such as the Tencent Meeting's number, experimental time, and experimental precautions through the email provided by the participants. In order to ensure the authenticity of the experiment and data, the camera remained on throughout the entire experiment. Before the experiment began, a pretest was conducted to collect data samples to confirm that there was no significant difference in lexical richness between the two groups. The research subjects were required to write a prose titled "In the Forest" by pen and paper within one hour. The use of dictionaries or other reference materials was prohibited during the pretest, and the writing must be completed independently. The length of the prose must be no less than 120 words. After the pretest, the research subjects were required to take photos of their writings and uploaded them to the designated email within 3 minutes. Given Then a total of 15 centralized training sessions would be conducted for approximately 8 weeks. Among them, there were two sessions per week in the first seven weeks and one session in the last week. The sessions

of experimental group took place from 9:00-11:00 am on Mondays and Fridays, while those of the control group took place from 9:00-11:00 am on Tuesdays and Saturdays. The experimental group received a combination of music training and training of English vocabulary and writing, while the control group only received conventional training of English vocabulary and writing. The guidance and writing time would be adjusted according to the actual situation to ensure that the research subjects could understand and master the learned content.

3.2.1 Experimental Procedure of the Experimental Group

The music training for the experimental group was divided into two parts: music theory instructions and music appreciations (see Figure 1 for the specific procedures), which were explained in a combination of Chinese and English. The music theory instructions were conducted in the first 8 sessions, and music appreciations were conducted in the following 6 sessions. In the final experiment, participants were allocated one hour for independent music score analysis, music appreciation, and to complete a one-hour posttest writing task.

(1) Music Theory Instructions

In terms of music theory instructions, the researchers explained the definition of a certain musical symbol and guided the research subjects to describe the characteristics of the musical symbols in English by playing the corresponding melodies and combining them with the performance of instruments such as piano and violin, including arpeggios (see example 1), major and minor chords, forte (powerful), piano (quiet), etc. At this time, the research subjects shared and learned the vocabulary provided by each other in the chat box through brainstorming. The researchers supplemented additional terms that were not initially mentioned by the research subjects, incorporating words or phrases that they needed to learn, thereby expanding their vocabulary banks. Finally, the researchers explained the role of musical notations in music to the research subjects, and replayed the corresponding pieces to reinforce the vocabulary that the research subjects had learned. Based on what they had learned, they wrote a short paragraph about the scene or image represented by the musical sections and shared it in the chat box. Finally, the researchers provided feedback. However, it is worth noting that this experiment did not require the research subjects to specifically memorize Italian nouns for musical symbols and terms (e.g. arpeggios, Andante, Moderato), as long as they could recognize them. In addition, there was no need to write these terms when writing essays.

(1)Vocabulary to describe arpeggios:
①diversity; various notes, multiple...
②hierarchical; melodic line; linear; one-sided...
③flowing; sequential; fluctuate...
...
About the functions of arpeggios:

① Arpeggios allow each note in a chord to sound sequentially, creating a clear melodic line that is easily recognizable even in complex harmonic backgrounds.

②Arpeggios can convey specific emotions, such as tenderness, dreaminess, passion, or melancholy, depending on the speed, intensity, and overall context of the music.

...
Note: the underlined part was the vocabulary that the research subjects needed to learn.

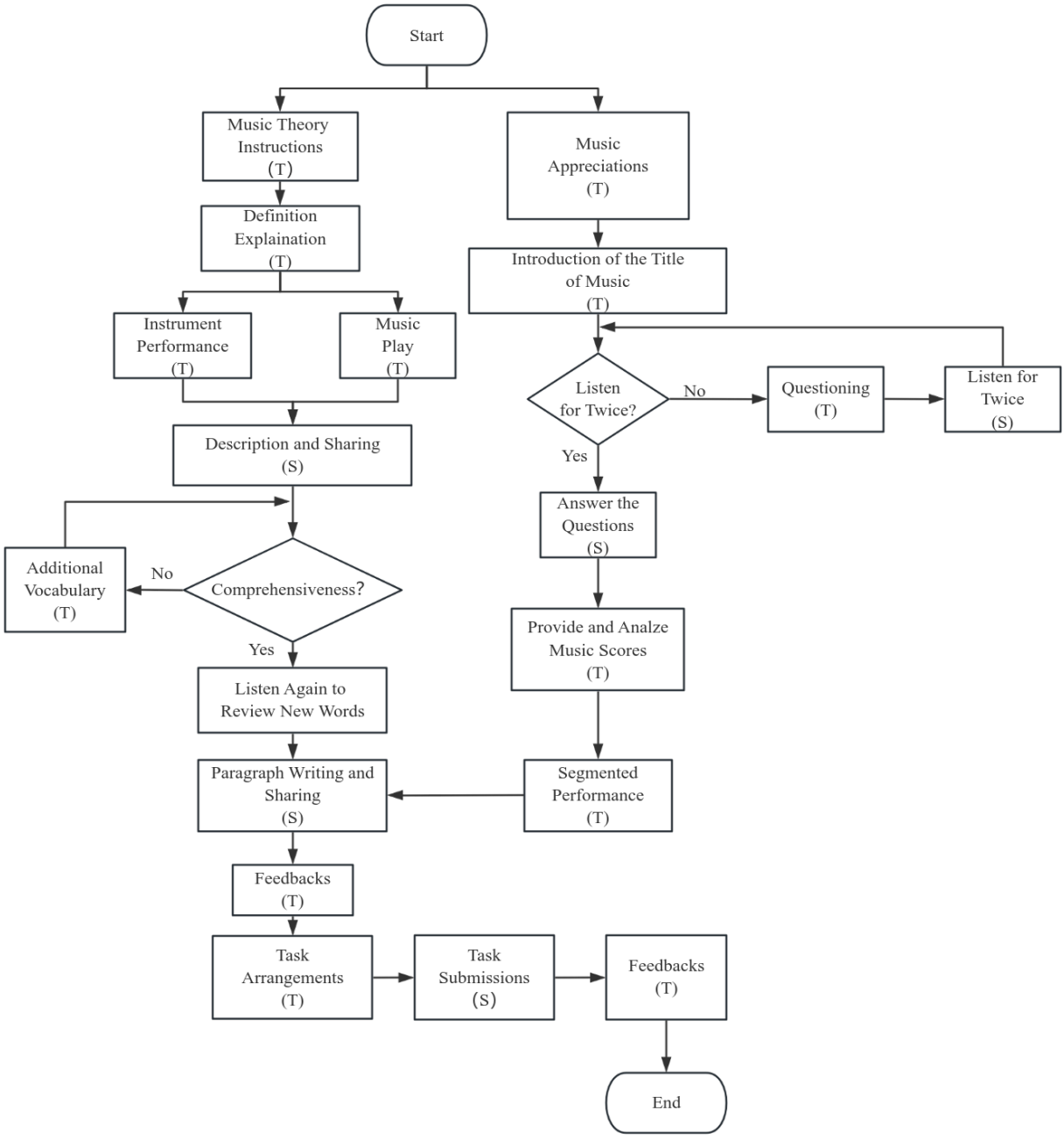
Example 1 The Explanation of Arpeggios

(2) Music Appreciations

After mastering a certain level of music theory, the research subjects began to participate in music appreciations. In this stage, the researchers selected music with rich emotional expression for appreciation (see example 2). Firstly, the researchers introduced the title of the music to the research subjects and played it twice: the first time, the research subjects were allowed to immerse themselves in the melody and emotions of the music, while the second time, after posing some relevant questions, the music was replayed to enhance their comprehension, after which the research subjects were asked to share their personal insights and opinions. Subsequently, the researchers provided the music score and conducted a detailed analysis of the music, including the surface and deep meanings of the title, the ideas and emotions conveyed by different parts of the music, musical symbols, and performance instructions. Afterwards, the researchers played the music in segments and guided the research subjects to analyze the music in English from 3 dimensions: imagery, emotion, and values. They also encouraged the research subjects to practice writing short paragraphs by using previously learned vocabulary and shared them in the chat box. Finally, the research subjects shared their short paragraphs each other and the researchers provided feedback. After each session, the researchers tasked the research subjects with a writing assignment that required them to conduct a further analysis of the music and musical score discussed in the class. The research subjects were instructed to synthesize the elements of imagery, emotion, and values to compose a story, which was to be expressed in the genre of prose. They were required to take photos of their writings and send them to the designated email address before 12:00 a.m. on Sundays and Thursdays. The researchers would provide feedback on each subject's writings through email. In the subsequent experimental session, the researchers would present some excellent writings produced by the research subjects as instructional examples, aiming to facilitate a more profound comprehension of the musical themes among the research subjects and to improve their proficiency in utilizing vocabulary within their writings.

