The Teaching Method of STEAM Education-based Audio-visual Aesthetics in College Vocal Music Teaching

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Abstract: *This study explores the effect of the STEAM teaching method on college music education and its impact on students' audio-visual aesthetics. The research was conducted over one semester with 60 undergraduate students in China, randomly divided into two groups: a traditional music appreciation course (n=30) and a STEAM-integrated course (n=30). The traditional course followed the original curriculum, while the STEAM course involved a collaborative approach with teachers from multiple disciplines, who tailored the curriculum based on the music creation context and song lyrics. Using the folk song Chengdu as a case study, the study assessed students' abilities, learning methods, disciplinary engagement, and teachers' perceptions through observation, questionnaires, and interviews. The findings indicate that, compared to the traditional course students, those in the STEAM course were better able to engage with interdisciplinary knowledge, adopt diverse learning strategies, deepen their understanding of the material, and enhance their aesthetic appreciation. Teacher interviews revealed high satisfaction with the performance of students in the STEAM course. Additionally, the study offers strategic insights into the role of audio-visual aesthetics in music education. The multi-disciplinary STEAM approach significantly enhanced classroom participation, improved music learning outcomes, broadened students' knowledge base, and fostered greater aesthetic development, making it a promising model for future music education.*

Keywords: *STEAM education; vocal music teaching; audio-visual aesthetics; music appreciation; course design*

1. Introduction

With the continuous development of world science and technology, cultivating talents with creative thinking ability is extremely important for the long-term development of society and the country, which puts forward significant requirements for the training of talents. Nowadays, school education began to pay attention to classroom integration concept and new curriculum concept, and take this as a standard to cultivate talents, always pay attention to the changes in students' learning state, follow the development of students themselves, and carry out personalized education courses suitable for children on this basis.

STEAM education concept was proposed by American scholar Jacques Man based on STEM education when studying comprehensive education [1]. That is, Art is integrated into the original four disciplines of science, technology, engineering, and mathematics to make the concept more comprehensive and help students understand the relationship among various disciplines from different perspective and promote the development of students' creative thinking [2]. "Art" here refers not only to art, but also to humanities, history, philosophy, and other disciplines. STEAM education is developed based on STEM and is a change to traditional educational concepts [3]. It emphasizes the importance of knowledge and competence, and closely links learning, life, and practical experience, which play an important role in fostering innovative talents and improving international competitiveness [4].

STEAM education plays an important role in students: (1) Interdisciplinary and integration: The traditional Chinese classroom teaching model is divided according to subjects, while STEAM education emphasizes the comprehensive education of multiple subject integration [5]. It is emphasized that the concept of interdisciplinary needs to link knowledge with topics, and that a complete knowledge framework needs to be formed, focusing on issues rather than a single discipline, and using expertise from each discipline to improve students' comprehensive ability to solve learning and life problems [6]. (2) Experience and situation: Situational learning can help students to gain a more real sense of

experience, which is conducive to improving students' interest in learning [7]. Situational teaching in the classroom allows students to gain knowledge while they are happy in situational learning, and ultimately to gain the joy of learning over accomplishment [8]. (3) Design and cooperation: First, teachers should develop corresponding teaching plans and programs to guide students to actively participate in the classroom according to the set educational methods [9]. In practice, students are guided to cooperate with each other, unite collective wisdom, reasonably divide labor, exercise their cooperation ability, and allow students to enjoy this cooperation model [10]. (4) Regression: Regression means that the curriculum should be able to reflect. The proposal and practice of STEAM education gradually highlight the value of reflection. In terms of curriculum content, STEAM education provides students with interesting knowledge of subject integration and STEAM-related resources inside and outside schools; in the implementation of courses, attention is paid to students' dominant position, so that students actively participate in the learning process, cultivating students' creative thinking and innovation capacity [11].

Under the influence of the traditional concept of "test-oriented education", the curriculum of some schools is futile and still dominated by teachers, and the integration of students' practical ability and knowledge disciplines is not universal. Teachers are also limited to teaching knowledge in textbooks. They have no access to practical problems in life and other disciplines [12]. With the new curriculum reform vigorously promoted and advocated, music has received more and more attention, its teaching model has become more comprehensive and perfect. Although teachers can carry out rich classroom activities and create situations in the classroom, it will be found that students' happiness is only a moment [13]. After learning, the humanistic knowledge they really master is very weak, and the true meaning of the song is not deep enough, so there is no real integration [14]. STEAM education in China is being continuously implemented, schools comply with the new trends of education and comprehensively carry out subject integration learning. In order to adapt to the general direction of national education, many schools are trying to carry out interdisciplinary learning of subject integration and implement STEAM teaching, but they have not really put it into practice. Many schools are still teaching in independent disciplines and essentially do not carry out interdisciplinary integration and teamwork, losing the real significance of STEAM education.

