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Artificial Intelligence-Assisted Music Learning: A Systematic Review of the Risks and Crises of Higher Music Education

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Abstract

Based on the rapid development of artificial intelligence (AI) technology and its increasing application in music education, we need to understand the application and development trend of AI in higher music education, as well as possible risks and crises. Supported by qualitative research methods, this study focuses on literature review and analysis. This study selects scientific publications to evaluate the influence of AI on all aspects of music learning, to further develop the application of AI in music education. The research in the summary shows that AI can effectively promote students' participation and investment in music learning, enhance the learning experience, increase the number of students and the efficiency of teachers, and improve the supervision, implementation, and evaluation of music courses. It is suggested to further discuss the effective curriculum design or implementation strategy of integrating AI into music education, which is very important for effectively improving the effect of music learning.

Keywords: Artificial Intelligence-Assisted Music Learning; Higher Music Education; Systematic Review; Literature Review

Introduction

With the rapid development of science and technology, it is the latest development trend of global music education to apply a set of science and technology represented by AI to music education (Olvera-Fernández et al.,2023). A common way to define AI in education is any application of AI technology or method in the educational system (Holland,2013). In this study, AI-assisted music learning (AIAML) is defined as any application of AI technology or method in higher music education system.

Previous systematic reviews have examined the use of AI in music education (Holland, 2013) and in higher education (Chu et al., 2022). However, there is no comprehensive review that evaluates the existing research on AIAML in higher music education. Therefore, this paper aims to fill this research gap by analyzing the existing research on AIAML in higher music education.

Higher music education is very helpful in cultivating the comprehensive ability of college students and preparing them for careers other than music (Olvera-Fernández et al.,2023). The application of AI to music education is in response to the recent development trend of global music education. It involves updating traditional methods and replacing them with other methods that are more suitable for this background. However, we often find that these

changes are introduced into schools under the influence of temporary short-term trends, and few studies reflect on why they are doing this, nor do they consider supporting scientific research that is beneficial to learning. Unless the problem is addressed, these changes will remain largely on the surface. For the most common example, digital technology has been widely used in the process of music learning, but it is limited to teachers using PowerPoint to show the content of lectures. This seems to be inconsistent with the expectations of global music education. That is, to build flexible and diverse teaching modes and promote the all-round development of students.

Therefore, it is important to better understand the relationship between AI and music education . Three research questions are presented to guide this systematic review.

RQ1. What is the current situation of AI-assisted music learning in higher music education?

RQ2. What is the main purpose of AI-assisted music learning in higher music education?

RQ3. What is the influence of AI-assisted music learning in higher music education?

Methodology

Literature review is to combine empirical research with theoretical research, and to collect, analyze, and summarize the research on a particular topic. Some cautious procedures are needed to make such an assessment in this study. The comprehensive review compiles the findings from various sources and broadens people's understanding of the subject under study. The research of this review follows eight steps, which are as follows: (1) determining and defining the scope of the research; (2) selecting a database; (3) deciding the keywords for the search; (4) collecting and storing data from the database; (5) selecting articles according to the inclusion and exclusion criteria obtained from the title, abstract, and keywords; (6) extracting data from the selected articles; (7) assessing items; (8) synthesizing and interpreting data. Wefollowed conducted according to the PRISMA (preferred reporting items for systematic reviews and meta-analysis) 2015 flow chart standard, including the number of records collected, filtered and selected (Figure 1).