"The Smiling Clock"
— By Yukie Nishimura from Japan
(1)Questions for the second time:
①What is the deeper meaning behind the title of this melody? For example, what do "smiling" and "clock" represent? How is the melody expressed?
②What are the imagery, emotion, and values of this melody?
(2) The music score (omit here).
(3) Answers for the questions:
...(omit here)

Example 2 The Explanation of Music Appreciations



Note: the research subjects' sections (students) are marked as "S", and the researchers' sections (teachers) are marked as "T".

Figure 1 Experimental Teaching Procedure of the Experimental Group

In the 15th experiment, the research subjects were provided with a musical score and audio of a piece of music called "The Morning Sun Beamed through the Trees". According to the requirements mentioned during music training, the score and audio were independently analyzed before writing in the first one hour, and then a posttest was conducted by the pretest question "In the Forest" and requirements in the later one hour. The posttest data was compared and analyzed with the pretest data.

After the experiment, the researchers obtained the consent of 15 subjects and conducted a separate interview by Tencent Meeting, recording the interview for 15-20 minutes each. The interview questions and some of answers are presented in Appendix I.

3.2.2 Experimental Procedure of the Control Group

The experimental procedures of the control group mainly focused on conventional training of English vocabulary and writing without music training, with the purpose of comparing the different effects of music intervention and conventional English teaching methods in improving students' vocabulary and writing abilities. The experimental process of the control group was divided into vocabulary teaching and writing teaching, each part lasting 1 hour. The specific process is shown in Figure 2.

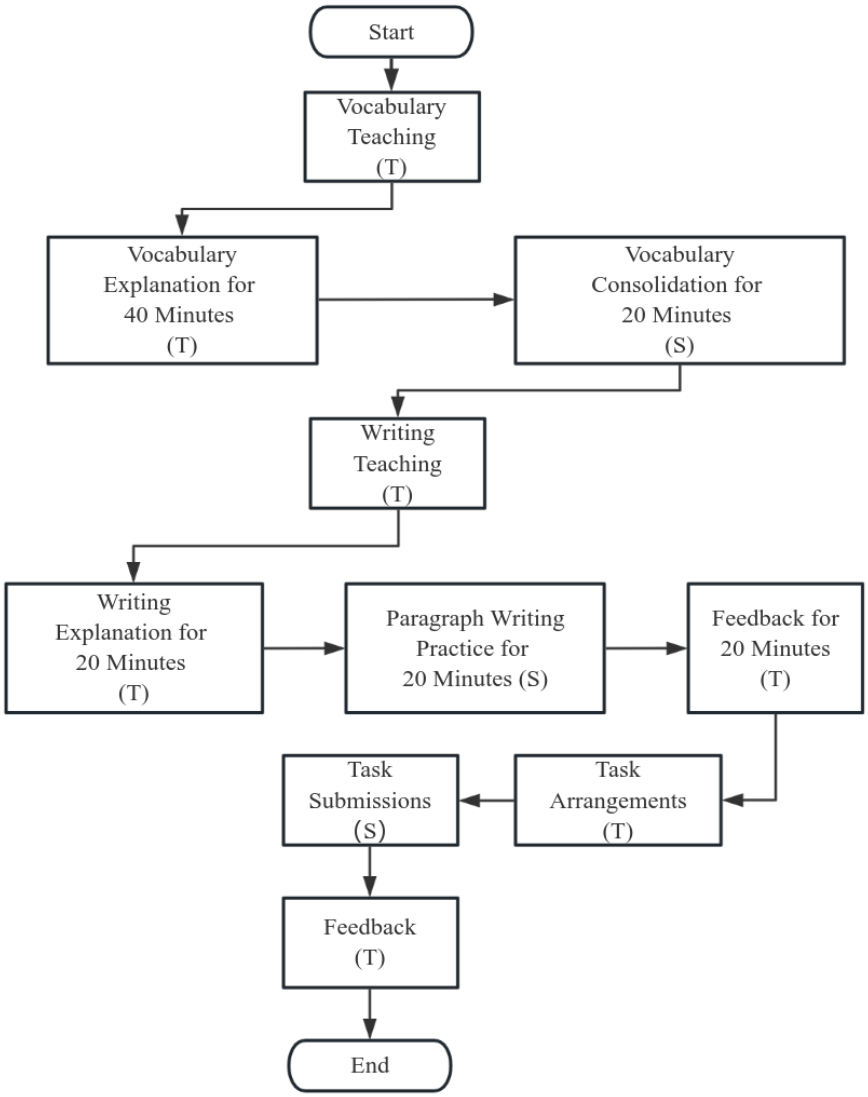
(1) Vocabulary Teaching

The researchers selected the same vocabulary learned in the experimental group and provided bilingual explanations in Chinese and English to help research subjects understand the meaning, usage, and context of the vocabulary. During the explanation process, the researchers combined examples to make students experience the application of vocabulary in practical contexts, and guided them to actively participate in learning through questioning, discussion, and other methods, deepening their understanding and memory of vocabulary. The vocabulary explanation session would last for 40 minutes, followed by 20 minutes for research subjects to organize their notes and consolidate their newly-learned vocabulary.

(2) Writing Teaching

The researchers first provided a 20-minute guide of prose writing, which included introducing writing requirements, explaining writing techniques, sharing excellent sample writings, etc., to help research subjects understand the writing task and learn about writing methods. Subsequently, the researchers guided the students to practice writing short paragraphs by using the vocabulary they had learned for 20 minutes, and took photos to share in the chat box. This process was roughly the same as the steps of the experimental group, aiming to consolidate and enhance students' writing ability in practice. In the last 20 minutes, the researchers would provide feedback and make revisions.

After each experiment, the researchers arranged writing tasks for the research subjects. They were required to take photos of the writings and send them to the designated email address before 12:00 a.m. on Mondays and Fridays. The researchers provided feedback on each research subject's writing via email. The relevant writing topics and requirements for the control group were the same as those of the experimental group, excluding the intervention of musical elements. Similarly, in the subsequent experimental session, the researchers would present some excellent writings produced by the research subjects as instructional examples, aiming to improve their proficiency in utilizing vocabulary within their writings.



Note: the research subjects' sections (students) are marked as "S", and the researchers' sections (teachers) are marked as "T".

Figure 2 Experimental Teaching Procedure of the Control Group

Researchers collected students' writings and conducted correction and analysis. In addition to correcting regular grammar errors, content structure, and expression styles, individual guidance was also be provided based on students' personal writing situations, such as pointing out improper vocabulary use, suggesting ways to improve expression, and providing writing skills. Unlike the experimental group, the guidance for the control group was mainly based on English writing itself, without involving analysis and discussion of musical elements. In the 15th experiment, the research subjects were given one hour to summarize their learning independently, and a posttest was conducted by the pretest question "In the Forest" and the requirements. At last, the posttest samples were collected to compare and analyze with the pretest data.

To ensure fairness in the experiment, the researchers provided the research subjects in the control group with the opportunity for music training after the whole experiment, and all of them participated in the subsequent music training. After all experiments were completed, the researchers obtained the consent of 12 subjects and conducted interviews with them by Tencent Meeting for 15-20 minutes each. The interview questions and some of answers can be found in Appendix II.