Audio-visual aesthetics refers to the ability of individuals to appreciate audio-visual works [15]. For music majors, audio-visual aesthetics is one of the basic reasons that affect the learning effect. If students do not have basic aesthetic ability in the process of learning music, it is difficult to understand the charm of songs [16]. Only regular independent thinking of songs can produce more musical beauty. Therefore, independent thinking is an important part of audio-visual aesthetics [17]. In order to cultivate students' independent aesthetic ability, teachers should not only teach students basic aesthetic knowledge, but also cultivate students' aesthetic experience, give students more time to think, and feel the uniqueness of different song types and the music creation of different authors [18].

However, in terms of the current actual teaching situation in many colleges and universities, teachers are still unable to strengthen students' audio-visual aesthetics, and still teach according to the original music elective courses, without considering students' feelings, which can't achieve the desired effect [19]. In short, there are still many problems in the music teaching system. Educators should think deeply to obtain practical teaching strategies and optimize the quality of music teaching, so as to ensure that students' music literacy and aesthetic ability are really improved [20]. Multidisciplinary STEAM education was tried to integrate into music teaching. Multidisciplinary teachers revised teaching methods, observed, and investigated the differences between STEAM and traditional music teaching. In addition, combined with the observation in the experimental process, it put forward some strategies of aesthetic teaching methods for reference

2. Study method

2.1 Method overview

Using the method of combining classroom case analysis and online questionnaire survey, STEAM is applied to classroom practice, and combined with examples for analysis and research. Variables such as class and teaching method are added to collect them in the form of questionnaire, and the classroom effect is compared and analyzed after STEAM teaching. Finally, the data are analyzed, the results are summarized and evaluated, and the teaching strategies are discussed combined with observation.

2.2 Study subjects

60 undergraduate students were selected and divided into STEAM group, a traditional music appreciation group. The students in STEAM group were randomly divided into 5 subgroups with 6 people in each subgroup. The reason for choosing college students is that students in this grade basically master the basic knowledge of music and study various courses in junior high school and senior high school. They have knowledge reserves of different disciplines, can better accept and master the learning of comprehensive knowledge, have good learning ability and exploration ability, and have strong curiosity and creativity. Students have a preliminary ability to perceive and express music learning, and can perform under the guidance of teachers. Therefore, it is a good time to adapt to and give full play to STEAM teaching, and have a good ability to process and answer the accuracy of survey data.

2.3 Study protocol

(1) Identifying the study subjects. University students and STEAM music classes.

(2) Selecting study tools. Questionnaires were designed using Wenjuanxing and links were shared to students for completion.

(3) Result analysis. According to the result of data analysis, the influence of music teaching on audio-visual aesthetics of students in college was summarized based on STEAM education concept, the teaching methods and strategies in music teaching were put forward, and the teaching effect was analyzed and summarized.

2.4 Research tools

1) Questionnaire survey method

Relevant data were collected through questionnaire survey, and then the obtained data (attribute) were analyzed, sorted out, and compared. After the implementation of classroom teaching, a questionnaire was designed for students with two different learning methods to obtain the impact and value of the application of STEAM education concept in college music classes, as well as the impact on College Students' audio-visual aesthetics. The data were analyzed and summarized.

2) Observation method

In the process of experimental research, this experiment goes deep into the classroom to observe the learning status of students and the teaching situation of teachers in different classes and lectures. The effect of ordinary music class was compared with STEAM class designed.

3) Case method

In order to explain the concept of STEAM education and the design of STEAM teaching, it selected a relatively successful course case. Steam course design example gave a detailed description of the whole process of teaching.

4) Interview method

Through STEAM classroom practice, the participating teachers were interviewed to summarize the teaching impact of STEAM on students and teachers.

2.5 Steam curriculum design--taking Chengdu as an example

(1) Curriculum implementation framework

The whole experiment process is shown in Figure 1. Students are the main body and teachers are an important part of the experiment. In addition to participating in curriculum design and classroom experience, researchers also conduct interviews and data analysis.
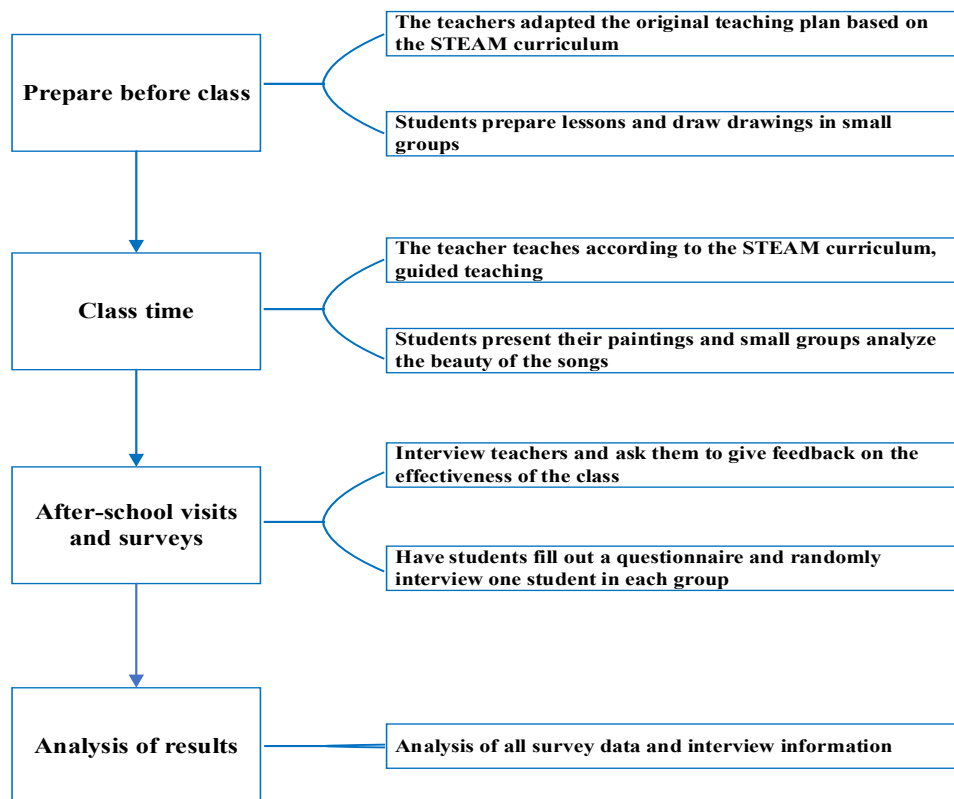
Figure 1: Curriculum implementation framework