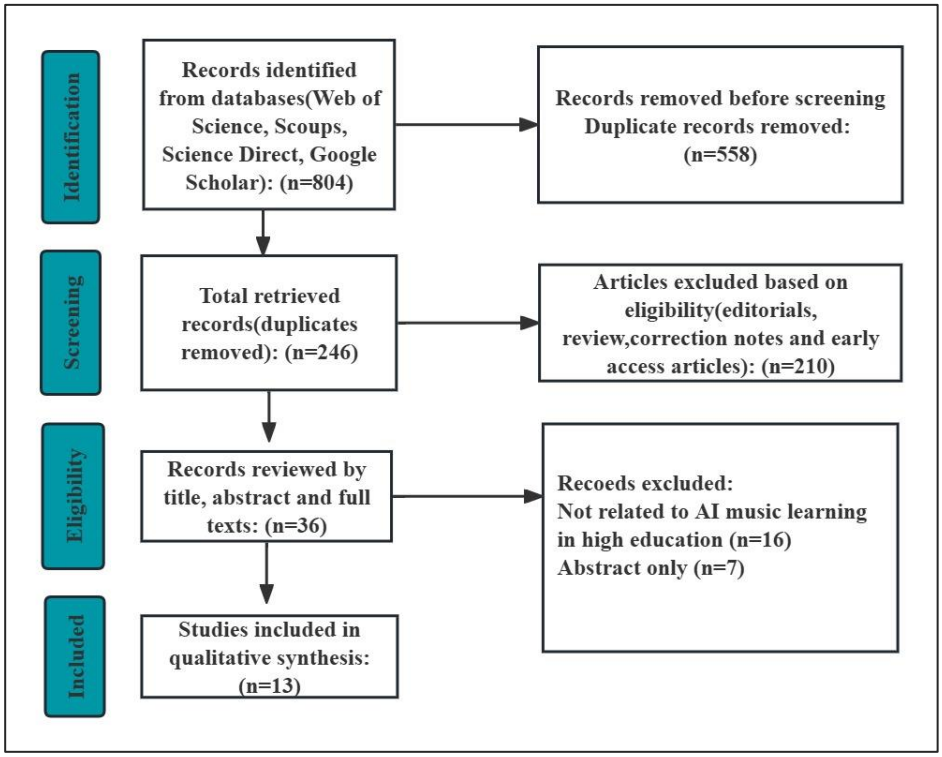

Figure 1. Flowchart of selection, exclusion, and inclusion of studies

It is important to provide higher education institutions, music teachers, and AI developers with a comprehensive

understanding and analysis to help them make wise choices when selecting AI-based music learning in higher music education. We decided to use broad keywords because this field of research is still in its infancy. AI and music learning are two key terms, and the addition of higher education has narrowed the research on academic systems. We use the Boolean operators "AND" and "OR" to connect these phrases to expand and narrow the search space. The Google Scholar, Scopus, Web of Science and Science Direct databases were searched to find the research that met the inclusion criteria.

Inclusion Criteria

The must meet the following criteria to ensure our findings are valid: The articles, written in English, and were published for the period from 2010 to 2024. These studies must be published in peer-reviewed journals. In addition, the participants in these studies must be students at institutions of higher education.

Exclusion Criteria

The samples examined do not include articles that meet any of the exclusion criteria listed below:

a. Only journal articles.
b. Books, non-indexed journals and Conference proceedings.
c. Articles that contain keywords but do not clearly resolve the relationship between AI and music learning.
d. In addition, there are articles with abstracts but no full text and articles whose research subjects are not students of institutions of higher education.

Results and discussion.

After the first search, 804 publications were found (Web of Science:87; Scopus:164; Google Scholar:275; Science Direct:278). Inclusion and exclusion criteria were used in the analysis of titles, keywords, and abstracts. By using this careful method, 13 articles were selected and read in full (Table 1).

Table 1 Information of the reviewed articles (n =13)

Authors	Year	Nature	Primary purpose of study	Study design	Country	Sample size
Jing Wei, Marimuthu Karuppiah, A Prathik	2022	Empirical	Strengthening music education by combining artificial intelligence with music education.	Quasi-experimental design	China	Music students(n=100)
Wang Zhou, YeaJin Kim	2024	Empirical	Improve music learning performance with AI	Quasi-experimental design	Korea	Music students (n=74)

Lv Hua Zhen	2023	Empirical	Improve Music Learning Achievement and Learning Participation by Using AI	Quasi-experimental design	China	Non-music students（n=118)
Chu Xiaoli	2022	Theoretical	Develop a mathematical model for an AI music teaching evaluation system	Simulation experiments	China	Without sample
Wang Xiaoxiang	2022	Empirical	Solve the current problems of insufficient teachers and single teaching tools in music pedagogy reform and realize the sharing of teaching resources.	simulation experiments	China	Without sample
Li Xin	2024	Empirical	Improve music teaching quality and efficiency, offering a novel approach to artistic education and heritage preservation	Quasi-experimental design	China	Music students (n=500)
Mao Qiusi	2022	Empirical	Improve the demand pressure of traditional music on space, music equipment, and funds in the teaching mode, presents a music education model based on the model view controller (MVC) framework structure based on AI technology.	Quasi-experimental design	China	Teacher，students and parents(n=600)
Liu Jie	2022	Empirical	By using emotion recognition as an evaluation index to explore the evaluation role of artificial intelligence technology in college music teaching, and improve the quality and efficiency of music teaching	experimental design	China	non-music students（n=35)