3.3 Dimensions and Methods for Measuring Lexical Richness

Lexical richness is also known as lexical diversity or lexical complexity (Read, 2000; Daller et al. 2003; Zhu & Wan, 2013). Read (2000) pointed out that lexical richness needs to be measured from 4 dimensions: lexical variability (Type-Token Ratio, TTR), lexical complexity (referring to words in word list 3 and word list 4), lexical density (the proportion of content words in the total number of words, LD), and some lexical errors. The focus on this study is to evaluate the influence of music training on lexical variability, complexity, and density, and lexical errors are not the focus. Therefore, this research adopts the framework of lexical richness measurement proposed by Read (2000) to analyze the collected samples from the first 3 dimensions.

3.4 Corpus Processing and Data Statistics

Corpus processing plays a crucial role in data analysis. This study used Text Document, Antconc, Tree Tagger 3.0, Range 32, Excel 2007, and SPSS 22 to analyze the lexical richness of English writing, as shown in Figure 3.

Firstly, the researchers classified the collected corpus samples according to pretest and posttest, and then input each sample into a Text Document, and assigned a number to each sample. The data in the pretest was labeled as "Sub-corpus 1", with the experimental group labeled as "Sub-corpus E1" and the control group labeled as "Sub-corpus C1"; The data in the posttest was labeled as "Sub-corpus 2", with the experimental group labeled as "Sub-corpus E2" and the control group labeled as "Sub-corpus C2".

Regarding the statistics of lexical variability and density, Antconc was used to calculate the Type-Token Ratio (TTR) of each sample in each Sub-corpus, including the total number of types and tokens. The data was then input into Excel 2007 for statistical analysis. Subsequently, the samples in "Sub-corpus 1" and "Sub-corpus 2" were assigned part of pos tagging by Tree Tagger 3.0, and wrong recognition of tags was manually corrected, like some gerunds should be corrected to noun forms (e.g. rustling_VVG→rustling_NN), and the processed samples were classified as "Sub-corpus 1A" and "Sub-corpus 2A". Finally, Antconc was used again to calculate the pos distribution of each sample in "Sub-corpus 1A" and "Sub-corpus 2A", and the resulting data was input into Excel 2007 to calculate the proportion of each content word. Finally, the proportion data calculated in Excel 2007 was entered into SPSS 22 for *t*-test to obtain *t*-values and *p*-values, in order to test whether the data had significant difference.

Regarding the statistics of lexical complexity, Range 32 was used to calculate the proportion of high-frequency and low-frequency words in each sample in "Sub-corpus 1" and "Sub-corpus 2". According to the classification of Range 32, word list 1 contains high-frequency words, word list 2 contains secondary high-frequency words, word list 3 contains academic words (low-frequency words), and those words that are not in the first three categories of word lists are classified as word list 4 (out of list words). Finally, the researchers obtained the proportion of words in each word list, and then input the obtained data into Excel 2007 to calculate the mean value. Finally, the proportion data calculated in Excel 2007 was entered into SPSS 22 for *t*-test to obtain *t*-values and *p*-values, in order to test whether the data had significant difference.

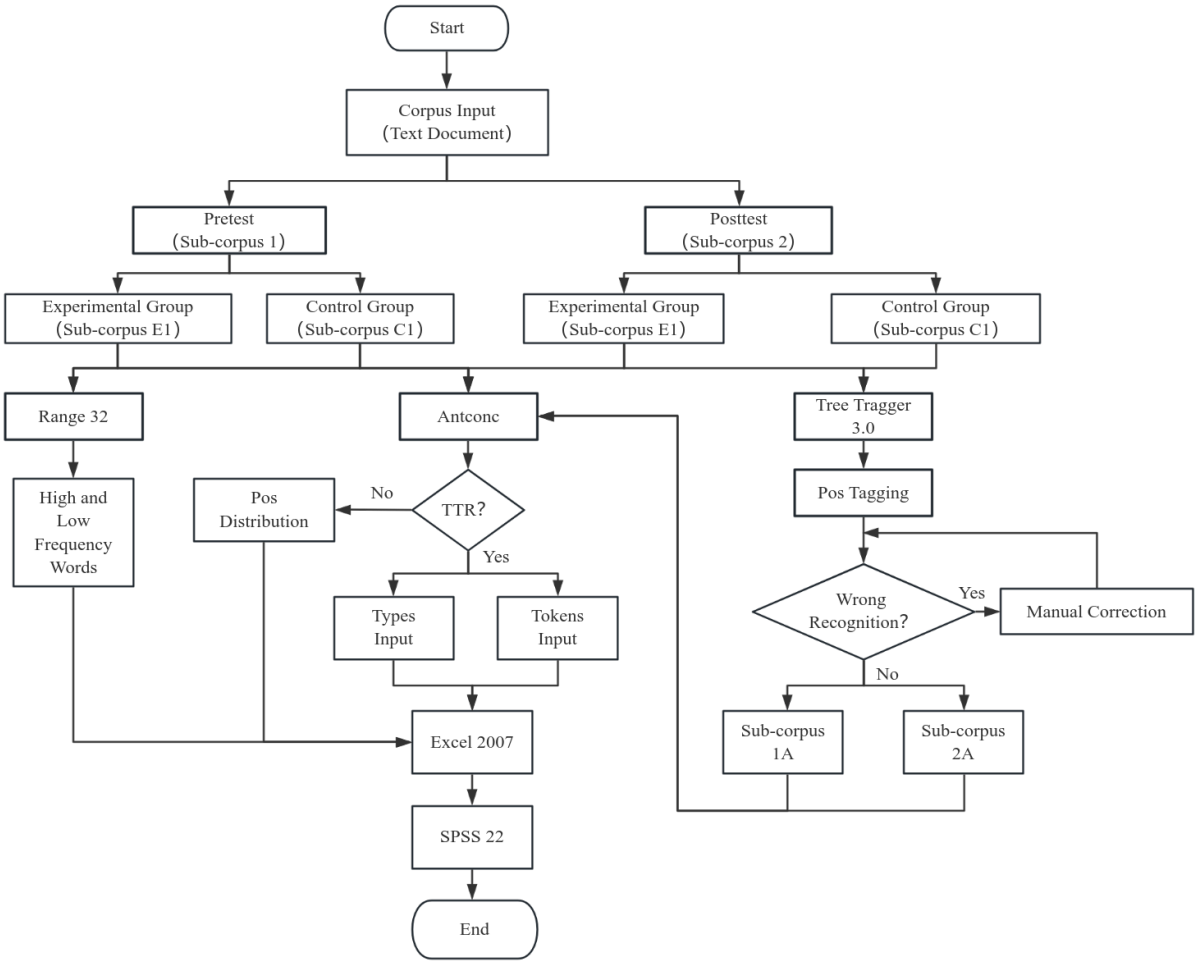


Figure 3 Procedure of Corpus Processing and Data Statistics

4.Results

4.1 Characteristics of Lexical Variability

Lexical variability refers to the Type-Token Ratio(TTR). Table 2 shows the TTR data of the pretest and posttest of both groups, with the pretest experimental group and control group accounting for 64.83% and 63.59% respectively, and the posttest experimental group and control group accounting for 68.88% and 66.33% respectively. Table 3 shows the *t*-test data for two groups of TTR. There was no significant difference (*df*=38, *t*=1.549, *p*=0.130) in the pretest data between the experimental group (*n*=20, *M*=64.83%, *SD*=2.23) and the control group (*n*=20, *M*=63.59%, *SD*=2.69) , but in the posttest, there was a significant difference(*df*=38, *t*=3.491, *p*=0.001) in the data between the experimental group (*n*=20, *M*=68.88%, *SD*=1.85) and the control group (*n*=20, *M*=66.33%, *SD*=2.46) .