(2) Training objectives

According to the *Chengdu*, students realize that the tune and melody of the song are slow, and the lyrics depict many details about Chengdu. The place names such as "Yulin road" in the song are the favorite pubs of many rock and folk musicians. Some ordinary things in life become stories and songs. Without fancy skills and gorgeous words, they naturally reveal their true feelings and inadvertently hit the listener's heart. According to the artistic conception of the above songs, students are guided to understand *Chengdu* in all aspects, combining the methods of drawing a work in a group to explain, so as to cultivate students' perception of the beauty of songs and improve their aesthetic ability.

(3) Course design

Preparation before class: One week before class, students needed to expand their knowledge to understand the basic situation of folk singers, and understand the historical culture, local characteristics, climatic conditions, humanistic geography, and other knowledge of this city in Chengdu. It needed to understand the place names that appeared in songs and drew a painting according to the artistic conception of songs. Statistics was performed on the way by which students get to know this knowledge.

Interpretation in the class: Course 1: At the start of the class, enjoying the song, then each group started to show their own paintings, combining the paintings and the understanding of the song before the class, interpretation was carried out for 10 minutes. Each group made comments. After that, the teacher made comments. Finally, the best group was selected based on the paintings and explanations. Course 2: Learning to sing, at the beginning of the course, appreciating and learning to sing, and then they opened their mouths and sang quietly with their emotions. Finally, the group performed according to the tune of the song. The best group was selected by each group and the teacher. Course 3: Course development, appreciating the songs *Parallel Galaxies* and *the Road of Youth*, understanding the background of the authors and the songs, as well as the key information in the lyrics. The characteristics, beauty, and appreciation of folk songs were discussed and summarized. The flow of three courses is shown in Figure 2.
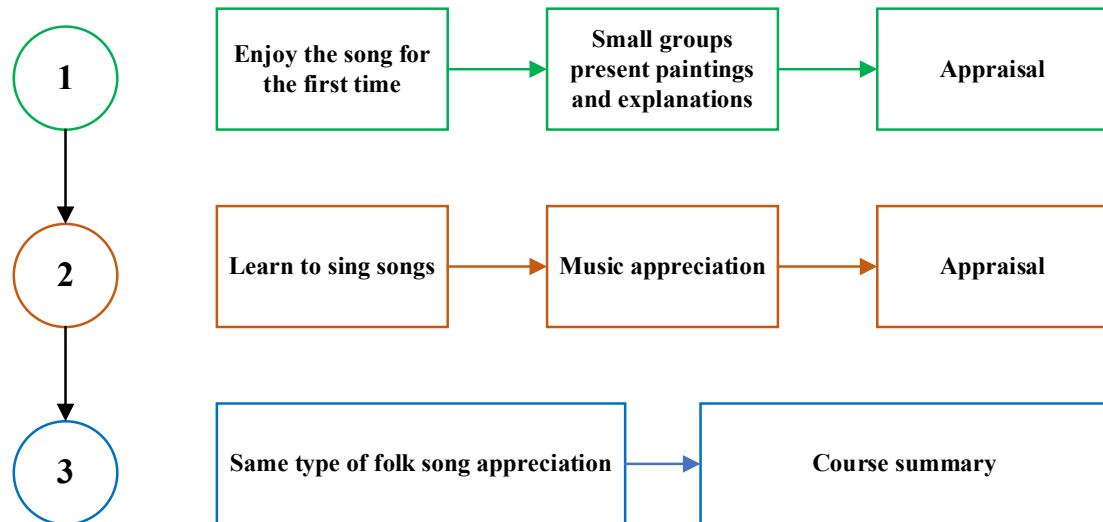
Figure 2: Process arrangement of classroom

After-class interview: Each group gave feedback to the teacher for relevant investigation, mainly including the way to understand the song, the knowledge of other subjects learned through the course, the learning method reflected in the class, and the students' own knowledge improvement.