ZhangWei	2024	Empirical	Establish a blended music diversity curriculum in colleges and universities and practical exploration is conducted.	Quasi-experimental design	China	Music students(n=60)
Dai Xiaoqin	2023	Empirical	In the teaching process, automatic arrangement and piano concerto repertoire based on artificial intelligence technology are introduced to assist teachers in teaching; With the help of AI+ professional teachers' collaborative evaluation module, the purpose of cultivating college students' creative thinking in music art is achieved.	Quasi-experimental design	China	Non-music students(n=740)
Wan Lei	2024	Empirical	Based on platform data, this paper makes a correlation analysis of the influencing factors of the learning effectiveness of music courses in colleges and universities and explores the influence of practice times on the learning effectiveness of music courses.	Survey	China	Non-music students(n=1283)
Zhou Xiaoshan	2024	Empirical	Combining advanced technologies such as voice sensing recognition, artificial intelligence and performance robots, it provides students with more convenient, personalized and efficient music learning experience.	Experimental design	China	Without sample
Ji Chen, Tong Meng	2024	Empirical	More targeted teaching to improve the efficiency of students' daily practice.	Quasi-experimental design	China	Non-music students(n=30), music students(n=30)

RQ1: What is the current situation of AI-assisted music learning in higher music education?We analyzed the publication years of the articles from 2010 to 2024. Figure 2 shows the increasing trend of research, indicating that people are more and more interested in the topic of AIAML in higher music education.

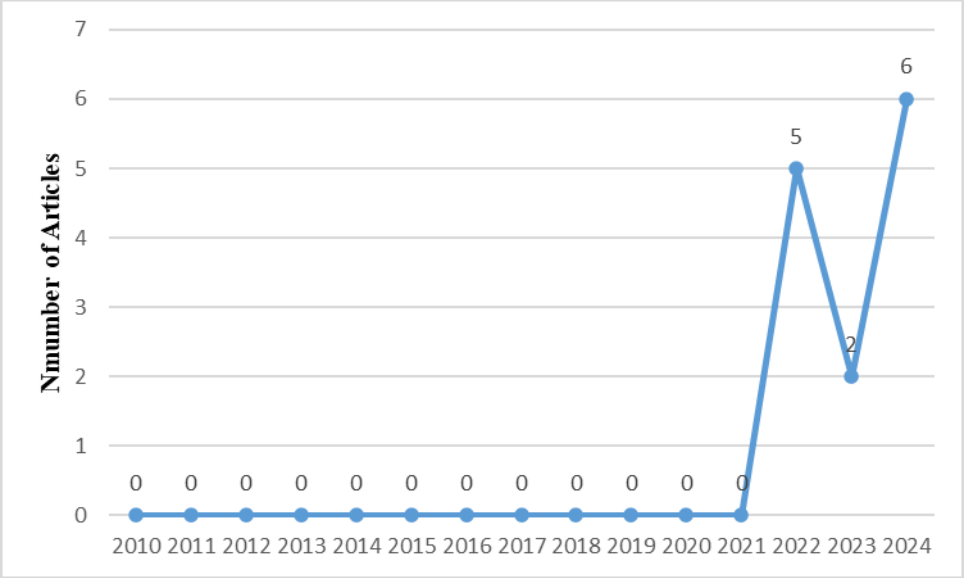

Figure 2. Distribution of articles by publication years.

In addition, all papers (n=11) are written in English, and empirical research (n=12) outnumber theoretical research (n=1). The first authors of these studies are all from China. The sample size of the study ranges from a small study of 35 people to a large study of 1283 people. The sample population consists of music students (n=4), other majors' students (n=5), and no sample (n=3). There is also a research sample consisting of students from other majors and music major(n=1). These studies showed the close relationship between AI and music learning.