Table 2 Data of Types,Tokens and TTR of Both Groups

		Types	Tokens	TTR
Pretest	Experimental Group	1965	3031	64.83%
	Control Group	1886	2966	63.59%
Posttest	Experimental	2344	3403	68.88%

	Group			
	Control Group	2315	3490	66.33%

Table 3 *t*-test of TTR Changes of Both Groups

TTR	Experimental Group（*n*=20）		Control Group(*n*=20)		*df*	*t*	*p*
	M	*SD*	*M*	*SD*			
Pretest	64.83%	2.23	63.59%	2.69	38	1.549	0.130
Posttest	68.88%	1.85	66.33%	2.46	38	3.491**	0.001

Note: *p＜0.05; **p＜0.01; ***p＜0.001.

4.2 Characteristics of Changes in Lexical Complexity

Lexical complexity is an indicator of the difficulty of using vocabulary in a text. As shown in Table 4, according to the *t*-test, there was no significant difference(*df*=38, *t*=-0.071, *p*=0.944) in the pretest data between the experimental group (*n*=20, *M*=77.99%, *SD*=3.06) and the control group (*n*=20, *M*=78.05%, *SD*=2.45) for word list 1 (high-frequency words) . However, in the posttest, there was a significant difference(*df*=38, *t*=-5.045, *p*=0.000) in the data between the experimental group (*n*=20, *M*=70.12%, *SD*=2.40) and the control group (*n*=20, *M*=73.67%, *SD*=2.03) .

Table 4 *t*-test for Changes in Word List 1 of Both Groups

Word List 1	Experimental Group（*n*=20）		Control Group(*n*=20)		*df*	*t*	*p*
	M	*SD*	*M*	*SD*			
Pretest	77.99%	3.06	78.05%	2.45	38	-0.071	0.944
Posttest	70.12%	2.40	73.67%	2.03	38	-5.045***	0.000

Note: *p＜0.05; **p＜0.01; ***p＜0.001.

As shown in Table 5, according to the *t*-test, there was no significant difference(*df*=38, *t*=0.314, *p*=0.756) in the pretest data between the experimental group (*n*=20, *M*=11.47%, *SD*=2.99) and the control group (*n*=20, *M*=11.2%, *SD*=2.41) for word list 2 (secondary high-frequency words) . However, in the posttest, there was a significant difference (*df*=38, *t*=-2.500, *p*=0.017) in the data between the experimental group (*n*=20, *M*=8.15%, *SD*=1.39) and the control group (*n*=20, *M*=9.34%, *SD*=1.62).

Table 5 *t*-test for Changes in Word List 2 of Both Groups

Word List 2	Experimental Group（*n*=20）		Control Group(*n*=20)		*df*	*t*	*p*
	M	*SD*	*M*	*SD*			
Pretest	11.47%	2.99	11.2%	2.41	38	0.314	0.756
Posttest	8.15%	1.39	9.34%	1.62	38	-2.500*	0.017

Note: *p＜0.05; **p＜0.01; ***p＜0.001.

As shown in Table 6, according to the *t*-test, there was no significant difference (*df*=38, *t*=-0.364, *p*=0.718) in the pretest data between the experimental group (*n*=20, *M*=2.81%, *SD*=1.68) and the control group (*n*=20, *M*=2.97%, *SD*=0.99) for word list 3 (low-frequency words) . However, in the posttest, there was a significant difference (*df*=38, *t*=6.823, *p*=0.000) in the data between the

experimental group (*n*=20, *M*=8.44%, *SD*=1.74) and the control group (*n*=20, *M*=5.54%, *SD*=0.76).

Table 6 *t*-test for Changes in Word List 3 of Both Groups

Word List 3	Experimental Group（*n*=20）		Control Group(*n*=20)		*df*	*t*	*p*
	M	*SD*	*M*	*SD*			
Pretest	2.81%	1.68	2.97%	0.99	38	-0.364	0.718
Posttest	8.44%	1.74	5.54%	0.76	38	6.823***	0.000

Note: *p＜0.05; **p＜0.01; ***p＜0.001.

As shown in Table 7, according to the *t*-test, there was no significant difference (*df*=38, *t*=-0.080, *p*=0.937) in the pretest data between the experimental group *(n*=20, *M*=7.73%, *SD*=1.59) and the control group (*n*=20, *M*=7.78%, *SD*=2.16) in word list 4 (not listed as the first three word lists). However, in the posttest, there was a significant difference (*df*=38, *t*=2.662, *p*=0.011) in the data between the experimental group (*n*=20, *M*=13.29%, *SD*=1.67) and the control group (*n*=20, *M*=11.45%, *SD*=2.60).

Table 7 *t*-test for Changes in Word List 4 of Both Groups

Word List 4	Experimental Group（*n*=20）		Control Group(*n*=20)		*df*	*t*	*p*
	M	*SD*	*M*	*SD*			
Pretest	7.73%	1.59	7.78%	2.16	38	-0.080	0.937
Posttest	13.29%	1.67	11.45%	2.60	38	2.662*	0.011

Note: *p＜0.05; **p＜0.01; ***p＜0.001.

4.3 Characteristics of Changes in Lexical Density

Lexical density (LD) reflects the proportion of content words in a passage. Thus, an increase in lexical density indicates an increase in the proportion of content words. This section will explore the characteristics of changes in LD and analyze the specific changing features of each content word.

Table 8 shows the LD data of the pretest and posttest groups, with the pretest experimental group and control group accounting for 63.41% and 62.41% respectively, and the posttest experimental group and control group accounting for 69.50% and 67.25% respectively. Table 9 shows the *t*-test data of two LD groups. There was no significant difference(*df*=38, *t*=1.851, *p*=0.072) in the pretest data between the experimental group (*n*=20, *M*=63.41%, *SD*=2.50) and the control group (*n*=20, *M*=62.41%, *SD*=2.48). However, in the posttest, there was a significant difference (*df*=38, *t*=2.465, *p*=0.018) in the data between the experimental group (*n*=20, *M*=69.50%, *SD*=3.72) and the control group (*n*=20, *M*=67.25%, *SD*=2.72) .

Table 8 Data of LD of Both Groups

		Content Words	Tokens	LD
Pretest	Experimental Group	1922	3031	63.41%
	Control Group	1851	2966	62.41%
Posttest	Experimental	2365	3403	69.50%

	Group			
	Control Group	2347	3490	67.25%

Table 9 *t*-test for Changes in LD of Both Groups

LD	Experimental Group（*n*=20）		Control Group(*n*=20)		*df*	*t*	*p*
	M	*SD*	*M*	*SD*			
Pretest	63.41%	2.50	62.41%	2.48	38	1.851	0.072
Posttest	69.50%	3.72	67.25%	2.72	38	2.465*	0.018

Note: *p＜0.05; **p＜0.01; ***p＜0.001.

Table 10 shows the noun proportion in the pretest and posttest groups, with the pretest experimental group and control group accounting for 35.50% and 35.06% respectively, and the posttest experimental group and control group accounting for 33.88% and 35.62% respectively. Table 11 shows the *t*-test data for the noun proportion of two groups. There was no significant difference (*df*=38, *t*=0.698, *p*=0.490) in the pretest data between the experimental group (*n*=20, *M*=35.50%, *SD*=1.80) and the control group (*n*=20, *M*=35.06%, *SD*=2.20). However, in the posttest, there was a significant difference (*df*=38, *t*=-2.266, *p*=0.029) in the data between the experimental group (*n*=20, *M*=33.88%, *SD*=2.53) and the control group (*n*=20, *M*=35.62%, *SD*=1.83) .