2.6 STEAM course evaluation indicators--compared with common music appraisal courses

(1) The cross-discipline of music curriculum, and the number of the two groups who learned music, art, natural science, and social science in the curriculum was evaluated.

(2) The learning method of experience in music course, the number of students in the two groups who experienced scientific exploration, communication and display, hands-on production, and rhythmic experience in the course was evaluated.

(3) Ability cultivation through learning, the number of students in the two groups who improved their innovative ability, practical ability, cooperative consciousness, expressive communication ability, and aesthetic ability was evaluated.

(4) Finally, the number of people who liked to participate in the two courses was counted.

2.7 Data processing

All data were analyzed by Excel, measurement data were expressed as mean ± standard deviation ($\overline{x}\pm s$), and enumeration data were expressed as n (%).

3. Study results

3.1 Basic information of investigation results

According to the basic information of the questionnaire survey, a total of 62 people participated in the questionnaire, 15 boys and 16 girls in the ordinary music course group; 17 boys and 14 girls in the STEAM course. One person was excluded from each group due to missing questions, so the number of people in each group was 30 (Table 1). All students were involved in two courses.

Table 1: Statistics of basic information of personnel included in the experiment

Type	Total number	Gender (persons)		Age (years)
		Male	Female	
Ordinary music course	30	15	15	22.14±2.02
STEAM course	30	16	14	21.07±1.98

According to the summary of single choice questions, students of ordinary music class chose group cooperation 0 times, 100%; students of STEAM music class chose group cooperation 1-3 times, 100%. Thus, the STEAM curriculum applies the model of group cooperation well, while ordinary classrooms

do not have the opportunity to cooperate. According to the survey results, 90% of the people like STEAM course, mainly because STEAM course is interesting, there are more opportunities to communicate and cooperate with others, and there are more things they learn, which greatly expands their knowledge. In addition, STEAM course also improves their aesthetic ability to music. Many students said in interviews that they changed their mind about music after STEAM course.

3.2 Statistics of pre-class preparation methods

In the ninth question of the questionnaire, 15 students in ordinary music classes chose other methods, 5 did not perform pre-class studies, 7 used Internet access, 4 viewed books, and 12 watched videos. In STEAM, 20 people chose other methods, 15 people used Internet access, 11 people viewed books, and 16 people watched videos. According to the data analysis of Figure 3, the students of STEAM course have strong independent learning ability and can collect their desired knowledge content through a variety of ways.
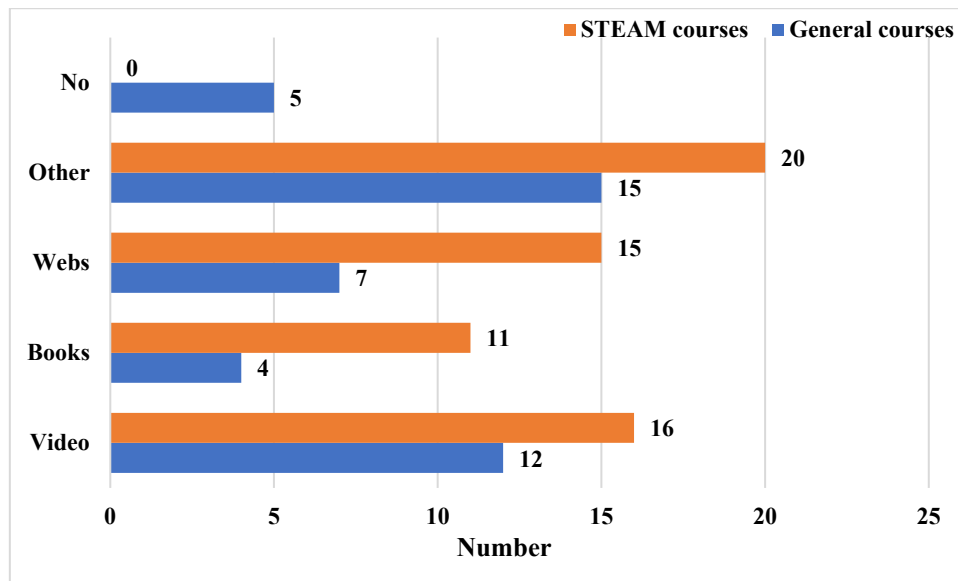