RQ2. What is the main purpose of AI-assisted music learning in higher music education?Among the 13 reviewed articles, 2 discussed the improvement of music learning performance, 4 discussed the evaluation of music learning, 2 discussed the promotion of music learning participation, 2 discussed the improvement of music learning efficiency, and 3 discussed the problem of solving the shortage of teaching resources. The purpose of these studies is to strengthen music education by using AI.

RQ3. What is the influence of AI-assisted music learning in higher music education? After reviewing these articles, we found a positive relationship between AI and music learning. Based on these studies, AIAML has some positive effects. It helps to improve learning participation and investment, and effectively supports the whole process of music education, including curriculum implementation and evaluation. At the same time, it can increase the number of students and improve the performance of music learning. In addition, AIAML can also improve the efficiency of teachers and provide personalized teaching services. The pressure on classrooms, music equipment and funds has also been reduced accordingly.AI technology can enhance the learning experience and provide a wider range of hands-on practice opportunities. These platforms and applications are designed to provide personalized courses, exercises, and feedback specifically designed to improve students' musical skills. The interactive function of AI allows students to choose different learning contents according to their own situation. Therefore, the teaching content becomes more diversified and visual, which makes it easier to teach according to students' musical level and improves the efficiency and level of teaching.Its influence on music learning is mainly reflected in six aspects (Table 2).

Table 2 Presentation of viewpoints and references included in the study

The Influence of AI on Music Learning	Reference	Argumentative position
Increase participation and investment in music learning.	Wei et al., 2022; Lv, 2023; Li, 2024; Zhang, 2024	**AIAML can increase participation and investment in music learning.** With the help of AI, students get more opportunities to experience different types and styles of music, from passive learning to active participation (Wei et al., 2022). Students could learn at a comfortable pace, spend more time learning specific materials they like, and re-learn necessary information (Lv, 2023). For example, AI is used to enjoy music. Zhang (2024) built a musical emotion recognition model and set up a mixed music diversity course in higher education institutions. The results showed that the time range of musical emotion perception changes is about 2.5~3.2s, and the success rate of students' recognition of all kinds of musical emotion fragments is over 4/5 with AIAML. It effectively stimulates students' interest in learning and improves the learning efficiency of music teaching. Similarly, a research result by Li (2024) showed that in the teaching of AI and modern music, students' participation has been significantly improved - compared with traditional methods, their understanding and appreciation of music has been improved by 30%.
Effectively support the monitoring, implementation and evaluation of music education.	Wei et al., 2022; Chu, 2022	**AI can effectively support the monitoring, implementation and evaluation of music education.** AI can model, analyze and systematically study the teaching process, and make scientific decisions on the accurate allocation of music education and resources. However, compared with the application of AI in other fields, the amount of data generated in music education is relatively small and not detailed enough, which further limits the application of AI in music education. Ji &Tong (2024) developed an AI piano learning system and realized the intelligent piano teaching mode through intelligent piano music practice design and automatic harmony arrangement design. Through the test, it is found that it can accurately grade students' practice and test the effect of students' practice.
Increase student enrollment and teacher efficiency.	Wei et al., 2022; Wang, 2022; Wan, 2024	**AIAML can increase student enrollment and teacher efficiency.** AI improves the efficiency and durability of music curriculum development and helps to improve the teaching process. AIAML can increase the number of students, shorten the study time, but increase the teaching content and provide more practical experience. Music teachers are the core of the teaching process. AI can maximize teachers' efficiency, present more learning materials and effectively correct students' mistakes within the set time. AIAML ensures the simultaneous arrival of teaching quality and efficiency in the