Table 10 Data of Noun Proportion of Both Groups

		Nouns	Tokens	Proportion
Pretest	Experimental Group	1076	3031	35.50%
	Control Group	1040	2966	35.06%
Posttest	Experimental Group	1153	3403	33.88%
	Control Group	1243	3490	35.62%

Table 11 *t*-test for Changes in Noun Proportion of Both Groups

Noun Proportion	Experimental Group（*n*=20）		Control Group(*n*=20)		*df*	*t*	*p*
	M	*SD*	*M*	*SD*			
Pretest	35.50%	1.80	35.06%	2.20	38	0.698	0.490
Posttest	33.88%	2.53	35.62%	1.83	38	-2.266*	0.029

Note: *p＜0.05; **p＜0.01; ***p＜0.001.

Table 12 shows the verb proportion in the pretest and posttest groups, with the pretest experimental group and control group accounting for 15.80% and 15.75% respectively, and the posttest experimental group and control group accounting for 18.78% and 17.36% respectively. Table 13 shows the *t*-test data for the verb proportion of two groups. There was no significant difference (*df*=38, *t*=0.122, *p*=0.903) in the pretest data between the experimental group (*n*=20, *M*=15.80%, *SD*=1.25) and the control group (*n*=20, *M*=15.75%, *SD*=1.50). However, in the posttest, there was a significant difference (*df*=38, *t*=2.616, *p*=0.013) in the data between the experimental group (*n*=20, *M*=18.78%, *SD*=2.51) and the control group (*n*=20, *M*=17.36%, *SD*=0.80).

Table 12 Data of Verb Proportion of Both Groups

		Verbs	Tokens	Proportion
Pretest	Experimental Group	479	3031	15.80%
	Control Group	467	2966	15.75%
Posttest	Experimental Group	639	3403	18.78%
	Control Group	606	3490	17.36%

Table 13 *t*-test for Changes in Verb Proportion of Both Groups

Verb Proportion	Experimental Group（*n*=20）		Control Group(*n*=20)		*df*	*t*	*p*
	M	*SD*	*M*	*SD*			
Pretest	15.80%	1.25	15.75%	1.50	38	0.122	0.903
Posttest	18.78%	2.51	17.36%	0.80	38	2.616*	0.013

Note: *p＜0.05; **p＜0.01; ***p＜0.001.

Table 14 shows the adjective proportion in the pretest and posttest groups, with the pretest experimental group and control group accounting for 6.43% and 6.27% respectively, and the posttest experimental group and control group accounting for 9.67% and 7.82% respectively. Table 15 shows *t*-test data for the adjective proportion in two groups. There was no significant difference (*df*=38, *t*=0.647, *p*=0.521) in the pretest data between the experimental group (*n*=20, *M*=6.43%, *SD*=0.90) and the control group (*n*=20, *M*=6.27%, *SD*=0.97). However, in the posttest, there was a significant difference (*df*=38, *t*=4.240, *p*=0.000) between the experimental group (*n*=20, *M*=9.67%, *SD*=1.39) and the control group (*n*=20, *M*=7.82%, *SD*=1.45).

Table 14 Data of Adjective Proportion of Both Groups

		Adjectives	Tokens	Proportion
Pretest	Experimental Group	195	3031	6.43%
	Control Group	186	2966	6.27%
Posttest	Experimental Group	329	3403	9.67%
	Control Group	273	3490	7.82%

Table 15 *t*-test for Changes in Adjective Proportion of Both Groups

Adjective Proportion	Experimental Group（*n*=20）		Control Group(*n*=20)		*df*	*t*	*p*
	M	*SD*	*M*	*SD*			
Pretest	6.43%	0.90	6.27%	0.97	38	0.647	0.521
Posttest	9.67%	1.39	7.82%	1.45	38	4.240***	0.000

Note: *p＜0.05; **p＜0.01; ***p＜0.001.

Table 16 shows the adverb proportion in the pretest and posttest groups, with the pretest experimental group and control group accounting for 5.61% and 5.09% respectively, and the

posttest experimental group and control group accounting for 7.76% and 6.30% respectively. Table 17 shows the *t*-test data for the adverb proportion of two groups. There was no significant difference (*df*=38, *t*=1.581, *p*=0.122) in the pretest data between the experimental group (*n*=20, *M*=5.61%, *SD*=0.96) and the control group (*n*=20, *M*=5.09%, *SD*=1.24). However, in the posttest, there was a significant difference (*df*=38, *t*=3.543, *p*=0.001) in the data between the experimental group (*n*=20, *M*=7.76%, *SD*=1.43) and the control group (*n*=20, *M*=6.30%, *SD*=1.05).

Table 16 Data of Adverb Proportion of Both Groups

		Adverbs	Tokens	Proportion
Pretest	Experimental Group	170	3031	5.61%
	Control Group	151	2966	5.09%
Posttest	Experimental Group	264	3403	7.76%
	Control Group	220	3490	6.30%

Table 17 *t*-test for Changes in Adverb Proportion of Both Groups

Adverb Proportion	Experimental Group（*n*=20）		Control Group(*n*=20)		*df*	*t*	*p*
	M	*SD*	*M*	*SD*			
Pretest	5.61%	0.96	5.09%	1.24	38	1.581	0.122
Posttest	7.76%	1.43	6.30%	1.05	38	3.543**	0.001

Note: *p＜0.05; **p＜0.01; ***p＜0.001.

5.Discussion

This research aims to discuss two research questions, namely the influence of music training on the lexical richness of English writing, and the methods to integrate music training into English vocabulary teaching to enhance students' lexical awareness of writing.

5.1. Discussion on the Results of Music Training on the Lexical Richness of English Writing (RQ1)

From the results of the data, it can be seen that music training has a significant positive influence on the lexical richness of English writing, specifically in terms of lexical variability, complexity, and density.

5.1.1 Lexical Variability

According to the data in Table 3, there was no significant difference in TTR data between the two groups in the pretest (*p*=0.130). This result can be attributed to the fact that the writing level of the research subjects remained consistent without any specific intervention measures, so there was no significant difference in TTR between the two groups. This may be due to their relatively balanced backgrounds, educational levels, and language abilities before the experiment.

After a nearly 8-week experimental intervention, based on the specific analysis of posttest data, both groups showed an increase in TTR in their writings with the improvement of their English proficiency. This finding is consistent with the findings of Zhu & Wang (2013). However, the growth trend of TTR in the experimental group was significantly better than that in the control group (*p*=0.001), with a mean of TTR of 68.88% in the experimental group compared to 66.33% in

the control group. In addition, compared with the pretest results, the mean increase in TTR in the experimental group (4.05%) was significantly higher than that in the control group (2.74%), indicating a more significant improvement in lexical variability in the experimental group. The above reasons are mainly reflected in the following 3 aspects.

(1) In the experimental group, the researchers used the method of "brainstorming" to guide the research subjects to describe the characteristics of music performance by their own mastered vocabulary, which enabled them to learn many new words from each other. In this process, researchers analyzed the characteristics of music, combined with the vocabulary shared by the research subjects and the relevant vocabulary supplemented by the researchers, to jointly construct a vocabulary network closely related to music. This interactive learning allowed the experimental group members to establish conditioned reflexes more directly and clearly, promoting their memory encoding and retrieval efficiency in vocabulary learning, thereby deepening their understanding of vocabulary. After organizing the vocabulary shared and supplemented by the experimental group members, the researchers applied it to the experimental teaching of the control group the next day. Without music assistance, teaching of the control group only involved mere vocabulary explanations, which led to more difficulties in vocabulary memory for the control group members, as well as difficulty in memorizing synonyms.

(2) The "ambiguity" and the "uncertainty of meaning" in music (Zhang, 2018) stimulated the infinite imagination of the experimental group members, invisibly inspiring them and making them expressive. In this creative environment, the members of the experimental group showed a significant enhancement in their intrinsic creativity and expressive abilities while exposed to music. They drew inspiration from the melodies, rhythms, and harmonies of music and transform them into rich and colorful vocabulary expressions. However, due to the lack of musical stimulation among the control group members, they could only rely on the words given in the writing requirements to stimulate their imagination, which limited their thinking range. Therefore, repeated vocabulary was used more frequently in their writings. Although there might be more tokens (see Table 2), it actually reduced the lexical diversity, thereby reducing the TTR to some extent.