Figure 3: Statistics of pre-class preparation methods
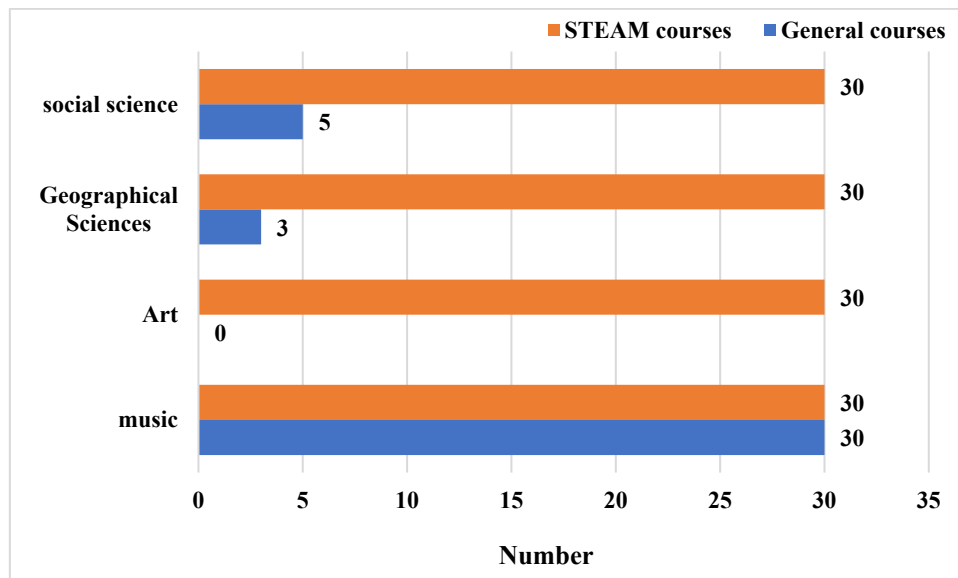
3.3 Cross-disciplinary learning statistics

Figure 4: Statistics of other subjects in different music classes

In the tenth question of the questionnaire, 30, 0, 0, and 5 students of ordinary music class chose music,

fine arts, geographic science, and social science, respectively. The number of students who chose music, fine arts, geographical science, and social science for the STEAM course was 30, 30, 30, and 30, respectively. According to Figure 4, ordinary music classes only have music itself, while STEAM courses integrate multiple disciplines, and multiple disciplines can better promote students' understanding of music content, deepening the learning of music courses.

3.4 Experienced learning methods statistics

In the eleventh question of questionnaire survey, the number of people who experienced scientific exploration, communication and display, hands-on production, and rhythm experience in ordinary music courses was 2, 12, 0, and 30, respectively. The number of people who experienced STEAM courses was 12, 30, 30, and 30, respectively. According to the number of options in Figure 5, it can be found that students in STEAM course have higher classroom participation and can experience various learning methods in many aspects, which well stimulates students' creativity and organizational communication ability.
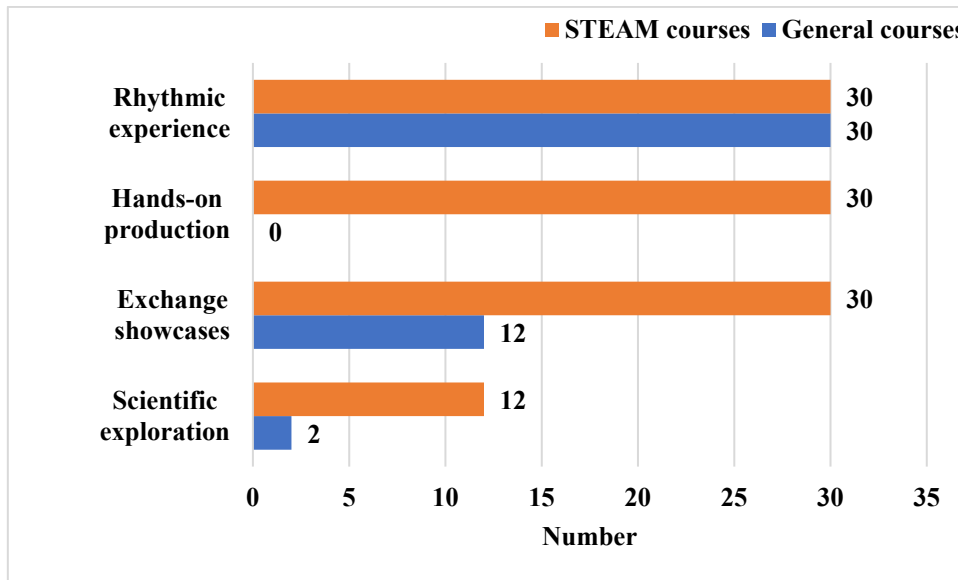

Figure 5: Statistics of learning methods experienced by different music courses

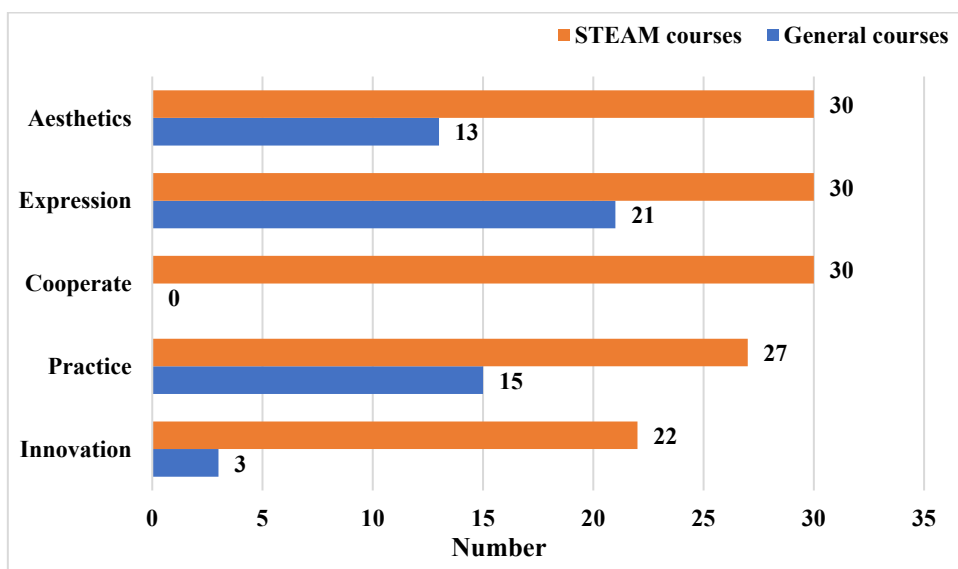### 3.5 Survey statistics on capacity-building