		classroom and guides and encourages students to integrate step by step. Teachers receive questions on the network console, and then the answers can be forwarded to individual users who receive questions through applications on mobile devices (Wei et al., 2022). However, although there are various auxiliary tools for music teaching, few of them are suitable for music classes. This also highlights the importance of this research and provides a deeper understanding for platform developers. To solve the problems of insufficient teachers and one-size-fits-all teaching methods in higher music education, Wang (2022) designed an AI-based vocal music teaching system. Teachers track students' learning through reasoning and analysis, so that students can learn independently. But overall, in the context of AI learning, the ability of teachers is questioned. Wan (2024) investigated and understood the development and utilization of music curriculum resources in 10 universities in China. The results showed that there are significant differences in the development and utilization of curriculum resources in these schools, especially the poor human resources. Therefore, under the background of AIAML, all educational institutions need to strengthen teacher training and cultivate teachers' diversified teaching skills.
Improve academic performance in music.	Zhou & Kim,2024; Lv, 2023; Li, 2024; Dai, 2023	**AIAML can improve academic performance.** Scholars have discussed the impact of AIAML on music performance. In terms of basic music knowledge, Zhou & Kim (2024) compared the differences between students who used AI to support music learning and those who didnot. As compared with the control group, the experimental group showed more obvious learning results in music knowledge, and the use of AI significantly improved their academic performance by 15%. In terms of musical skills, Li (2024)'s research showed that the differences between the two groups of students under different conditions are compared. The scores of students in the control group in traditional teaching improved by an average of 3-8 points, while the scores of students in the experimental group in musical expression, singing level and musical rhythm improved by an average of 11-18 points after using the AI music teaching system. In terms of music appreciation ability, Dai (2024) adopted a teaching mode based on internet and AI technology, which combines automatic composition, arrangement and piano concerto teaching with AI and collaborative evaluation by professional teachers. Data showed that students who participated inAIAMLimproved their music appreciation skills by an average of 25%. Students' creative thinking skills also improved, and 85% of students demonstrated a high level of innovative composition.

Customize the music experience to meet the specific needs of each student.	Dai, 2023; Zhou & Kim, 2024; Zhou,2024; Ji & Tong,2024	**AIAML can customize the music experience to meet the specific needs of each student.** Music courses are very flexible. Teachers should think about students' learning needs from the students' perspective to adapt to the different developmental levels of students at different stages. Students are the main body of the classroom, and teachers should always pay attention to them. By analyzing students' different preferences, we can optimize the difficulty of the course and stimulate their curiosity and motivation for related courses. Zhou (2024) designed a framework of online music classroom that combines speech recognition and control algorithm to provide targeted feedback and interaction for students. This framework optimizes the teaching of music online classroom. The feasibility and effectiveness of AIAML are verified through experiments and analysis, which provides students with a more convenient, personalized, and efficient music learning experience.
Improve the traditional music education demand pressure on space, music equipment and funding.	Mao, 2022; Liu, 2022; Li, 2024	**AIAML can improve traditional musiceducation anddemand pressure on space, music equipment and funding.** Some studies showed that combining music teaching with AI can effectively reduce the cost of human and material resources. For example, Liu (2022) constructed a music teaching evaluation system based on AI. The experimental results showed that only the use of this system can significantly improve the positive music learning mood of teachers and students. The positive emotion rate of teachers and students based on picture data is 57.8% and 44.5%, respectively. The positive emotion rate of teachers and students based on phonetic data is 53.3% and 51.1%, respectively. The classroom mood is negative in 7 ~ 13 minutes, the classroom mood is still depressed in 28 ~ 40 minutes, and the teachers and students are more positive in 13 ~ 28 minutes. This data provides a reference for the reform and improvement of music teaching mode.

Conclusion

The results of this study showed that AIAML has great potential. As an effective tool, AI can improve students' music learning experience and cultivate their positive attitudes and participation. AIAML has improved students' music knowledge and skills, so they are more likely to accept and adapt to the use of AI in the classroom. These results showed the importance and practicality of using AI in higher education music classrooms. After the introduction of AI in music courses, we observed that not only the level of musical literacy of the students improved, but also their acceptance and enthusiasm for its use. The benefits of AIAML are not only statistically proven, but also evident in evaluation and comparison. It can be used by students to expand the channels of knowledge acquisition and improve their skills at any time, regardless of time and place. Students can benefit from the AI system's ability to simplify and deepen difficult musical concepts.

This study provides valuable insights that can help policymakers make wise decisions about integrating AI technology as a supplemental tool to enhance students' musical education experiences. These resources have the potential to be used in various music education environments, including classroom and non-classroom settings. They are designed to be consistent with the goals and content of formal music courses. This study demonstrates the potential of innovative research on the pressing issue of bringing AI into the higher music education environment. This is a very important issue for governments, educational institutions, teachers and students around the world.

However, the existing research mainly focuses on the development and design of AI technology itself and discusses its influence on music learning. There is still a lack of in-depth understanding, such as effective curriculum design or implementation strategy of integrating AI into music education. Further deepening the discussion of related topics is very important to effectively improve the effect of music learning.

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