(3) Music stimulation enhanced the experimental group members' memory of synonyms, while the interaction and use of new vocabulary during music training, as well as the their imitation of musical expression methods, motivated them to try using a wider range of vocabulary to describe music and emotions. This training enables them to proficiently use different vocabulary to express the same concepts in writing, resulting in a more significant improvement in the proportion of types and a greater improvement in TTR. However, members of the control group, having not received similar musical assistance, slightly underperformed in vocabulary memory compared to the experimental group. Their writings also tended to employ a less rich vocabulary, resulting in less significant improvement in TTR compared to the experimental group.

5.1.2 Lexical Complexity

The data in Tables 4, 5, 6, and 7 clearly demonstrates the differences in lexical complexity between the two groups. The data indicates that there is no significant difference in lexical complexity between the two groups in the pretest (p=0.944, p=0.756, p=0.718, p=0.937), but the posttest data shows that the mean proportion of high-frequency words (word list 1) and secondary high-frequency words (word list 2) in the two groups shows a decreasing trend, while the mean proportion of low-frequency words (word list 3, word list 4) in the two groups shows an increasing trend.

This indicates that after training, the two groups gradually reduced their dependence on common vocabulary in writing, began to seek more diverse ways of expression, and used more of these vocabulary to express more complex meanings and ideas. This aligns with the finding of Bao

(2008), which indicates that lexical complexity increases linearly as learners' proficiency level improves. Additionally, this is also consistent with the research conducted by Wan (2010), which shows that as training progressed, the English proficiency of the research subjects improved, and the lexical complexity in their writings also increases.

However, the posttest data shows significant differences between the two groups (p=0.000, p=0.017, p=0.000, p=0.011), and the experimental group outperformed the control group notably with respect to reduced mean value proportions in both word list 1 and word list 2, as well as increased mean value proportions in word list 3 and word list 4. Specifically, the experimental group showed a mean decrease of 7.87% and 3.32% in word lists 1 and 2 respectively, and a mean increase of 5.63% and 5.56% in word lists 3 and 4 respectively. In contrast, the control group showed a mean decrease of 4.38% and 1.86% in word list 1 and word list 2 respectively, while the mean increase in word list 3 and word list 4 was 2.57% and 3.67% respectively, both of which were smaller than the mean decrease and increase in the experimental group. The above reasons are as follows.

Due to the stimulation of music, the experimental group were able to effectively combine their learned vocabulary with music and performed better than the control group in memorizing low-frequency words. It can be seen that music training significantly improves students' vocabulary application ability, not only reducing excessive dependence on high-frequency words, but also increasing the use of low-frequency words and uncommon words, thereby improving lexical complexity and depth of expression. This transformation enriches students' lexical awareness, enhances their expression ability, and enables them to express ideas and emotions more accurately and vividly. The experimental group members studied music and carefully analyzed the content of the melodies and scores. They jointly improved their understanding of emotional expression through vocabulary sharing among peers and researchers' explanations of advanced vocabulary. This learning method promotes the accumulation of low-frequency words and enables the members to effectively apply these words to writing, thereby increasing the lexical complexity.

5.1.3 Lexical Density

The data in Table 9 clearly shows the differences in lexical density (LD) between the two groups. Tables 11, 13, 15, and 17 respectively show the differences in the proportions of noun, verb, adjective, and adverb changes between the two groups. The data shows that there is no significant difference in the mean proportion of LD between the two groups in the pretest (p=0.072). There was also no significant difference in the mean proportion of nouns, verbs, adjectives, and adverbs in the pretest data (p=0.490, p=0.903, p=0.521, p=0.122). However, the posttest data shows that the mean proportion of LD, verbs, adjectives, and adverbs in both groups shows an upward trend. At the same time, the mean proportion of nouns in the experimental group shows a downward trend, while the control group shows an increase but the growth is not very significant.

From the posttest data, there is a significant difference in LD between the two groups (p=0.020), and there are also significant differences in the data of nouns, verbs, adjectives, and adverbs between the two groups (p=0.034, p=0.013, p=0.000, p=0.001). This indicates that there is a significant difference in vocabulary usage ability between the two groups after training. These results indicate that the experimental group significantly improved their ability to accurately select and apply content words in writing through music training, while the control group's improvement in vocabulary usage was not as significant as the experimental group's. Regarding LD, the mean increase in the experimental group was 6.09%, which is higher than the 4.84% increase in the control group. Regarding verbs, the average increase in the experimental group is 2.98%, which is greater than the 1.61% increase in the control group. Regarding adjectives, the mean increase in the experimental group is 3.24%, which is greater than the 1.55% increase in the control group.

Regarding adverbs, the mean increase in the experimental group is 2.15%, which is greater than the 1.21% increase in the control group. However, regarding nouns, the mean decrease in the experimental group is 1.62%, while the control group shows an increase of 0.56%. The above factors are primarily demonstrated across three key dimensions.

(1) The number of nouns of both groups has increased (see Table 10). However, through a detailed analysis of the "Sub-corpus E2" and "Sub-corpus C2", the researchers found that the experimental group members had lower noun usage rates than the control group members. This is because music training stimulated the creativity and imagination of the experimental group members, enabling them to avoid repeating noun phrases in writing and instead seek more diverse vocabulary to express the same or similar concepts. For example, members of the experimental group tended to use the word "aspiration", while members of the control group chose phrases like "aim and dream". Therefore, the intentional inspiration brought by music to the experimental group members enabled them to use different nouns more flexibly in writing, reducing the repetition of nouns and improving the overall quality and diversity of expression of the text.

(2) The number of verbs in both groups has increased (see Table 12). However, from the posttest "Sub-corpus E2" and "Sub-corpus C2", it can be found that the experimental group members were able to write more sentences such as "Success will ultimately embrace us." and "This moment will be forever engraved in my heart." than the control group members. These metaphorical words (embrace, engraved) indicate the dynamism of music, such as rhythm, chord changes, tone changes, etc., which helps cultivate students' metaphorical and symbolic thinking. Music often involves metaphorical and symbolic expressions, which helps students transfer this way of thinking to writing, using more complex vocabulary with metaphorical meanings, not only enriching the expression of the text, but also increasing the artistic and depth of language.

(3) The number of adjectives and adverbs in both groups has increased (see Tables 14 and 16). However, further analysis of the "Sub-corpus E2" and "Sub-corpus C2" in the posttest revealed that the adjectives and adverbs used by the experimental group members were more precise and delicate than those used by the control group members. For example, the experimental group members were able to use low-frequency words such as "arduous" and "strenuously", while the control group members used more high-frequency words such as "difficult" and "tough". In addition, the experimental group students showed more flexibility in converting adjectives into adverbs or vice versa, while the control group students had relatively less application in this regard. What's more, the experimental group members tended to use more various types of adjectives and adverbs than those in the control group, who used relatively more repetitive adjectives or adverbs. All these show that music is an art form of emotional expression. In music training, students often need to understand and express emotional changes in music, which helps them to use various adjectives and adverbs more delicately in writing to express emotions and atmosphere.

5.2 Discussion on the Influential Mechanisms of Music Training on the Lexical Richness of English Writing (RQ2)

Based on the above research findings, we can conclude that music training has a positive effect on enhancing lexical richness in English writing, specifically manifested in the research subjects from the experimental group using a more diverse and low-frequency words in their writing. By analyzing past research, experimental procedures, result data, and follow-up interviews with participants, the mechanism by which music training improves lexical richness in English writing may include the following three aspects.