Figure 6: Statistics of two music courses on students' ability improvement

In the 12th question of questionnaire survey, 3, 15, 0, 21, and 13 students in the ordinary course felt

that innovation capacity, practical ability, cooperation consciousness, expression and communication, and aesthetic ability were improved, respectively, while there were 22, 27, 30, 30, and 30 students in the STEAM course. According to the number of options in Figure 6, it is found that STEAM course can improve the comprehensive ability of students, but the role of ordinary course is limited.

3.6 Teachers' feelings about the course

Teachers' interviews were mainly judged from the interest of the classroom, student participation, and the overall effect of the classroom, with a score range of 1-10 points, and the higher the score, the better the evaluation effect. 1-3 points showed the general effect, 4-6 points showed a good effect, and 7-10 points showed a very good effect. Table 2 shows that STEAM course is better than general music course in classroom interest, student participation, and overall teaching effect.

Table 2: Results of teachers' evaluation of ordinary course and STEAM course

	Interest	Participation	Overall effect
Ordinary course	3.54±1.41	2.51±1.73	2.99±1.62
STEAM course	5.15±2.01	6.73±2.23	8.01±3.74

4. Research on teaching methods and strategies

4.1 Students' subject position

Music teaching should be involved in the reform of modern education curriculum as other subjects, and the curriculum should respect the status of students as the main body. From the previous music teaching practice, it is found that the teaching mode with teachers as the core will not have a very good teaching effect. Therefore, music audio-visual aesthetic education should pay more attention to students' feelings about the course. Therefore, in music teaching, the specific audio-visual aesthetic education model should fully take students as the main position. Teachers must find ways to mobilize more students' initiative in the teaching process, so that students are willing to share their unique music aesthetic feelings with classmates and teachers, ultimately promoting students to more actively integrate into the new music teaching classroom.

4.2 Comprehensive improvement of music teachers' appreciation ability

The creation and application of any music teaching mode should be advocated and implemented by music teachers. Therefore, teachers' professional level and appreciation ability are very important. By continuously improving teachers' music appreciation ability, complying with the development trend of music, electro-aesthetic teaching can be carried out smoothly. From the creative point of view, teachers with certain music appreciation ability can correctly guide students in the teaching process, giving students more inspiration and help.

4.3 Integrating STEAM education thought into teaching

In the teaching course, music teachers should try to compile teaching contents with teachers of other subjects, combine STEAM teaching methods, and construct a new educational model by using contemporary advanced and excellent educational concepts and methods. Of course, teachers should cleverly add the knowledge of STEAM disciplines to enrich the original single music teaching content. It can not only help students learn the theoretical knowledge of music courses, but also let students understand more music development and evolution, comprehensively improving students' various abilities and eventually improving music aesthetic ability.

4.4 Using network and media

With the continuous development of social information, receiving knowledge in a variety of ways, music teaching in colleges and universities can not only use the sound equipment in the classroom, but also use video to attract students' attention. In addition, it can use a variety of mobile phone apps and computer music software to create music, which can fully mobilize students' subjective initiative. For example, in STEAM classrooms, teachers often use the story background in songs to make musical drama, or directly cite students' favorite film and television works. This can not only quickly attract students

into the learning state, but also help students more intuitively contact with the aesthetic sense of music, ultimately improving students' aesthetic ability for music.

4.5 Exploring new methods of music teaching

The simple and single teaching mode of ordinary music class will lead students to lack the opportunity to think, and students can't truly experience music. Therefore, teachers of colleges and universities should think about new educational methods to break through the current music education dilemma. In the process of teaching, it should closely follow the trend of the times, with the latest hot spots, hot songs to cultivate students' musical interest. For example, education programs can choose TikTok, Kwai, and other hot short-video background music as the theme of learning, and choose the hot film and television works as the teaching entry point.

5. Discussion

STEAM is an important innovation in educational models. Its advantage lies in the fact that students' interest can be greatly improved in the classroom, and teachers will notice information such as students' shortcomings and demands and discover new educational opportunities from students [21]. In addition, STEAM classrooms are better at integrating students' interests and needs into new educational models [22]. In this experiment, the activities designed by the teachers were scientific and interesting, and the whole teaching process was smooth and natural. In an efficient and interesting classroom atmosphere, teaching goals were perfectly achieved, stimulating students' inner potential, motivation, and enthusiasm.