(1) The synergistic effect of the left and right brains. Some researchers who used brain imaging technology (e.g. EEG, fMRI) have revealed the phenomenon of functional lateralization in the

brain, where specific brain functions are primarily executed in one hemisphere (Sun, 2017). In other words, the left brain shows advantages in language processing, reasoning, and judgment, while the right brain is more prominent in music comprehension, creativity development, and memory functions. Additionally, studies have found multiple intersections between the brain's processing areas for music and language (Liu et al., 2022). Based on these findings, it can be argued that music training effectively stimulated the creativity and working memory of the right brain, which helped the research subjects in the experimental group to use vocabulary more flexibly and innovatively in English writing, and to memorize English words and phrases more efficiently. At the same time, music training further enhanced the language processing and reasoning abilities of the left brain, enabling them to understand and use vocabulary more precisely in the writing process, and to better infer the meanings conveyed by music, thereby selecting more appropriate vocabulary and expressions. Thus, music plays a mediating role (Cores-Bilbao et al., 2019), acting as a bridge connecting the two hemispheres of the brain, promoting harmonious collaboration between them, and enabling research subjects to more effectively draw from a rich vocabulary bank when writing in English.

(2) Behaviorist Theory. According to Behaviorist Theory, music training provides intuitive and repetitive stimuli through rhythm, melody, and other features, which can form conditioned responses when associated with specific vocabulary. Guided by it, music training helps learners establish a stable connection between vocabulary and musical features through repetition and reinforcement. When research subjects in the experimental group were exposed to specific music, they could naturally associate it with related vocabulary. This associative memory mechanism aided them in effectively recalling and using the learned vocabulary in English writing, thereby enhancing lexical richness. Music training involved repetitive practice and patterned learning, which helped them form stable conditioned responses by associating musical features with new vocabulary, thus better understanding and remembering new words.

(3) Emotion and motivation. Music training not only enhances the perception and expression of emotions but also improves the precision of vocabulary selection and the expressiveness of the text in English writing. This ability allowed research subjects in the experimental group to express emotions more profoundly in their writing, as evidenced by the more frequent use of metaphors and analogies, and the innovative application of vocabulary by the experimental subjects. Moreover, the rhythm and melody of music significantly increased the learning interest of them, enhancing their intrinsic motivation and making them more actively engage in the learning process. Therefore, music training not only strengthened their perception and expression of emotions, but also stimulated their intrinsic motivation, leading to a more proactive exploration and use of new vocabulary in English writing.

5.3 The Methods to Integrate Music Training into the Teaching of English Writing Vocabulary (RQ3)

The findings from the above study suggest that engaging in music training enhances the lexical richness of English writing. According to the research procedures and results, music training can be integrated into the teaching of English vocabulary in writing from the following 3 aspects to enhance effectiveness of students' vocabulary acquisition (Kumar et al., 2022), thereby improving the lexical richness of English writing.

(1) Lenovo memory method. Teachers can integrate music theory into vocabulary teaching, such as explaining music symbols, performance techniques, etc., and guide students to describe these features by mastered English vocabulary, and then introduce new words to learn relevant vocabulary. By linking vocabulary with musical features, associative memory is generated,

forming conditioned reflexes. For example, in learning the new words like "successive" and "diversity", students can first listen to an arpeggio and describe its characteristics by mastered English vocabulary, such as "continuous sound with different notes", "all kinds of notes with the sound", etc., thus guiding students to learn new words. Therefore, when students hear arpeggios again, they are more likely to associate them with newly-learned vocabulary, thereby deepening their understanding and memory of the vocabulary.

(2) Method to stimulate imagination. Teachers stimulate students' creative thinking by playing an inspirational piece of music, encouraging them to fully utilize their imagination through the "ambiguity" and "uncertainty of meaning" of the music (Zhang, 2018). They are prompted to describe the specific images, scenes, or even a vivid stories that emerge in their minds in detail. For example, when a teacher plays a melodious melody, students may imagine a vast and boundless sea, and then vividly describe these mental images in English. This process not only exercises students' language expression ability, but also promotes their deep understanding of music emotions, enhances their imagination, and enables them to achieve an organic combination of sensibility and rationality in the process of English learning.

(3) Emotional experience method. Teachers can use music appreciations to allow students to experience the emotions and values expressed in music, encourage them to express their emotions in English, and encourage them to use rich vocabulary and sentence structures. For example, teachers can choose a piano piece full of sadness and ask students to write a paragraph in English after listening. This not only depicts the emotions of sadness, but also attempts to capture the subtle emotional changes in the music, such as melancholy, loss, or contemplation, so as to achieve a deep integration of emotions and language in writing.

6. Limitations and Future Research

Based on research findings, the two groups showed an improvement in lexical variability, complexity, and density after the experiment, and there were significant differences between the two groups. However, this research also has some limitations. Firstly, the number of research subjects was relatively small, with only 40 research subjects tested, which is insufficient for drawing more universal conclusions. Secondly, this study only focuses on freshmen, whose English proficiency was at the average level, so it is not yet possible to determine to what extent the research results will affect other grades or students with different English proficiency levels. Thirdly, the selected music type for the experiment is relatively single, only involving absolute music and not including music with lyrics, which limits the wide applicability of the experimental results. Fourthly, some participants in the interview believed that music training is more suitable for economically and educationally developed areas, so there may be implementation difficulties for underdeveloped areas. Fifthly, the selected writing themes only involve imaginative prose writing, and it is unclear whether music training is effective for writing other types of themes. In addition, this teaching method necessitates a profound knowledge of musical literacy and theory from educators, as well as a judicious allocation of time and effort between music learning and English learning. Therefore, based on the results and limitations of the research, future studies can be conducted from the following five aspects:

(1) Expanding the sample size. To improve the universality and reliability of the research, the first consideration should be to increase the sample size to cover students from different regions and levels, including middle and high school students as well as students from other academic stages.

(2) Exploring the influence of different types of music on the lexical richness of writing.

Further research can be conducted on the specific effects of various music genres, including Chinese folk music, classical music, vocal music, etc., on the lexical richness of writing to verify the effectiveness of music training.

(3) Exploring the influence of music training on metaphorical and rhetorical dimensions of writing vocabulary. Future research can further explore how music training affects metaphorical and rhetorical techniques in writing. By analyzing students' writing samples before and after music training, researchers can reveal the specific role of music in improving writing quality.

(4) Diversification of writing themes. In future research, the effects of combining music with different writing themes can be explored. For example, reading continuation writing is an effective writing method that stimulates students' imagination and creativity through music, thereby enriching their writing vocabulary.

(5) Long-term tracking. Researchers can attempt to conduct long-term tracking studies on the research subjects to observe the sustained influence of music training on the lexical richness of English writing. Through long-term tracking of students' development, we can more accurately understand the role of music training in improving the lexical richness of writing, and provide strong support for educational practice.

7.Conclusion

This study investigated whether music training had a positive influence on the lexical richness of English writing by conducting 15 music training sessions over a period of nearly 2 months on 40 research subjects (20 in experimental group and 20 in control group). Based on the above findings, music training has a positive influence on the lexical richness of English writing, and overall enhances the lexical awareness of the research subjects (Kumar et al., 2022). Especially in music appreciations, the intuitiveness of music helped students learn vocabulary from each other and consolidated their vocabulary. At the same time, the "ambiguity" and "uncertainty of meaning" in music (Zhang, 2018) stimulated the imagination and creativity of the experimental group members, prompting them to more consciously transform the features and details perceived in music into written expression, thereby helping to enhance their vocabulary expression ability. Although conventional English teaching improved the lexical richness of the control group to some extent, the improvement in the control group was relatively limited compared to the progress made by the experimental group. Therefore, incorporating music elements into the teaching of writing vocabulary can have a positive influence on enhancing students' lexical richness of writing.

Upon investigation, the results of the interviews show that 27 research subjects generally believed that music brought positive emotions and motivation. For example, a member of the experimental group stated, "Music can stimulate emotional resonance and drive emotions, creating a strong emotional experience during the listening process. If this emotional experience is transformed into words, it will make writing more infectious." From the perspective of the Affective Filter Hypothesis from Krashen, pleasant background music can reduce students' anxiety, improve concentration, weaken emotional filters, reduce cognitive load, and enable students to learn in a relaxed atmosphere, which is more conducive to language knowledge input and absorption. Meanwhile, the "Music Mediated Language Learning Experience (MeLLE)" suggests that music can help learners improve their social and emotional skills, such as enhancing cooperation, improving self-efficacy, and enhancing mediation abilities, thereby further enhancing learning outcomes and creating a positive learning environment (Cores-Bilbao et al., 2019).

In view of the limitations of this study, future research will be able to comprehensively and deeply understand the role of music training in the teaching of English writing, so as to provide

more effective teaching strategies.

Acknowledgment: we sincerely appreciate the institution's financial support, the full participation of participants, and the valuable suggestions provided by the reviewers for this research.

Funding: this study was supported by grant from 2024 Sichuan International Studies University Key Discipline Graduate Research Innovation Project "Study on the Influence of Music Training on the Lexical Richness and Accuracy of English Writing (SISU2024XK103)".

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Appendix I

Interview Questions and Some of Answers for the Experimental Group

Questions	Answers (Examples)
1.During the experiment, did you feel any specific benefits of combining music training with English writing?	A12: Yes. Music has melody and rhythm, which can help me express sentences more smoothly and completely during the writing process. Through music training, I can experience the emotions that need to be conveyed in music, and also increase strong emotional expression in writing.
2.Do you think the combination of music training and English writing is	A5:Yes. English learning is a continuous and long-term lifelong learning, and music is also something that can

sustainable in practical applications? Please explain your reasons.	accompany people throughout their lives. It is feasible to combine the two and apply them in practice, for example, learning a song and a few words every day, and the accumulated gains over time will be enormous.
3.What challenges did you encounter during the experimental process? Please provide a detailed description and explain how you overcame these challenges.	A3: The main challenge I encountered during the experiment was how to balance the schedule of music training and English writing. Due to the fact that both require a significant amount of time and effort for learning and practice, I need to develop a reasonable study plan and strictly adhere to it. To overcome this challenge, I adopted a time management approach by dividing my daily study time into different stages and assigning them to music training and English writing tasks. At the same time, I also use my spare time to review and consolidate the learned content to improve my learning efficiency.
4.What influence do you think music training has on the lexical richness of your English writing? Please provide specific explanations.	A2:There is a positive influence. For example, when listening to the song "My Glorious Moment", I can associate it with my own experiences and use more vocabulary when writing. I can also learn and accumulate English vocabulary from other classmates.
5.Do you think music training has a positive influence on your English writing vocabulary, emotional expression, and style? Please provide examples to illustrate.	A11:Yes. When I listened to a soothing song, the emotions I expressed were more gentle and reserved; whereas with an energetic, rhythmically strong, and fast-paced piece, the emotions I displayed were more intense, excited, and exuberant. Also, depending on the style of the music I listened to, I also accordingly adjusted the choice and application of my vocabulary.
6.Which procedures do you think are effective in improving vocabulary richness in music training? Please give some examples.	A4: I think both music appreciation and music theory are effective in improving lexical richness, because music appreciations are about studying the imagery, emotions, and values conveyed by music. It contains a lot of content, and vocabulary also increases accordingly. Moreover, there is a lot of room for expansion in appreciations, and I can also see other members' ideas, learn more vocabulary from them, and expand my vocabulary. Music theory can also learn various types of adjectives, verbs, etc., and explain them to us most directly.
7.Would you be willing to recommend the method of combining music training with English writing to others? Please explain your viewpoints.	A11: I am willing to recommend it. Firstly, the method of combining music training with English writing can greatly enhance skills. It fosters creativity in writing, preventing it from becoming too formulaic. Additionally, integrating music with writing also adds a sense of fun and innovation to the process. I believe it is an excellent method.

8. What is your summary or outlook on the influence of music training on the richness of English writing vocabulary? Please explain your viewpoints.	A5:The combination of the two is undoubtedly very beneficial for both language and music enthusiasts. If learning can start from one's hobbies, engaging with the music that learners enjoy, it might be more effective. That is to say, enriching the integration of the two offers undeniable benefits for those passionate about language and music. By beginning with personal interests and using the learners' favorite music as a starting point, we might achieve better results. In other words, enriching teaching with music, expanding vocabulary learning, and broadening the scope of study can lead to greater rewards. A15: Although this teaching method is fun, in reality, it might only be feasible in economically developed areas. In less developed regions, one might need to consider how to incorporate music into English teaching.

Appendix II

Interview Questions and Some of Answers for the Control Group (After Music Training)

Questions	Answers (Examples)
1.How do you evaluate your writing performance in terms of lexical richness after completing 15 writing experiments without music training?	B3: I noticed that my writing performance was limited in terms of lexical richness. I tended to reuse familiar vocabulary rather than exploring new or more precise expressions. Although my writing vocabulary has improved to some extent, there was clearly still a lot of room for improvement. I realized that I need more strategies to expand my vocabulary.
2.During the experiment without music	B9: Yes. For example, when writing, I find myself

training, did you encounter any challenges, especially those related to vocabulary selection and use?	frequently repeating the same vocabulary, resulting in a lack of diversity and richness in the article. And I have found that without music as a memory aid, it becomes even more difficult to remember newly learned vocabulary, which affects my ability to use these words in writing.
3. After receiving a music training session, how do you feel that this experience is different from the previous writing experiment?	B12:I have deeply experienced the tremendous benefits that music brings. During the first experiment, the traditional method of learning English vocabulary exerted considerable pressure on me; it lacked individuality and had obvious limitations in fostering imagination. I clearly felt my ability to translate visual and sensory experiences into English words becoming increasingly numb. When I attempted to make such a translation, I found my vocabulary repository nearly empty, unable to accurately reproduce the scene before my eyes. In the music experiment, being exposed to a variety of musical styles brought me more enjoyment in learning vocabulary, and memorizing words became easier, with twice the result with half the effort. At the same time, it also stimulated my imagination, allowing me to engage in writing more creatively.
4.During the music training process, what specific activities did you find helpful in enriching your writing vocabulary?	B1: The teacher's explanation and description of the song, as well as the section where everyone expressed their own opinions during class, were very effective in improving my writing vocabulary.
5. Can you give examples of new or richer vocabulary used in your writing after music training?	B7: Sure. For example, when I leaned the staccato, I felt a dynamic beauty, and I would think of the little cat jumping around, which also reminded me of the word "bounce" that I have learned in the music training. However, before the music experiment, if I were to describe this word, I might only think of "jump".
6.How do you think music training has influenced your understanding and expression of writing themes?	B10: For example, I can gain a more intuitive understanding of why the composer created this piece of music, or what emotions it expresses. In terms of style, listening to music and expressing imagery greatly stimulated my imagination. The scenes that come to mind or come to mind make me boldly write them down on paper, evaporating my imagination. When listening to music and writing, I also have some emotional resonance with composers. Therefore, music training has allowed me to learn more emotional words and helped me better understand writing themes, especially in terms of emotions.
7.Would you be willing to recommend the method of combining music training with English writing to others? Please explain your viewpoints.	B4: I am very willing to recommend this method because I believe I have made significant progress in my English writing skills. Through this learning method that combines music, I not only feel relaxed and happy during the learning process, but also develop a strong interest in English composition. This method has allowed me to conceive and express myself more freely, while also enhancing my creativity and

	language proficiency. I believe that such a learning experience can greatly stimulate everyone's enthusiasm for English composition, allowing more people to make rapid progress in English writing while enjoying music, thus generating a more comprehensive and in-depth interest in English learning.
8.What is your summary or outlook on the influence of music training on the richness of English writing vocabulary? Please explain your viewpoints.	B1: I support using music training as a method to improve the richness of English writing vocabulary. I think this method is very beneficial for improving vocabulary richness, and it allows for an immersive experience of that emotion without being speechless. B7: This is a very good way to learn English. I think it's a good idea to implement happy English teaching, and it will also be of great help to me in my future English learning process. I will also try to try this good learning method.