Vocal art is artistic and practical in real life, and aesthetics are an important foundation in the whole vocal art [23]. However, in general music teaching, vocal aesthetics are often easily ignored by courses, focusing on vocal music technology, which deviates from the nature of music [24]. According to the analysis of music education in many colleges and universities, most non-music colleges and universities do not have music aesthetics theory courses. On the one hand, because elective courses often do not get the number of elective students to open classes, on the other hand, schools and teachers pay attention to music technology, in order to improve students' singing level. Even in the postgraduate stage, students' music courses are basically the same as in the undergraduate stage, which leads to slow improvement of students' overall vocal aesthetic ability throughout the learning stage [25]. Therefore, in the whole music teaching process, special attention should be paid to cultivating student' aesthetic ability, and the concept of aesthetic consciousness should be fully realized in all aspects of teaching, which not only makes students have the correct aesthetic ability, but also greatly expands students' artistic imagination and creativity. It allows students to recognize the true meaning of vocal music, and express the artistic charm of singing through their own understanding [26]. An interview for four teachers in Hong Kong who were engaged in STEAM music education was performed to ask their views on STEAM education: how they performed STEAM in music classes, what they obtained, what obstacles they encountered, and some possible solutions. The analysis of the responses suggests that these teachers reach a consensus that STEAM is the future trend and that it can cultivate students' creativity and thus enrich general skills. In addition to the benefits mentioned above, STEAM education also positively impacts on narrowing classroom learning disparities. However, teachers always face some unexpected challenges: inadequate training of music educators and vague conceptualization. High-quality training sessions for teachers and STEAM meetings are recommended to address these issues. Further studies require comprehensive data to support and investigate more in depth [27]. In addition, Kim tested the advantages of STEAM-based music class for pupils in music class in the third grade. Their project is called iMuSciCA [28]. Andreotti and Frans offered curricular music education that includes physical and engineering fields. They have also achieved good teaching results by establishing horizontal relationships among disciplines [29]. Acan used STEAM teaching methods in biology curriculum to transform proteins and other biomaterials into music using bioinformatics tools, and STEAM methods can bring fun to protein structure education [30]. In order to investigate the role of aesthetic experience in the learning process involved in the integration of art, science, and technology, Mun was able to recognize the limitations of his thoughts after experiments and change thoughts by applying new scientific knowledge and skills [31]. After STEAM learning, compared with traditional music appreciation, there are more and wider selectivity in the choice of tools for pre-learning music courses. The STEAM program is also able to contain other disciplines beyond music, particularly arts and humanities. Teamwork can better integrate students into the course to show themselves, so students' innovation capacity, practical ability, cooperation consciousness, expression and communication, and aesthetic ability have been greatly improved. It is found that the overall satisfaction of teachers with this course is still relatively good, although teachers respond to

STEAM course time spent about 3 times the original music appreciation, and it needs to coordinate multidisciplinary teachers for curriculum design. However, from the performance of students in class, the teacher still thinks it is worthy. Teachers agree that multidisciplinary STEAM music education course can improve students' comprehensive ability, music and other disciplines can interact and promote each other, and has a great role in students' music aesthetic ability. Therefore, colleges and universities should pay attention to the influence of STEAM education on aesthetic ability in vocal music teaching, and it is of great significance to return to the artistic essence in vocal music teaching.

6. Conclusion

Under the situation of continuous reform of modern education and teaching system in China, it is necessary to urgently improve the teaching methods of music courses and recognize the shortcomings of music education. Schools and teachers must give full play to their teaching strength, cultivate students' aesthetic ability and music expression ability through a variety of effective ways, continuously stimulate students' interest in music, promote students to improve their aesthetic ability, and carry forward Chinese excellent traditional culture. Thus, the exploration of music learning mode is of great significance for students' growth. After analyzing STEAM education and ordinary music appreciation courses, this experiment finds that STEAM can improve students' comprehensive literacy and aesthetic appreciation ability. In this experiment, the factors and implementation strategies of audiovisual aesthetic teaching methods are explored in detail, hoping to help improve the music teaching level in colleges and universities in China. Because the number of study subjects is limited, students from more colleges can't be considered. In future research, more students will also be included, and more in-depth and comprehensive research will be carried out.

References

[1] Khine, M., & Areepattamannil, S. (2019). Steam education. Springer, 10, 978-983.

[2] Perignat, E., & Katz-Buonincontro, J. (2019). STEAM in practice and research: An integrative literature review. Thinking skills and creativity, 31, 31-43.

[3] Aguilera, D., & Ortiz-Revilla, J. (2021). STEM vs. STEAM education and student creativity: A systematic literature review. Education Sciences, 11(7), 331.

[4] MacDonald, A., Hunter, J., Wise, K., & Fraser, S. (2019). STEM and STEAM and the spaces between: An overview of education agendas pertaining to 'disciplinarity' across three Australian states. Journal of Research in STEM Education, 5(1), 75-92.

[5] Shen, S., Wang, S., Qi, Y., Wang, Y., & Yan, X. (2021). Teacher Suggestion Feedback Facilitates Creativity of Students in STEAM Education. Frontiers in Psychology, 12, 723171.

[6] Wang, X., Xu, W., & Guo, L. (2018). The status quo and ways of STEAM education promoting China's future social sustainable development. Sustainability, 10(12), 4417.

[7] Fan, Y., Yang, Y., Li, W., Gong, C., & Xie, L. (2020). Exploring STEAM Education Activities Based on Project Production—A Case Study on "the Changeable Road" Project. Research in Education Assessment and Learning, 5(1), 1-14.

[8] Mengmeng, Z., Xiantong, Y., & Xinghua, W. (2019). Construction of STEAM curriculum model and Case Design in kindergarten. American Journal of Educational Research, 7(7), 485-490.

[9] Anisimova, T., Sabirova, F., & Shatunova, O. (2020). Formation of design and research competencies in future teachers in the framework of STEAM education. International Journal of Emerging Technologies in Learning (iJET), 15(2), 204-217.

[10] Newman, J. L., Dantzler, J., & Coleman, A. N. (2015). Science in action: How middle school students are changing their world through STEM service-learning projects. Theory Into Practice, 54(1), 47-54.

[11] Liao, C. (2016). From interdisciplinary to transdisciplinary: An arts-integrated approach to STEAM education. Art Education, 69(6), 44-49.

[12] Herro, D., & Quigley, C. (2017). Exploring teachers' perceptions of STEAM teaching through professional development: implications for teacher educators. Professional Development in Education, 43(3), 416-438.

[13] Kim, O. J. (2018). The effects of music lesson applying the blended learning-based STEAM education on the musical knowledge and STEAM literacy of pre-service kindergarten teachers. Journal of the Korea Convergence Society, 9(2), 217-227.

[14] Bell, J. & Bell, T. (2018). Integrating computational thinking with a music education context. Informatics in Education, 17(2), 151-166.

[15] Howlin, C., Vicary, S., & Orgs, G. (2020). Audiovisual aesthetics of sound and movement in contemporary dance. Empirical Studies of the Arts, 38(2), 191-211.

[16] Millea, J. (2020). Transmedia Directors: Artistry, Industry and New Audiovisual Aesthetics: edited by Carol Vernallis, Holly Rogers, and Lisa Perrott, New Approaches to Sound, Music, and Media, Carol Vernallis, Holly Rogers, and Lisa Perrott, series editors, New York, NY, Bloomsbury, 2020, xvii, 509 pp., $34.95 (paperback), ISBN-13: 978-1-5013-4100-7.

[17] Liu, H. (2022). THE INTEGRATION OF PSYCHOLOGY AND ART APPRECIATION IN AESTHETIC EDUCATION IN COLLEGES AND UNIVERSITIES. Psychiatria Danubina, 34(suppl 1), 488-489.

[18] Baladehi, A. S., & Shirazi, A. (2016). Study of the appropriate and inappropriate methods of visual arts education in the primary schools according to the types of multiple intelligences. Journal of History Culture and Art Research, 5(4), 501-513.

[19] Sochacka, N. W., Guyotte, K. W., & Walther, J. (2016). Learning together: A collaborative autoethnographic exploration of STEAM (STEM+ the Arts) education. Journal of Engineering Education, 105(1), 15-42.

[20] Yuldasheva, N. I. (2021). Formation of art and aesthetic competence in future fine art teachers. ACADEMICIA: An International Multidisciplinary Research Journal, 11(3), 1465-1471.

[21] Berk, S. (2016). Designing for the future of education requires design education. Art Education, 69(6), 16-20.

[22] Harris, A., & de Bruin, L. (2017). STEAM Education: Fostering creativity in and beyond secondary schools. Australian art education, 38(1), 54-75.

[23] Vishio, A. (2015). Empathies of Musical Performance and Understanding. Empirical Musicology Review, 10(1-2), 116-120.

[24] Redman, D. J., & Bugos, J. A. (2019). Motivational factors in adult, auditioned community choirs: The power of aesthetic experiences. Psychology of Music, 47(5), 694-705.

[25] Ng, D. T., Ng, E. H., & Chu, S. K. (2022). Engaging students in creative music making with musical instrument application in an online flipped classroom. Education and information Technologies, 27(1), 45-64.

[26] Borisova, E. N., & Letkina, N. V. (2019). English for professional communication: a project-based approach to teaching university students (a case study of music students). Интеграция образования, 23(4), 607-627.

[27] Ng, S. F. E., & Ng, C. H. (2021). Reports from the Field: Secondary School in Hong Kong Integrating the Spirit of Humanities into STEAM Education. Journal of Learning for Development, 8(2), 456-464.

[28] Katsouros, V. (2018). iMuSciCA-Interactive Music Science Collaborative Activities. Impact, 2018(9), 47-49.

[29] Andreotti, E., & Frans, R. (2019). The connection between physics, engineering and music as an example of STEAM education. Physics Education, 54(4), 045016.

[30] Acan, SC, & Acan, LA (2019). Music Notes To Amino Acid Sequence: A STEAMApproach Tostudy Protein Structure. Biochemistry and Molecular Biology Education.47 (6), 669-671.

[31] Mun, K. (2022). Aesthetics and STEAM education: the case of Korean STEAM curricula at the art high school. International Journal of Science Education, 44(5), 854-872.